Paper presented at APEC-TSUKUBA International Conference
December 9-14, Tokyo & Kanazawa, Japan

The Mountain-Climbing Learning Method to Activate Communicative Ability in Mathematics Classroom

Yutaka OHARA
Ritsumeikan University

Maitree INPRASITHA
Khon Kaen University

Noboru SAITO
Naruto University of Education

Abstract

We propose "The Mountain-Climbing Learning Method" as a new approach to activate communication ability in mathematics classroom. In nature, this method aims to make functional network of the knowledge and information for creativity development in students' mind. The additional effect of this method was to improve the understanding of newly created knowledge in a systematic way and to enhance communicate ability (about 12-15%) to other students.

Background

"The Mountain-Climbing learning Method (MCM)" had gotten glowing notices in Japan for the reason that activates creative thinking and acquire fundamental contents tightly. Saito (1994) has developed this effective MCM approach. We have been practicing MCM approach in many primary, secondary schools, and the considerable effects have been confirmed. MCM is highly effective for enhancing their creativity not only in higher achievement students but also in lower achievement students. In this paper, we report an improvement of communicate ability as further effect of MCM.

It is well known that connected knowledge can be used to enhance creativity. In this sense, expert teacher's knowledge is systematic and structural. Consequently, we posed the central issue on communication via structure charts as concept map (Fig.1) to construct the functional network of knowledge in student's mind (Fig.2).

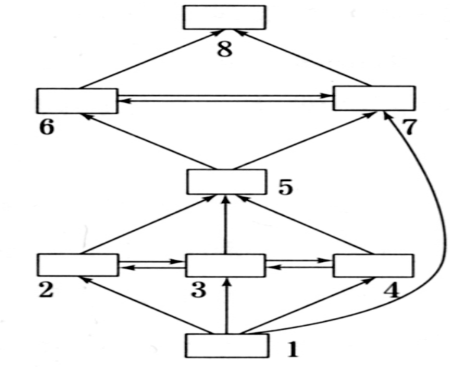

Fig.1. Example of blank chart

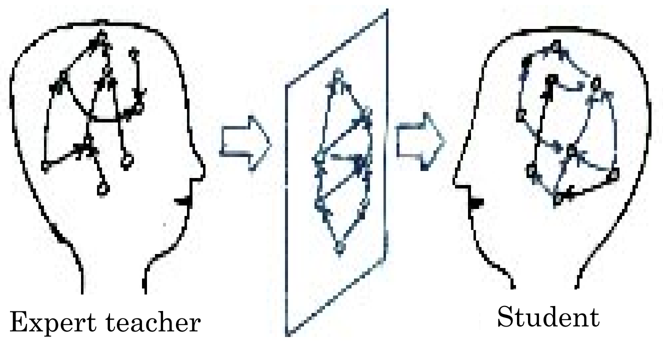

Fig.2. Reification of expert teacher's conception

Concept mapping was originally posed and promoted by Novak and Gowin in the field of science education in the 1980s to promote structuring of student's knowledge. It is advocated as a teaching and evaluation tool for raising a student's meta-cognition (Novak, 1990). However, concept mapping is by no means all-round tool. It needs some devices for reducing time to make the knowledge network, and we need to analyze and evaluate these maps in daily lesson constantly. To cover these shortcomings, MCM tried to activate the sequence of construction process of concept mapping more uncomplicated and collaborative in mathematics lesson. Moreover, compared with the scientific field which mainly treats natural phenomenon, it poses a problem in the mathematics field that concepts have inclusive relation. So we should concern their complicated representation as scaffoldings.

In MCM, the teacher gives the students a chart which is drawn based on the expert teacher's thinking and structure of learning contents in a unit, and makes the students use it as a learning tool in order to help them in their comprehension.

At the beginning of teaching unit, the teacher analyses teaching contents and makes them hierarchically in order to develop "structure chart", "table of the reasons for the arrow lines" and "self-diagnosis sheet". Students fill in the blanks in the chart; 1) the explanations of the learning terms, 2) formulas, 3) typical exercises or their own problems and answers. Then, students write the reasons for each arrow line" and reflect their own activities by writing "self-diagnosis sheet". After that, they make the presentation and discussion using these charts and sheets. The goal of these presentations and discussions on problem solving is to improve the ability to understand newly created knowledge in a proper context and in a systematic way and to communicate it to other people. Presentations and discussions on learning contents allow students to verbally externalize the conceptual structure of the teaching unit that they have in their mind, and help them acquire a more detailed, contextualized and systematic understanding of the contents to form a functional network of knowledge and information, improving their communicative ability.

Methodology

We have introduced the MCM into a considerable number of schools in this decade. Here, we will take up an example of a public lower secondary school. Teaching methods and other conditions employed in the research are described below.

Learning groups

Group A : Classes for which the Mountain-Climbing learning Method was adopted

Group B : Classes for which the problem solving method was adopted

Students in Group A were given learning structure charts, while the students in Groups B were not. In the stage of presentations and discussions, we evaluated the communicative ability of students from the following perspective.

Table 1. Grades and teaching materials

Grade, Number of students	Teaching material	Class hours
7th graders, n=190, (Group A 76, B 77)	" Solid figures"	14 hours
8th graders, n=204, (Group A 68, B 68)	"Similarity of Figures"	14 hours
9th graders, n=224 (Group A 73, B 75)	"Circles"	16 hours

First, we made a distinction between two aspects of communicative ability, i.e., "the organization of information (descriptive expression)" and "communication of information (verbal expression)," and broke down each of these aspects into the following elements that we believe to be essential. The perfect score for each of the following elements 1) through 5) listed below is 20 points.

Organization of information (Descriptive expression)	1) Ingenuity in expression 2) Organization of the contents
Communication of information (Verbal expression)	3) Logical reasoning 4) Clarity of the argument 5) Persuasiveness

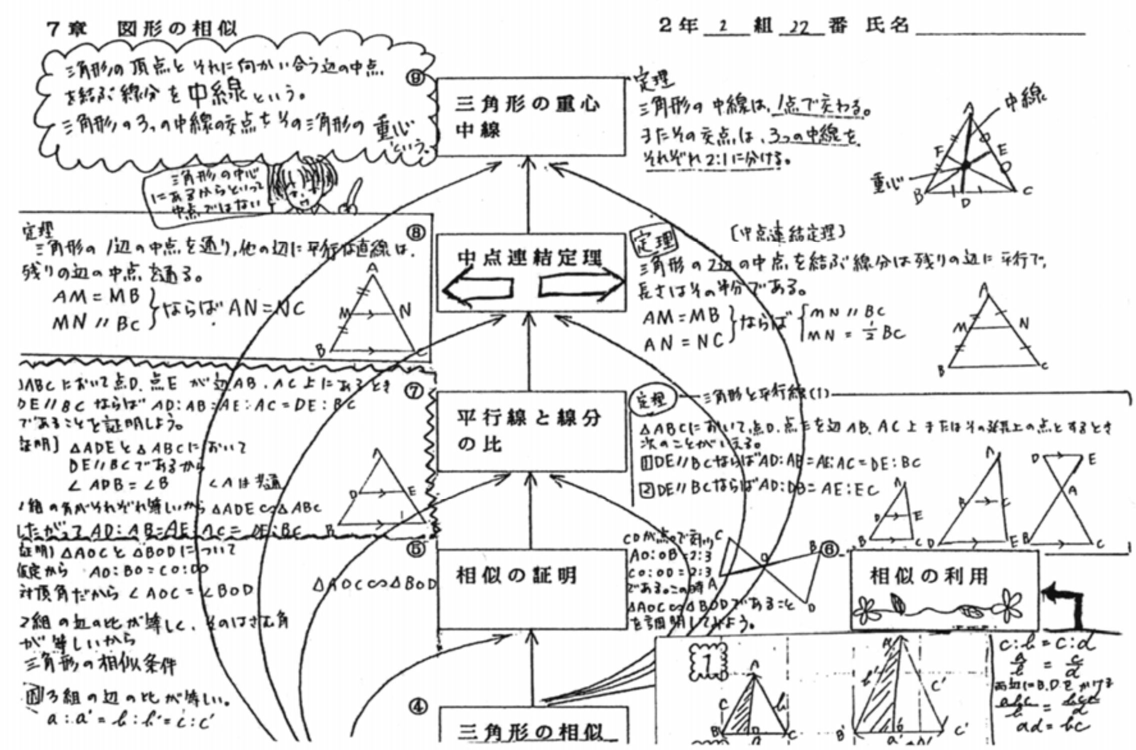

Fig.3. A piece of Structural chart that student described

Results and Discussion

The combined effects of each grade and mathematical contents on student's communicative ability are too complicated to examine in detail here. Table 2 just shows the evaluated scores of information communicative ability for the students in Groups A and B of each grade.

Table 2. Levels of information communicative ability

Category	Group	Organization of information: Ingenuity in expression	Organization of information: Organization of the contents	Communication of information: Logical reasoning	Communication of information: Clarity of the argument	Communication of information: Persuasiveness	Amount
1	A	14.3	14.1	13.5	13.1	13.4	68.4
	B	10.7	11.7	10.8	10.1	10.3	53.5
2	A	15.9	15.7	14.7	14.3	14.5	75.1
	B	11.5	12.9	12.1	12.5	12.3	61.3
3	A	16.1	16.0	15.3	15.0	15.4	77.8
	B	11.6	13.8	13.5	13.3	13.0	65.2

One can see from the table that in all of the grades, Comparing with the controlled class (group B), students' communicate ability in the experimental class (group A) could be enhanced 12-15%. These results suggest that "students who have developed a habit of thinking about learning contents in a structured and systematic way have higher levels of information communicative ability."

Imaginably, may we surmise that concept mapping does not suit for mathematics education? Contrary to this kind of delusion, above results indicated that MCM could lie high-quality foundations for development of communicate ability.

Over the past few decades, a considerable number of studies have been conducted on mathematical communication. MCM turned our attention to the concrete tool used in communication. What should be kept in mind here is the importance of total control activities and actual filter of communication in mathematical classroom.

References

Novak, J. D., Gowin, D. B., & Johansen, G. T. (1983). The use of concept mapping and knowledge: Vee mapping with junior high school science students. Science Education, 67(5), 625–645.

Novak, J. D. (1990). Concept maps and Vee diagrams: Two metacognitive tools for science and mathematics education. Instructional Science, 19, 29-52.

Saito, N.(2004). Mountain-Climbing Learning Method. Meijitosho. (in Japanese)

Saito, N.(1999). Development of Mountain-Climbing Learning Method of Task Pursuing Type to Cultivate Creativity Basis and Its Effect. Journal of Japan Society of Mathematical Education, 81 (22), 226-236.