Asia-pacific Journal of Education Management Research
Vol.2, No.1 (2017), pp.1-6
http://dx.doi.org/10.21742/ajemr.2017.2.1.01

A Microgenetic Study on Descriptive Concept Formation

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Abstract

The purpose of this study was to analyze the process of descriptive concept formation using a microgenetic method. Ten university students were asked to solve the Creature Card Test over the course of six sessions. At each session, the students were asked to think aloud during the entire task-solving process. Afterward, changes in the students' thinking processes and strategies in descriptive concept formation were analyzed using unstructured interviews. As a result, examples were used to find commonality and generate hypotheses. Counter-examples were variously used, and the developmental stages from intentional neglect to hypothesis confirmation were verified. As the sessions progressed, choosing the answer from the options developed the direction of choice based on the property.

Keywords: *Descriptive concept, Descriptive concept formation, Process of the concept formation, Microgenetic analysis*

1. Introduction

Scientific concepts can be classified as descriptive concepts and theoretical concepts [1]. A descriptive concept is one that can be directly observed [2]. Lawson et al. [3] explained the formation process of the descriptive concept as inductive-deductive reasoning. Inductive-deductive reasoning, which consists of "if –and –then –but –therefore", is a process of observing an object and identifying its attributes by induction, or by evaluating the attribute by deduction to judge its validity [4].

The process of descriptive concept formation has been analyzed [4, 5, 6] through the Creature Card Test [7]. Prior research has proved that in the process of descriptive concept formation, it is necessary to apply inductive-deductive reasoning, or compared the characteristics of experts who can form descriptive concepts and novices who cannot. Therefore, in this study, we analyzed the developmental process of descriptive concept formation using a microgenetic method.

2. Method

2.1. Participants

Ten students from K University in Chungcheongbuk-do voluntarily participated in this research. As the purpose of the study was to understand students'processes of descriptive concept formation, university students were chosen because of their ability to explain their

Article history:
Received (January 22, 2017), Review Result (March 13, 2017), Accepted (April 28, 2017)

Print ISSN: 2207-5380, eISSN: 2207-290X AJEMR

cognitive processes in the tasks they were performing and to explain the reasons for the strategies they chose and actions taken.

2.2. Task

Tasks that could analyze descriptive concept formation were created by modifying the items in the Creature Card Test [7] used by Lawson et al. [3] and Kim et al. [6]. This task minimizes the impact of prior knowledge on problem solving as it utilizes shapes and terms that the students will encounter for the first time [4, 8]. Example of task was presented in [Fig. 1].

Figure 1. Example of a task

2.3. Data collection

At each session, students were asked to solve one item that could track the process of descriptive concept formation. They were asked to think-aloud while solving the item so that their cognitive processes could be analyzed. Because think-aloud cannot reveal the entire cognitive process, unstructured interviews about the participants' reasons for choosing specific strategies or changing their solutions were conducted.

2.4. Data analysis

In order to analyze changes in the students' descriptive concept formation, a coding framework (see [Table 1]) as devised for descriptive concept formation. This coding framework was used to analyze transcripts of the students' task solutions and interviews.

Table 1. Coding framework

Category	Behavior	Object
Examples (first line)	Exploration	Commonality of examples
	Detection	Some attribute
		All attribute
	Elaboration	Reduction/Expansion/Modification of attribute range
Counter-Examples (second line)	Exploration	Commonality of counter-examples
		Characteristics of some cases
	Decision	Correspondence of Examples' attribute
Options (third line)	Exploration	Same shape as examples
	Elimination	Shape that are not examples or counter-examples
		Shape that are not some cases at examples
		Shape that are some similar cases at counter-examples
		Attribute that are some cases at counter-examples
		Attribute that violate examples
	Selection	Unusual shape
		Shape that are similar with examples
		Attribute that match the examples
etc.	Noticing	Unusual pattern or shpae
	Confusing	Having trouble solving tasks

3. Results and discussion

3.1. Change in the formation of descriptive concept

[Table 2] shows the students' descriptive concept formation during the 5th session. Although many students formed a descriptive concept at every session, they did not form a descriptive concept at the beginning, but some students formed a descriptive concept by repeating the session, and they formed a descriptive concept according to the session.

Table 2. Whether the descriptive concept is formed according to each session

Session	Whether a narrative concept is formed (Student)									
	A	B	C	D	E	F	G	H	I	J
1	×	×	○	○	○	×	○	○	○	○
2	×	○	×	○	○	○	○	○	○	○
3	×	○	○	○	○	○	○	○	○	○
4	○	○	○	○	○	○	○	○	○	○
5	○	○	×	○	○	○	○	○	○	○

3.2. The development process of examples, counter-examples, and optional utilization

Almost all of the students used the example in the first line to find commonalities and generate a hypothesis. Even when the students were searching the examples, they tended to look at the examples as a whole. Only student J generated a hypothesis using one example presented in the first line, and then tested his hypothesis on the second example in the first line. He elaborated his hypothesis by testing it on the other examples in the first line.

There are various ways to use the counter-example shown in the second line. The process is shown in the developmental stage, as shown in [Figure 2]. In the beginning, although it was confirmed to be contrary to the hypothesis, “intentional ignorance” of the counter-example, which means choosing or eliminating the option without considering the counter-example, was confirmed. However, increasingly, the counter-example came to be used to generate or test the hypothesis.

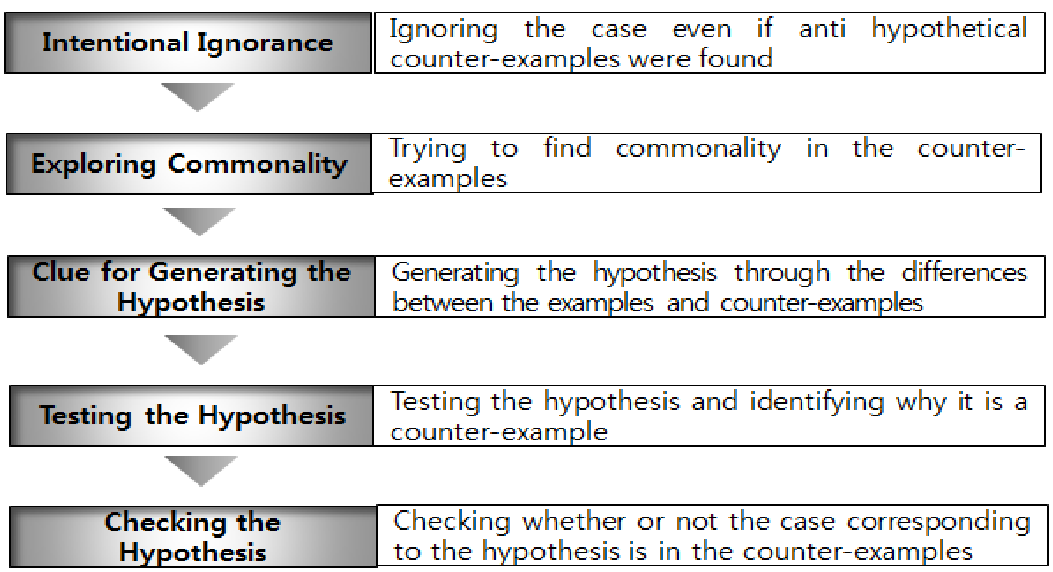

Figure 2. Developmental stage of using counter-examples

In the beginning of the choosing answer to the option, the similarity of appearance between the example and the counter-example was considered; however, as the sessions go on, choices came to be based on the attributes of the descriptive concept formed through hypothesis testing. If the number of attributes increased or if only a part of the attribute was found, the answer was selected by eliminating some of the options.

4. Conclusion

This study used microgenetic method to examine changes and developments in the process of forming descriptive concepts. In the process of descriptive concept formation, students used the examples in the first line to find commonalities and generate hypotheses. The counter-examples presented in the second line were variously used. As the sessions progressed, when choosing the answer in the option, the choice of direction developed based on the attribute.

Students who did not form a descriptive concept were not able to use counter-examples as important clues [5]. In addition, this study examined the various types of counter-examples used when students formulated descriptive concepts, and the direction of the methods of the counter-examples utilized was confirmed. Based on these observations, it is possible to provide a variety of reasoning strategies and step-by-step questions for the formation of descriptive concepts for students who experience difficulty doing so.

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