This study started from the question "What is learning?" Although it's a short question, the answer to this question can appear different by character of disciplines. For some researchers who research on education or specific subjects, comprehension about learning can help them to develop effective instructions. For this reason, efforts of understanding about learning are important for education research. In this study, we focus on the brain, the place where learning occurs, to understand about learning. It is common sense that the place of learning is the brain. However, in the societies of education, there are little studies on learning with knowledge of brain function. On the other hand, some disciplines like neuroscience, neurophysiology, clinical and psychology have accumulated results about the functions of the human brain. However, there are few communications among two disciplines. That is, many efforts of researchers in both disciplines are left alone. Therefore, in this study we investigated principles of learning from the perspectives of science education and tried to apply the results of neuroscience to students as an interdisciplinary study.

At first, we analyzed student difficulty as a starting point to investigate the principles of learning. An important moment in learning occurs when students encounter difficulties. Therefore, in this study, we tried to find out the sources of difficulties through analyzing interviews and questionnaires. Consequently, students who experienced a conflict by discordance between their mathematical and qualitative conceptions had difficulties. Referring to the assertions of past researchers, the discordance is similar to conditions that can occur as a source of cognitive conflict. Thus, our research focused on cognitive conflict rather than student difficulty, which has broad meanings. Secondly, referring to the results of the first study, we made diagnostic test and applied it to the students. According to the results, students usually approached Curl problems with qualitative reasoning, but they couldn’t understand the meaning of Curl completely. Thus, we developed tutorials that were based on results of the first study and diagnostic test to dissolve students’ difficulties. After applying of the tutorials, the number of students who considered both sides (mathematical and qualitative reasoning) increased and, simultaneously, student difficulty decreased. In this manner, through the results of the analysis and the dissolving of difficulties, we found that the tutorial operated a positive role in learning Curl.

In the previous two studies, we affirmed that cognitive conflict is an important factor for learning Curl. After that, as a following study, we tried to understand cognitive conflict from the perspectives of neuroscience through research based on documents belonging to disciplines of neuroscience, neurophysiology and brain science. As a result, we considered student difficulty to cognitive conflict originated from discordances. The region in the brain associated with conflict is the Anterior Cingulate Cortex (ACC). Moreover, results of neuroscience studies about ACC and its functions are related with attention, cognitive control, top-down control, etc. These functions are similar to the after-effect of cognitive conflict in science education.

Overall, through comparing two disciplines (science education and neuroscience), we tried to consider how to approach contents in science education with a neuroscientific perspective. In addition, we tried to develop a design that could measure cognitive conflict by using an imaging method. Our study could help a research that develops a new method for understanding learning in both fields.

* Note: The text above is the abstract of the thesis.
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