

# 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 research is of a qualitative descriptive type. Data from this research was collected through test questions, direct observation, and in-depth interviews on the subject of research. Problems given to students were non-routine, open-ended questions that had more than one solution. The subjects of this study were two students who experienced cognitive conflicts. Based on direct observation, the subjects experienced curiosity, confusion, and prolonged thinking. The results showed that two processes occur when students experience cognitive conflict. (1) Students perform assimilation processes to integrate the perception or new experiences into schemata of the mind. (2) There are three stages of students in the process accommodation: first, the students experience a lack of mastery of the conception they have; then, they create a new conception that is easy to understand; and finally, 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 to students who do not start with a sense of dissatisfaction.

**Key words:** *Student Learning, Cognitive Conflict, Elementary School*

## 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 organize knowledge in the brain) and the environment (e.g., an experiment, demonstration, peer, book, or other); or conflicts between conceptions in cognitive structures (Lee et al., 2003). If a child became aware of the fact that she was holding two opposing views of the situation that are unlikely to both be true, this condition is called a cognitive conflict or disequilibrium. Cognitive conflict is the tension created when new evidence is recognized by students that is 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 in resolving these contradictions, the results are constructive; however, when students are frustrated with or depressed by the contradictions, the results are 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)) advocate for cognitive conflicts as a learning strategy that supports 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). This may include an intense argument over the initial knowledge of students that "rearranges", "reorganizes", or changes 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 be something like: doubt, chaos, contradiction, peculiarity, conceptual, conceptual odds, confusion, and irrelevance. Children in situations of cognitive conflict or who discover a doubt (reaction time) frequently experience anxiety and suspense (Smedslund, 1961). Measuring cognitive conflict in students is done by observing uncertainty levels and stored responses using the same method as Berlyne (Zimmerman and Blom, 1983). Movshovitz-Hadar and Hadass, (1990) measured the expression of students in a state of cognitive conflict through recorded discussions. They said the student expressed passion, curiosity, and an inner impulse to finish, followed by frustration, satisfaction of overcoming an inability to continue, and renewed self-confidence. Researchers have observed doubt, tension, and complete mental barriers in situations of cognitive conflict (Miller, 1944).

As a human being, one needs to take action to reduce conflict [5]. Piaget in (Kaasila et al., 2010) states that the schemata (cognitive structure) in the human brain is developed through interaction with its environment, assimilation, and accommodation. Assimilation and accommodation are the thought processes invented by Piaget. When given a problem, students will settle it by exercising their thinking process. In the thinking process, there is an interaction between incoming information and the schema (cognitive structure) in the human brain (Kang et al., 2004). Assimilation is the process that involves the interpretation of experience as it relates to an existing knowledge structure. Accommodation is the process of enhancing knowledge through modification of existing knowledge or existing knowledge structures to accommodate and adapt to the presence of new experiences. Because the assimilation process can be directly accepted by the students in this study, the researchers focused on the process of accommodation to observe changes in the structure of knowledge possessed by students. Some students used existing concepts to agree with new experiences (Ponser et.al., 1982). This first phase of concept change is called assimilation. Often, the student's concept is not enough to absorb a new experience correctly, so students must replace or set the general concept. 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 that is appropriate to the given stimulus (Hoppe and Segal, 2010).

The equilibrium in Piaget's theory refers to cognitive conflict (Lee et al., 2003). Students' initial knowing is a structure or scheme. They then have to deal with a new concept that is partially or entirely different from their schemes. If 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 they are said to experience cognitive imbalance (disequilibrium) or cognitive conflict. The state of equilibrium given by external stimuli will result in a state of disequilibrium. This state of disequilibrium will later give rise to the process of assimilation and accommodation so that the process develops your schemata. Cognitive imbalance or cognitive conflicts occur due to lack of data; the information obtained does not match the knowledge or cognitive structure (schemata) owned, so existing information cannot be assimilated. Consequently, the process of accommodating the information does not occur.

Based on the above explanation, research needed to be done to describe the thinking process of students when experiencing cognitive conflict. It is important to explore this because there is a possibility of a different thinking process being exhibited by each student experiencing cognitive conflict. Also, no studies have looked at students' thinking processes while experiencing cognitive conflict. The benefits of this research are being able to know when students are experiencing cognitive conflict and determining the appropriate approach or learning model for mathematics students who are experiencing cognitive conflict conditions.

The research focused on the discussion of Piaget's thinking process, namely the process of assimilation and accommodation, since the subjects chosen were students who experienced cognitive conflicts that challenged their thought processes.

## Method

This type of research is qualitative descriptive research, which describes the thinking processes of students who are experiencing cognitive conflict.

The subjects of the study were 27 VC students. Of the 27 students, only one student answered the questions correctly, two students approached the questions with the correct process but did not resolve the problem, fourteen students answered incorrectly, and ten students did not answer the questions. The researcher selected the two students who started the problem with the correct approach but did not solve the problem. The reason for selecting these two subjects was that when the researchers conducted direct observation, these two students exhibited cognitive conflict behaviour (curiosity, confusion, and prolonged thinking). These two subjects will be referred to as S1 and S2.

The mathematics problem used in the test was a nonroutine, open-ended question. The problem is designed such that researchers can find out whether students have cognitive conflict in the process of its 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 3.5dm 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 were six stages in this research. First, give a unit-related, non-routine, open-ended problem involving length. Second, make a direct observation of the students' reactions while working on the given problem. The focus of observation was on four components: introduction of contradictions, attracting attention, anxiety, and cognitive assessment of the situation. These components were observed as follows: observation of subjects' doubt, surprise, or strangeness about the given problem; observation of subjects' interest in the abnormal situation (attract attention, curiosity, attention); observation of subjects' worries over the abnormal situation (confusion, pressure); and observation of subjects' reassessment of the abnormal situation (postponing, thinking longer, more grounds as reasons).

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

Stage	Components	Operational Definition
Cognitive conflict stage	Recognition of 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 are exhibited by the subject of the research based on test results and direct observation. Fourth, determine whether the subject experienced cognitive conflict based on the results of the analysis. Fifth, triangulate the data to confirm the results of the analysis by conducting interviews that are unstructured and in-depth (in-depth interview). Since these interviews pertain to the thinking processes that occurs in students who experience cognitive conflict, data reduction is not needed after the interview. Sixth, conclude the analysis based on test results, direct observation, and interviews to obtain data about the thinking process of students when experiencing cognitive conflict.

**Table 2:** Indicators of Thinking Processes

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

## Result and Discussion

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

### ***Thinking Process in Subject***

At the beginning of the process of completing the test questions, S1 realised that the thinking process required by her question had been previously studied, and she then tried to recall what was already known. S1 realised that she might have solved similar problems before. S1 also exhibited the thought process of trying to recall what was known to solve a future problem. S1 recalled what had been done but forgot how to solve the problem. In this case, S1 exhibited a process of assimilation. This is evidenced by the interview between the researchers and S1, as follows:

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

*S1: "Yes, ever. 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 test, S1 experienced stages of disequilibrium on what to do first. S1 then adjusted her thinking process to formulate a plan that started by summing and converting the entire length of the existing drumsticks into the same unit, which was the metre unit.

S1 realised that if each drumstick was from a pair, then each drumstick length should be multiplied by two, since each pair of drumsticks have the same length. By using thought processes to create a new scheme that matched the stimulus provided, S1 exhibited the process of accommodation. This is evidenced by the interview between researchers and S1, as follows:

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

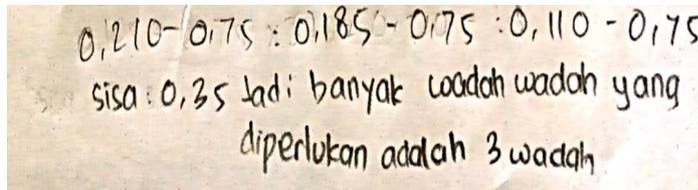
*S1: "Uhhh, I think .. actually I feel confused so .. what .. for it was asked .. a stick or two sticks so .." (form a new scheme)*

Furthermore, S1 modified the existing scheme to match the stimulus provided in their thought process. The problem mentioned pairing, meaning there were two sticks that had the same length in each of drum A, drum B, and drum C. This demonstrates the process of accommodation by S1 (modifying an existing scheme).

S1 modified their existing scheme to measure the container used to store all the sticks. Then, she deduced that all the drumsticks must be summed before the length of the drumsticks is converted to metres to adjust to the unit length of the storage container. S1 made a mistake in their process, which was realised by S1 during the interview. Here, S1 also exhibited the

process of accommodation. This can be seen from the interview between the researchers and S1, as follows:

**Figure 1.** Answer Sheet S1



*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).*

#### *Thinking Process In Subject 2 (S2)*

At the beginning of the process of completion of the test question, S2 realised that the test question had been studied before, and he then tried to recall what was already known about this material, whether he had ever worked on a similar problem, and whether he had ever solved a similar problem. In this case, S2 there has exhibited the process of assimilation. This is evidenced by the interview between the researchers and S2, as follows:

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

*S2: "Yes, ever".*

*Researcher: "Have you ever worked on a problem like this?"*

*S2: "Uhhh .. I forgot if I've ever done a problem like this."*

*Researcher: "What do you remember related to this subject?"*

*S2: "Ladder for unit length, then if it drops by 10 if rises divided by 10".*

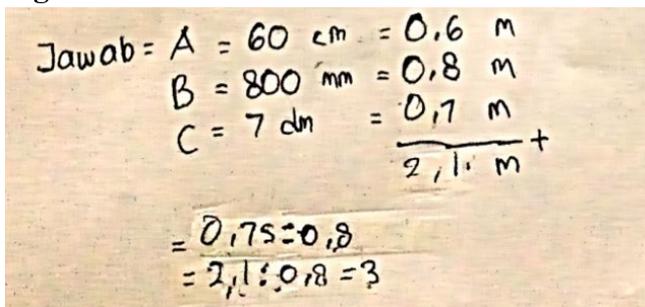
Furthermore, S2 experienced the process of accommodation, namely by creating a new scheme that matched the information provided. This can be seen during the interview between the researchers and S2, as follows:

*Researcher: "What are you doing after reading the question?"*

*S2: "write down what is known. First of all write down the length of each drumstick. Then because in the matter written a pair means there are two drumsticks. Then I add the same number to get the length of one pair of drumsticks "(create a new scheme).*

S2 modified their existing scheme to measure the container used to store all the sticks. Then, he deduced that all the drumsticks must be summed before the length of the drumsticks is converted to metres to adjust to the unit length of the storage container. Then, S2 divided the combined length of the drumsticks by the length of the storage container. Before dividing, S2 rounded the length of the storage container. Here, S2 experienced the process of accommodation. This can be seen from the interview between the researchers and S2, as follows:

**Figure 2.** Answer Sheet S2


$$\begin{aligned} \text{Jawab} = A &= 60 \text{ cm} = 0,6 \text{ m} \\ B &= 800 \text{ mm} = 0,8 \text{ m} \\ C &= 7 \text{ dm} = 0,7 \text{ m} \\ &\quad \quad \quad \underline{2,1 \text{ m}} + \\ &= 0,75 = 0,8 \\ &= 2,1 : 0,8 = 3 \end{aligned}$$

*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 metres. 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 test, both subjects of the research used existing knowledge to address the problem or question. This is in accordance with the opinion of the Piaget: a child brings new knowledge into their schemes (Ultanir, 2012). This indicates that the research subjects could integrate new perceptions and experiences into their existing mental schemes. This is consistent with (Ponser et.al., 1982), which states that some students use existing concepts to agree with new experiences, a process referred to as assimilation.

Differences in the process of completing the given questions occurred in both subjects of the study. Both demonstrated the accommodation process but not in the same problem. As, the first research subject is still confused by determining whether the drum sticks as much as 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) and formulate new ideas for approaching the problem. This condition states that the subjects of the research did not understand the problem well, so the information obtained from the problem cannot be directly used without first forming a new scheme. In this case, the subjects of the research experienced dissatisfaction with their conception (Ponser et.al., 1982). The research subjects

collected previously known information to solve the problem. In the end, the subject of the study said that each of drumsticks A, drumsticks B, and drumsticks C comprised two pieces. In this case, the subjects of the research created a new conception, such that the problem could be understood (Ponser et.al., 1982). The subjects of the study understood how the information provided could be constructed to explore the possibility new conceptual thinking. They then adopted a new concept that had the capacity to solve the given problem. The second research subject understood how information could be developed into new concepts to explore the possibility of solving existing problems. Both research subjects also knew that the concept adopted must have the capacity to solve the given problem; if not, then there will be no reasonable answer. It makes sense also to be the result of 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 dissatisfaction because the initial concept was already in accordance with the information provided.

In the first question, the subjects of the study also experienced the process of accommodation when they determined the dimensions of the container used to store all the sticks. In answering this question, the research subjects modified an existing scheme to match the information given in the question (Hoppes and Segal, 2010). Initially, the subjects of the research summed all existing sticks by first converting the unit of all sticks to the metre. After obtaining the length, in metres, of all the sticks, the study subjects subtracted the length of all drumsticks from the length of the storage container. The process of subtraction was done twice. Then, the remaining length of the drumsticks that did not occupy the storage container. The research subjects then experienced confusion about how to put the remainder into which storage container. In this case, the subjects of the research experienced dissatisfaction with the existing conception, which led to understanding of how to draft a new concept that is sufficient to answer the problem (Ponser et.al., 1982). Finally, by modifying the existing knowledge scheme, the research subjects wrote down their answer: that three containers were needed to store all the drumsticks. In this section, the subjects of the research were able to understand how the information could be compiled into a new concept that was sufficient to explore the possibilities of the problem. Each new concept raised by the research subjects needed to produce a reasonable answer to the given problem (Ponser et.al., 1982). If they did not, then there will not appear a reasonable answer. It makes sense also that these concepts were consistent with concepts from previous knowledge (Ponser et.al., 1982). There were three questions, but both research subjects were only able to solve one question because they experienced errors in the process of summing the length of all drumsticks.

## **Conclusion**

Based on the above discussion, students with cognitive conflicts may integrate perceptions or new experiences into the schemes already in their minds. Then, during the process of



accommodation, students' cognitive conflict in solving math problems is characterised by experiencing dissatisfaction with the concept they already have. After they experience the dissatisfaction, students create a new conception that is easily understood by themselves. Then, the new conceptions of emerging students can be used to provide a reasonable answer. Although there are students who did not start with a sense of dissatisfaction, in these cases, students' initial conceptions already conformed to the information provided.

### **Acknowledgments**

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



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