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How to Inhibit Rebounding to Responses Based on Misconceptions

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Abstract

The mistakes made by students are not absolute mistakes. The mistakes they make are based on their past experiences and are often reasonable to a certain extent. However, in normal school lessons, information is simply conveyed through a textbook, and the students' past experiences are ignored or denied. Teachers must support and promote learning activities to restructure a new knowledge configuration by combining the past experiences of students with new information from the teacher. However, past experiences and new information are often at odds with each other. How can the two be successfully combined? This question has not been clearly answered in psychology. In the current study, proposal of demarcation is explained, and the experimental results of are introduced. Here we focus on the problem of rebounding. Responses based on misconceptions can be temporarily curbed by means of instruction; however, there is a potential for an increase as the student reacquaints themselves with past experiences. To inhibit this phenomenon, it is important to create a cognitive conflict by emphasizing both past experiences and new information and to restructure and understand a knowledge configuration that integrates and allows both to coexist.

Keywords: Rebounding to Responses Based on Misconceptions; Rule Showing Demarcation; Maintaining Misconceptions; Cognitive Conflict

Introduction

Learning involves a process of restructuring a new knowledge configuration by combining the student's past experiences and knowledge with information conveyed by the teacher. Thus, learning is a self-directed and dynamic activity. In this regard Ausubel DP, et al. [1], discussed the types and formation of knowledge configurations. Chi MTH, et al. [2] stated that learning is a process of combining the students' existing knowledge with new information from the teacher, and they elucidated that eliciting self-explanations can aid the process. Tsai CC, et al. [3] stated that the restructuring of an integrated knowledge configuration, including past knowledge, experiences, new scientific concepts, and other related knowledge is essential to realize meaningful learning. Glynn SM, et al. [4] stated that it is the teacher's job to restructure personal theories and models that students bring to the class to align them with approved scientific knowledge. Uematsu K, et al. [5] clarified that the bidirectional connectivity of rules and examples heightens the memorization of rules and promotes the resolution of transfer problems.

Simultaneously, however, no clear idea has been presented as to how to integrate or restructure past experiences, knowledge of student and new information from the teacher

when they are at odds with each other. Teachers must not only convey correct information but also convey adjusted reconceptualized frameworks of the two-way conflicting relationship between the student's past experiences and the new information and assist with restructuring. A new insight into this problem was clarified by Hashweh MZ, et al. [6].

Summary of the Study by Hashweh MZ, et al. [6]

As a method of supporting the above restructuring activities by students, Hashweh MZ, et al. [6] proposed a teaching strategy called "demarcation." In this strategy, frameworks that integrate past experiences with new scientific information are presented. That is, the scopes (conditions) in which both are valid are divided into cases, such as "past experiences in the scope of xx," and "new scientific information in the scope of yy." In the case where there is a conflicting relationship between the students' past experiences and new scientific information from the teacher, students will often need to make a choice between the two by asking "Which one is correct?" However, with demarcation, rather than confrontational thinking that require a choice, the validity of both is conditionally acknowledged, so that both can coexist in the sense that "both are correct."

We will now describe an example stated by Hashweh MZ, et al. [6] child has a past experience and the preconception that the amount of water in a cup can be determined by its height in the cup. In the case where the cups to be compared are equal (they have the same bottom surface area), the past experience (preconception) is correct; however, in the case where the cups are not the same, the amount will be proportionate to the volume, and the scientific concept of "height x bottom surface area" is valid. This scientific concept is valid in any case, and the preconception based on past experience conforms to a specific case of this scientific concept. However, Hashweh MZ, et al. [6] highlighted that demarcation works even in cases where past experiences (preconceptions) are not specific cases of scientific concepts. Hashweh MZ, et al. [6] presented an approach to knowledge configurations in the case where it is difficult to integrate past experiences and new scientific information owing to a conflicting relationship between them and clarified the model of conceptual change.

Rebounding to Responses based on Misconceptions

Immediately after new scientific information has been taught in school lessons, the new scientific information precedes past experiences and misconceptions. Therefore, it can be predicted that the misconceptions based on the student's past experiences will decline. However, after students have learned new scientific information at school, they will re-experience and become reacquainted with past experiences in various settings inside and outside of school. At such times, it can be expected that the misconceptions that had declined will be reactivated. This phenomenon is the rebounding of misconceptions. Rebounding refers to the phenomenon by which there is an increase in responses based on misconceptions following a decrease in such misconceptions owing to instruction and following the acquisition of information about past experiences. How can rebounding of misconceptions be inhibited? This is an important issue that should be considered.

Summary of the Study by Uematsu K, et al. [7]

Having clarified rebounding to responses based on misconceptions, a study by Uematsu K, et al. [7] can be cited as successfully controlling rebounding. Uematsu K, et al. [7] studied the effect of demarcation, as proposed by Hashweh MZ, et al. [6], on rebounding to responses based on misconceptions. In terms of the hypothesis of the experiment, it was considered that rebounding to responses based on misconceptions could be controlled by attributing certain amount of validity to the students' past experiences, which were neither denied nor ignored, certain amount of validity to new scientific information, and by allowing both to be integrated and to coexist. Conversely, he thought that if a choice has to be made between past experiences and new scientific information as to which one is correct, even if there is a temporary post-instruction decrease in responses based on misconceptions, they would be reactivated and increase when the students subsequently reacquainted themselves with information from their past experiences.

The experiment was conducted among 175 psychology students at junior college and university in Japan. Most students had the misconception beforehand that tulips, potatoes, and some other types of plants that require a part of them to be planted in the ground (bulbs and tubers) do not produce seeds. The past experience of the students was that "tulips and potatoes are raised from parts of the plant, such as bulbs and tubers." On the contrary, the new scientific information stated that "if it blooms, it has seeds." The students were divided into two groups, namely, a group that was given a "rule showing demarcation," expressing the "demarcation" information as a rule, and a group that was given a "rule showing nondemarcation" as new scientific information (Figure 1). The students were further divided into a group maintaining the misconceptions before the learning session and a group not maintaining the misconceptions before the learning session, making a total of four groups.

The experiment was structured as follows: pre-test → survey to investigate the maintenance of misconceptions → reading literature about tulips (one of the two rules shown in Figure

1 was presented) → post-test 1 → reading information about past experiences → post-test 2. The pre-test, post-test 1 and post-test 2 all had the same questions. Students were asked to state whether tulips, potatoes, hyacinth, and onions produce seeds, with "○" showing a positive answer, "×" showing a negative answer, and "△" showing uncertainty. Simultaneously, they were given information stating that all four of them bloom. Therefore, the correct answer for all four was that it can "produce seeds." The negative and uncertain responses were defined as responses based on misconceptions. The minimum number of responses based on misconceptions was zero, and the maximum was four. Students who responded based on misconceptions with regard to tulips in the pre-test were covered in an analysis of the number of responses based on misconceptions. People who made errors while filling out the tests were excluded. The scope of the analysis comprised a total of 130 people.

The information about past experiences was the short statement that "tulips are cultivated by planting a bulb." After the number of responses based on misconceptions decreased in post-test 1, this information about past experiences was presented to investigate whether there would be a rebound toward an increase in responses based on misconceptions after reading the information about past experiences. The aforementioned experiment was implemented by asking students to read the booklet until the end. The time required was 20-30 minutes.

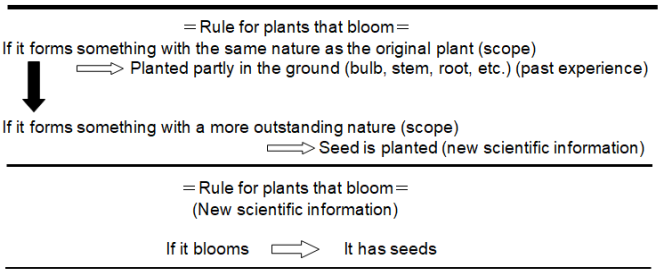

Figure 1: Rule showing demarcation (top) and rule showing nondemarcation (bottom)

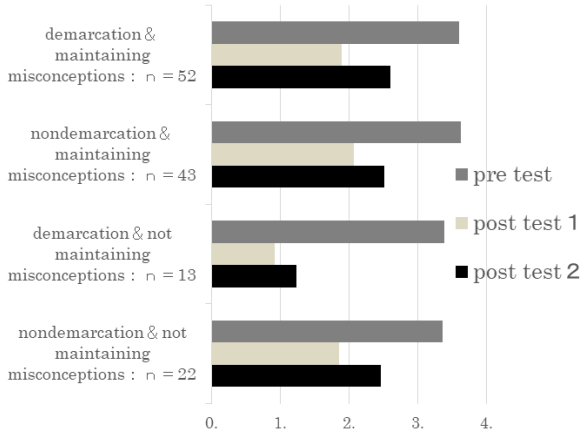

Figure 2: Transition in average responses based on misconceptions (results of Experiment 1).

In this experiment, rebounding was observed in all four groups (Figure 2). As a result of a two-factor analysis of variance, there was no support for the hypothesis that presenting the rule showing demarcation would have the effect of controlling rebounding. The other factor, maintaining the misconceptions, also did not yield significant results for controlling rebounding.

The students in the group to which the rule showing demarcation was presented wrote the impressions shown below in the booklet after the experiment. Reading this, it can be noted that the presentation of the information in the booklet manipulated their thinking and caused confusion.

"How something is written can quickly change the way you think."
"I could no longer understand what the correct answer was for tulips."

After the students read the information about tulips, the

number of responses based on misconceptions decreased temporarily, and they became aware that they produce seeds, but after the information about past experiences was presented, rebounding often occurred with the idea that there are no seeds because the bulb is planted. The biggest problem here is that even when the rule showing demarcation was seeds, not bulbs." Therefore, the validity of past experiences would have been greater based on the subsequent past experience information, which makes it easy for rebounding to occur.

To resolve this problem, it was decided to improve the procedure of the experiment. By emphasizing both past experiences and new scientific information, an effort was made to increase the cognitive conflict between both (whether it is a bulb or a seed). In addition, an effort was made to resolve the problem using the rule showing demarcation. That is, the integration and coexistence of both were promoted. The new procedure involved presenting the information about past experiences at the start of the booklet (before the pre-test). A black-and-white photograph of tulip seeds was presented in the reading material. The other processes were the same as in the presented in the reading material, they understood it to mean only that seeds are produced and they did not integrate or allow the past experiences and the new scientific information to coexist. This is a binary way of thinking that "the correct answer is seeds, not bulbs." Therefore, the previous experiment the participants comprised 271 psychology students at universities and junior colleges in Japan. They were all participating in this experiment for the first time. As with the previous experiment, students who responded based on misconceptions with regard to tulips in the pre-test were covered in the analysis. People who made errors while filling out the tests were excluded. The scope of the analysis covered a total of 196 people.

Rebounding was observed in all of the groups barring the group maintaining the misconceptions to which the rule showing demarcation was presented (Figure 3). However, the scale of rebounding was less than that in the previous experiment.

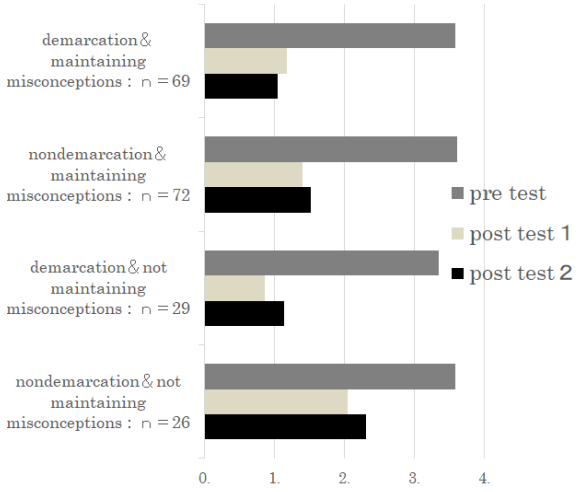

Figure 3: Transition in average responses based on misconceptions (results of Experiment 2).

As a result of a two- factor analysis of variance, the primary effect of maintaining the misconceptions was found in the changes between post-test 1 and post-test 2 ($F(1,192) = 4.58$, $p < .05$, $\eta^2 = .02$), suggesting that rebounding was less likely to occur among those maintaining the misconceptions. Furthermore, excluding the three people who gave only one response based on misconceptions in the pre-test, an analysis was conducted concerning the reduction in the number of responses based on misconceptions from the pre-test to post-test 2. Consequently, the primary effects of both the type of presented rule and the maintaining of the misconceptions were significant (respectively, $F(1,189) = 6.69$, $p < .05$, $\eta^2 = .03$; $F(1,189) = 4.30$, $p < .05$, $\eta^2 = .02$). There was a significantly large decrease among those to whom the rule showing demarcation was presented and those maintaining the misconceptions.

In this experiment, the procedures were improved to intensify the cognitive conflict. Therefore, a need would likely arise to resolve the cognitive conflict. In this situation, there was a serious cognitive conflict among those maintaining the misconceptions when reading the literature, which promoted integration and coexistence owing to the rule showing demarcation, thereby making rebounding less likely to occur. However, when the students not maintaining the misconceptions read the literature, there was no cognitive

conflict, which meant that integration and coexistence were less likely. Therefore, when the information about past experiences was presented again, they were more easily influenced, and rebounding was more likely to occur.

Discussion

To conclude, the issue of how rebounding to responses based on misconceptions can be inhibited will be explored. The foregoing study, as the basis for this issue, did not consider actual past experiences from daily life. The foregoing study dealt with awareness from past experiences using literature, and it is important to improve this point in future investigations. The key points are as follows.

- Even if responses based on misconceptions decrease after instruction, it cannot be assumed that they have been corrected and are gone. In the future, it will be necessary for teachers to be aware of the potential for rebounding later.
- In the case where misconceptions decline after instruction, it is necessary to identify whether this has changed into "knowledge that does not rebound." This cannot be understood from a problem given immediately after the instructional activities, so it will be necessary to confirm after the past experiences are recognized.
- It is important to provide support to reconceptualize the meaning of the student's past experiences without ignoring or denying them.
- Rather than a simple rule in the form of "if A, then B" that is at odds with past experiences and misconceptions, in the teaching stage, a rule showing demarcation that presents both past experiences and the new information from the teacher as being correct should be presented. This rule promotes the integration and coexistence of both past experiences and new information.
- Focus on past experiences in the teaching stage and emphasize their validity. In addition, emphasize the validity of the information from the teacher. This will increase the cognitive conflict between the two. Cognitive conflict will promote an understanding of the rule showing demarcation presented thereafter.
- Do not have a negative view of maintaining the misconceptions. Do not try to stop students from maintaining the misconceptions.
- Promote open discussion and debate as methods to reconceptualize past experiences and to integrate and allow them to coexist with new information.

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