



ANALYSIS OF ELEMENTARY SCHOOL STUDENTS' REASONING PROCESS IN UNDERSTANDING THE PHENOMENON OF FALLING FRUIT: MISCONCEPTION OR *P-PRIMS*?

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Abstract

This research aims to unveil elementary schools' reasoning process in understanding the phenomenon of falling fruit with their limited knowledge about it. This research employed qualitative approach with the approach of The Investigation of Lived Experience assisted with Cognitive Psychology. The data of this research were obtained by written test and interview. The subjects of this research were the students of 4th and 6th grade with the samples of 3 students in each class. The result showed that the reasoning of elementary school students were mostly inductive. Only one respondent had deductive reasoning. The result also showed that the case of *p-prims* with inductive analysis was caused by analogy and intuition, while *p-prims* with deductive analysis happened due to inadequate ability to explain certain phenomenon. Misconception was formed by two inductive reasonings, (1) inductive reasoning with unrelated premises and (2) inductive reasoning with related premises; however, incorrect preposition. Other findings related to this research is the initial understanding of the respondents was formed as *p-prims* and some other was formed as misconception.

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INTRODUCTION

Previous researches found that reasoning skills influence learning outcome (Markawi, 2015, Inayah, 2016), including to physics. Reasoning skills is defined as the ability to think in coherent and logical sequence using relevant facts or assumption (Guralnik, 1982). Based on Small (1996), reasoning means the ability to show the relation or connection between two or more things based on certain reasons and steps to create conclusion. Santrock (2008) defines reasoning skills as the ability to think logically in taking conclusion with inductive and/or deductive way. Reasoning skills is characterized with logics and analysis (Suariasumantri, 1998).

The process of taking conclusion to certain reason involve premises as the basis of conclusion (Gofur, 2014). Premis is a statement of whether something is correct or wrong. The process of reasoning can come from knowledge or assumption.

Reasoning is divided into two, inductive and deductive. Deductive reasoning is the process of reasoning involving one or two general premises to reach specific and logical conclusion (Sumaryono, 1999; Sternberg, 2006). In the other hand, inductive reasoning is a process of taking conclusion by involving specific conclusion to make specific conclusion (Sumaryono, 1999; Santrock, 2008).

Young *et. al.* (2002) states that to comprehend phenomenon of physics, there should be an ability of reasoning. One of the phenomena of physics is fallen fruit. This phenomenon is easily found in the surrounding environment. It happened due to weathering (biology and chemistry) as well as the earth's gravity. For the students, this phenomenon is difficult to understand because it is related to earth's gravity. This phenomenon cannot be observed with human sense. Some researches showed that there was a misconception of students' understanding related to gravity (Stein, *et. al.*, 2008, Kavanagh & Sneider, 2006, Rane, 2015).

Students come to the class bring different initial understanding of science (Pablico, 2010). If college students is presented with familiar phenomenon, they will understand the phenomenon based on their initial understanding. If the students are failed to assimilate the initial states, it will become a misconception. For the unfamiliar ones, the students will comprehend that with their personal experience (Fotou & Abhrahams, 2016). In other words, in understanding unknown happenings, students will use their intuition which is related to their personal

experiences. This process of knowledge building is called by diSessa's (1993) as *Phenomenological Primitive (p-prims)*.

P-prims is a phenomenology of people to explain something which they just found without enough support of information; instead with with a knowledge deemed as relevant by the people, even if it is actually irrelevant (1983). *P-prims* involves reasoning process and analogy (Fotou & Abhrahams, 2016). *P-prims* is almost the same to misconception in terms of the incapability of people to abstract natural phenomenon. A perspective with misconception considers students' explanation as incorrect with the new thing as the stable structure of science owned by other people. The perspective of *p-prims* views people's incorrect explanation as a new thing from the submission of questions. Thus, the lecturers do not need to eliminate the *p-prims* of the students (Hammer, 1996) as they try to eliminate students' misconception.

P-prims is a basic element of knowledge which is categorized in phenomenology which uses minimum abstraction ability from experiences or the closest phenomenon with the most similar characteristics with no clear explanation (diSessa, 1983). *P-prims* appears due to limited knowledge of people in understanding new phenomenon with limited knowledge or with similar experiences. For example, the research of misconception by Sadler *et. al.* (1989) proposes questions to students on why summer is hotter than winter. Students answer it by saying that during summer, the distance of sun to Earth is closer than in Winter (because of Earth's revolution track which is formed as oval with a central point not accurately in the middle of the earth). *P-prims* sees that students use their analogy by relating things to other related phenomenon, like "the closer the distance to a burning candle, it will be hotter", "the closer the distance to a lamp, it will be brighter". Thus, the analysis of reasoning process uses the perspective of *p-prims* will result original reasoning skills of the students.

P-prims acknowledges the productive aspects of science without scientific reasoning of which different to the concept of misconception which assumes students' ideas as inherently unacceptable to the principle of physics. It is possibly able to be used to achieve scientific ideas like what has been accepted by scientist

(Fotou and Abrahams, 2016). The perspective of *p-prims* allows the building of concept from an unscientific idea to become scientific. However, this concept works together to become the final scheme (diSessa, 1983).

P-prims will occur when there is a new phenomenon. If the phenomenon is familiar, respondents will answer it with the stored factual knowledge in their memory, which the scheme of the knowledge may not be original, but an explanation which is quoted from other people along with the scheme of the knowledge. Later, it makes the reasoning of the people becomes problematic.

This research aims to know the reasoning process of elementary school students in understanding the phenomenon of fallen fruit based only from their limited comprehension. This research relates reasoning with *p-prims* and misconception. The natural phenomenon of fallen fruit is chosen since this phenomenon includes abstract that students' reasoning will be original. This research also analyze the difference of reasoning which results misconception and *p-prims*. The questions given to the students are why fruit can be fallen from the branches.

METHODS

Research Design

This research employs qualitative design with the type of The Investigation of Lived Experience assisted with Cognitive Psychology (Gall *et al.*, 1982). The Investigation of Lived Experience digs inner experience, while Cognitive Psychology focuses on structure and mental activity, how the structure and process can be learned, and how to achieve maturity. A research with Cognitive Psychology is a research regarding perception, memory, attention, thinking skills, and problem solving skills.

Subjects of the Research

The subjects of this research were 4th to 6th grade elementary school students. The sampling was conducted in two steps. The first step is operational construct sampling which determines the sample based on the level of the class. Three students were taken from each level of the class. Then, to determine the three samples, maximum variation sampling was done. The samples should possess high, medium, and low variation of academic skills. The academic skills was from the learning outcome, or simply the report. Operational construct sampling

or maximum variation sampling is a technique of determining sample by Purposeful Sampling (Gall *et al.*, 1982).

Data and Source of Data

All data of this research came from primary data. The data directly came from the respondent. The data were in written and oral. This research used primary data, since Cognitive Psychology research do not allow valid secondary data. The data were the written answer of elementary school students in explaining the phenomenon of physics. The answer was then elaborated through interview. In collecting the data, triangulation was done with written test and interview. Finally, the obtained data were the answer of written test and the transcription of conversation.

Data Validity

The requirement of credibility, transferability, dependability, and confirmability should be fulfilled in a qualitative research (Sugiyono, 2006). These criteria exchanges the validity, external validity, reliability, and objectivity in quantitative research (Guba dan Lincoln, 1985). In this research, the credibility of data was confirmed by triangulation. The transferability was obtained by describing data in details. In this research, dependability of data can be obtained by taking 3 samples from each grade. The confirmability of data came from avoiding subjectivity in collecting data. The researcher made the guidance of interview, guidance of test scoring, and deliver it.

Data Analysis

This research adapt the fixed comparison method of Moleong (2012) in the sequence of: Organizing Data, Data Reduction, Categorization, Synthesizing, Arranging "Working Hypothesis". Organizing data can be done by transcribing the interview and combine the transcription with the result of the written test. Data reduction began with coding data based on respondents and continued to choose the category of data which is determined as *p-prims* and misconception. After the categorization, the data were synthesized by grouping the reasoning as similar or almost the same and describe its difference with other reasoning process. The next step was giving

group name to different reasoning processes based on its characteristic. The last step was the fixed comparison with formulating working hypothesis. The hypothesis is arranged by adopting and/or adapting the existing reasoning skills.

The question of why fruit can fall actually unveil students' conception regarding gravity. From their answers, it can analyze the category of conception from their cognitive and reasoning skills. The analysis can be seen in Table 1

RESULTS AND DISCUSSION

Table 1. The Analysis of Students' Reasoning Skills

No.	Respondents' Code	Type of Misunderstanding	Analysis of Reasoning Type	Other Findings
1	4.A	<i>p-prims</i>	Inductive	Intuitive Thinking
2	4.B	misconception	Inductive	
3	4.C	<i>p-prims</i>	Inductive	Intuitive and Analogical Thinking
4	5.A	<i>p-prims</i>	Inductive	Unstructured
5	5.B	<i>p-prims</i>	Inductive	
6	5.C	<i>p-prims</i>	Inductive	
7	6.A	<i>p-prims</i>	Deductive	
8	6.B	misconception	Inductive	
9	6.C	<i>p-prims</i>	Deductive	

The above data show that *p-prims* is built from intuitive and analogical thinking. The example can be seen by the answer of respondent 4C as follows:

A: (questions)

R: Due to gravity.

A: Can you give an explanation why gravity can make fruit fallen?

R: What is that? (Thinking) Err, because gravity has magnet.

A: If it has magnet, how do you explain it?

R: The fruit is falling down.

A: Explain! What do you know about gravity?

R: A force making things falling down to Earth.

A: If a fruit fell this day, yesterday, It hasn't fallen. Why can it be? Can you explain it?

R: Since gravity has not appeared.

A: It means, you think that gravity can appear or not, don't you?

R: Yes.

From the explanation above, it shows that respondent provides an analogy of gravity like a magnet. The analogy of gravity with magnet is actually incorrect; however, it is still acceptable. This result supports by Fotou and Abhrahams (2016b) who state that *p-prims* involve reasoning and analogy. Analogy is needed to apply other situation to understand the new situation.

From the responses of respondents, gravity has not appeared when fruit has not fallen. This reason shows that intuitive thinking plays important role in forming *p-prims*. The respondents' intuition has not appeared when the fruit has not fallen is not completely wrong, since to the case of fallen fruit, the force of gravity will change along with the growing mass of the fruit.

Intuitive *p-prims* also appears to respondents 4.A as follows.

A: In your opinion, why fruit can fall?

R: It is because of gravity.

A: Can you explain the relation between gravity and fallen fruit?

R: Fruit is falling down. In Earth, there is gravity. If there is no gravity, people will "float" on the air (it may mean flying).

A: If the fruit did not fall yesterday, but it falls today. Since you say that every falls is due to gravity and yesterday the fruit did not fall, did gravity exist yesterday?

R: Yes.

A: How come it can fall today and did not fall yesterday? It still has gravity, isn't it?

R: Since, yesterday, the fruit is still on the tree. The branch has not fallen.

A: If the branch was still there, it will not fall, right?

R: Yes.

A: What made the branch fall?

R: Since the fruit is ripe, the branch is not strong enough to hold the fruit.

A: Hold it from what?

R: (cannot answer)

The answer of the respondents show his intuition to gravity. He used his intuition to explain the concept of "if the fruit falls today, why it did not fall yesterday". Respondent answered that before the fruit fell, there was gravity. When the question is developed, the students' concept was somewhat confused by relating it to the branch of the tree. According to Juliyanto (2013), intuition is caused by weak reasoning skills. Meanwhile, Nugroho (2009) opines that intuition appears due to weak mastery of materials by the subject. Intuition is needed to choose similar situation to the new situation asked by the teacher.

Misconception appeared to respondent 4B's answer. Respondent answers it with why if we drop a pen on the sky it does not fall, since it does not have oxygen. Here is the excerpt of dialogue with respondent 4B.

A: (questions)

R: Rotten

A: Beside that?

R: I don't know.

A: Why rotten fruit can fall to the earth?

R: Due to gravity.

A: What is gravity?

R: I don't know.

A: Why can you state that it is because of gravity?

R: That is what my mom's told me.

A: If, this pen (I lift it through the air), is dropped, what will happen?

R: It falls.

A: Why can it be?

R: Because it is dropped.

A: (I hold a pen on the table, and drop it. The pen is still laying on the floor) If I drop it this way, why can't it fall?

R: Because . . . (confused).

A: If I drop this pen on the sky, will it fall?

R: No.

A: Why does it fall to the earth and does not fall on the sky?

R: Because there is no oxygen on the sky.

Based on the transcription above, reasoning which produced misconception is reasoning which was built with correct premises; somehow, it has wrong preposition, since the premises were unconnected. It is true that there is no oxygen on the sky, but the absent of oxygen does not make things floating on it.

Likewise, the reasoning of respondent 6B also showed misconception as follows.

A: If today, the fruit falls, why the fruit did not fall yesterday?

R: Since it was light, not heavy. It was small, right? Then it becomes bigger when it is ripe, making it heavier.

A: Then, what is the relation of heavier weight to Earth's gravity?

R: If the fruit is heavy, it will easily fall.

A: Then what is the relation to Earth's gravity?

R: It falls down to earth.

From the respondent above, it can be seen that the premises were right. Nevertheless, the premises were connected with incorrect preposition. The respondent cannot see the relation between gravity and the mass of the fruit. It is supported after Fa'ani *et. al.* (2016) who says that the reason of misconception is the use of inconsistent reasoning.

The interview to respondent 6A shows deductive reasoning with limited supporting information which results *p-prims*. The excerpt of the interview can be seen as follows.

A: (questions)

R: Due to gravity.

A: How can gravity make a fruit falls?

R: Since gravity makes all things fall down.

A: What do you mean by gravity?

R: Earth's force of attraction.

A: If I pull a table, there should be a contact between my hand (the giver of the force) and the table (the forced), how about Earth's case?

R: It doesn't work that way. Earth's gravity means that every thing which is thrown up will always fall down.

A: It means, Earth pulls everything like how I pull the table, doesn't it?

R: No.

A: Then, how?

R: It is just fallen.
 A: Where?
 R: Fallen down.
 A: How is the process of fruit to fall?
 R: Since it is ripe, the branch is withered. Then it falls.
 A: How if it is withered without gravity?
 R: It will float like on the space.
 A: Gravity always exists or there will be a specific time for fruit to fall.
 R: It always exists. We can stand due to it.
 A: If the fruit falls today and did not fall yesterday. What are the causes to it?
 R: It is not ripe, so it doesn't fall.
 A: Why it should be ripe to fall?
 R: It is still strong.

Deductive reasoning appeared when the respondent answered "how the gravity can make fruit falls". The respondents can answer "since gravity makes all things fall down". Respondents' limited knowledge to the concept of gravity results *p-prims*, even though the reasoning was deductive. Deductive reasoning is a reasoning which conclusion is not wider to the scope of its initial premises (Suharnan, 2005).

CONCLUSION

The result of the research showed that *p-prims* was formed using inductive reasoning which uses analogy and intuition. Analogi is needed to apply other familiar situation to the new asked situation. Intuition is needed to choose similar situation to that situation. *P-prims* can also come from deductive reasoning without adequate information. Meanwhile, misconception is formed by two inductive reasonings. First, misconception is resulted from inductive reasoning with no interconnected premises. Second, misconception is resulted from connected resulted, yet does not have correct preposition.

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