

A Microgenetic Study on Changes of Elementary Students' Mental Models Regarding the Particles Constituting Ice, Water, and Water Vapor

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Abstract. This study aimed to investigate the path to the change of elementary students' mental models in the particles constituting the ice, water, and water vapor. The study was conducted through the microgenetic methods. Subjects have been interviewed during 6 sessions, once a day. During this period, the students were asked to represent the particles constituting the ice, water, and water vapor through clay activities and texts and images. Semi-structured interviews had been conducted in order to understand the mental model that students currently have and the mental models' change of path. The results of this study were as follows. Students' mental models showed different views of the same situation, changes the path were also varied.

Keywords: mental model, microgenetic study, particle, water

1 Introduction

The particulate nature of matter is identified in science education standards as one of the fundamental concepts [1]. But, the size of particle is one characteristic that is difficult for students to understand because it lies outside the realm of their normal experience [2]. Therefore, it is necessary to know what a mental models the students are making and understanding the particulate nature of matter and how the mental model changes.

From a constructivist view of learning, mental representations, including mental models, are the personal representations of a concept or entity that resides in the mind of the knower [3]. In other words, the mental model that students have is difficult to grasp teacher because the student's mental models are private and can not be accessed by others. Especially, for the particulate nature of matter, students have mental model that differ from the scientific concepts since students have only macroscopic experience for matter [4]. A deeper understanding of student's mental models allows educators to identify potential impediments to learning [5] and provides insight toward planning curriculum and designing instruction that builds on students' existing mental models [6]. Also, if learning is to occur, it is important to examine whether the student's mental model how changes [7]. In particular, in order to capture moment-to-

moment changes in student's mental model in a domain as complex as matter, it is necessary to use the microgenetic method [8].

Problems in achieving the objective of this study are as follows:

What are the changes of paths in the student's mental model of the particles constituting ice, water, and water vapor?

2 Methodology

2.1 The sample

In this study, it was intended for nine elementary school 6th grade students to participate. This study was selected students who learned about the particles and the representation of the mental models are excellent.

2.2 The task and data collection

The purpose of this study is to understand change of path of elementary student's mental models in the particles constituting the ice, water, and water vapor. Research subjects were interviewed during 6 sessions, once a day. During this period, the students were to be represent the particles constituting ice, water, and water vapor through clay activities and texts and images. Semi-structured interviews were conducted in order to understand the mental models' change of path and the mental model that students currently have. The interview process was recorded on video. Also, mental model recording papers that students created were collected. After the collected materials were analyzed and classified, transcriptions were applied to the coding tools.

Table 1. Subjects' mental model categories of the particles constituting the ice, water, and water vapor

Content of categorized mental models	Characteristics of the particles constituting the ice, water, and water vapor	code
Material is composed of a number of particles		P
Material is composed of two~three particles or a few particles	The number of particles constituting matter	P`
Material is composed of one particle		p
Particles constituting the material are separated.	Particles distance	A

Particles constituting the material are attached		a
Particles constituting the material, there is movement.	Particles movement	M
Particles constituting the material, there is no movement		m

2.3 Data analysis

Things that were meaningful in what the subjects had to say were coded. Then, they were categorized the same ones. Thus the initial coding framework was created based on the fact that it has been categorized. Via initial coding frame, and applying the coding framework to other subjects' transcriptions. The transcription was further modified so that it can be applied to other subjects. Modified coding frame, after ensured the validity by two external experts, was completed. Table 1 shows the final completed coding frame.

3 Results

3.1 Change of path in the student's mental model of the particles constituting the ice, water, and water vapor During the 6 sessions.

Figure 1 shows change of path in the student's mental model of the particles constituting the ice, water, and water vapor. As shown in the figure, change of path in the student's mental model was varied. This is because the individual has conceived a mental model based on prior knowledge, existing ideas or concepts, and past experience. Second, children's theories are different from scientific theories because children's theories lack many important characteristics of scientific theories [9]. This is because student's mental models of the particles did not useful to understand the particle's concept itself. Students just know only about the particle, because do not know the other concepts associated with the substance. Third, each mental model represents what is common to a distinct set of possibilities [10]. For the particles constituting the water, some students expressed the particles constituting the non-moving water and moving water.

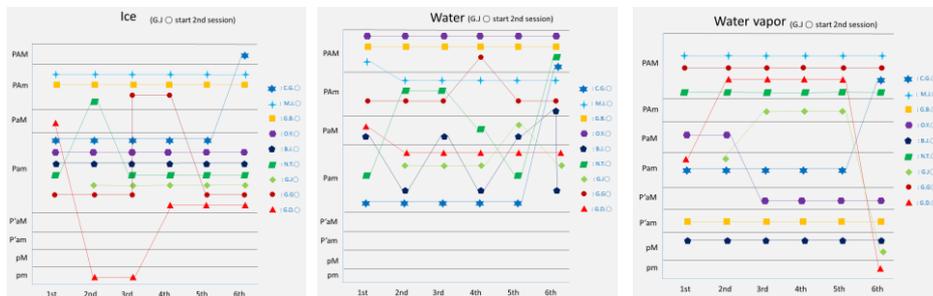


Fig. 1. Change of path in the student's mental model of the particles constituting the ice, water, and water vapor

3.2 Why the change of mental model has occurred?

First, changes in the student's mental model are done through the representation model and direct experience [11]. At first session, it was an abstract represent for a model that they had made. But, students interacted with models that themselves expressed. In the process, students were allowed to change their mental models. Second, because the concept of student on the particle is changed, student's mental model of the particles constituting ice, water, and water vapor has changed. This is associated with that has changed category in which particles belong on the basis of Chi(1994)'s Ontological Category. Third, changes in the mental models occurred on the basis of the knowledge that subjects have. Depending on the environment, prior knowledge, and experience, knowledge that students have is different, a process that accept or conflicts with the existing knowledge is different, also.

4 Conclusion

The conclusions of this study are as follows:

Learner's mental models showed different views of the same situation, change of path were also varied. This indicated that student's mental model of the particles constituting the ice, water, and water vapor closely related both the expressed model and student's the mental model of particle.

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