Research Article

MULTIPLICATIVE DISCOURSE FOR MAKING PATTERNS IN MULTIPLICATION TABLE IN AN OPEN APPROACH CLASSROOM TEACHING: A SEMIOTIC ANALYSIS

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Abstract

The aim of this study was to analyze multiplication discourse for making patterns in multiplication table emerging in a mathematics classroom taught through open approach. The research was carried out in one second grade classroom in the project school innovated by Lesson Study and Open Approach. Qualitative methods were employed for collecting and analyzing data through classroom observation on 11 consecutive lessons on multiplication. Teaching protocols, students' written works, field notes and classroom photographs were used as the research data. Semiotic analysis with protocol analysis was employed in this study.

The research result revealed what and how multiplicative discourse of students and teacher played a major role in discovering meaning of multiplication and constructing multiplication tables in each steps of open approach as a teaching approach. Two types of multiplicative discourse found in making patterns in multiplication tables were univocal and dialogic discourse. Univocal discourse like "number set", "adding it up", "multiplier increases by 1" and "answers increase by..." students use played a role in drawing arrows to represent various way of algebraic pattern after making multiplication by themselves. Dialogic discourse as teacher's revoicing of students' thinking in classroom discussion helped students to reflect and adjust complex algebraic pattern embedded in multiplication tables. The findings showed a construction

of a semiotic system of multiplicative discourse included a set of multiplication signs, rules of multiplication sign production and relationship between the signs and their meanings.

Keywords: Multiplication Discourse, Algebraic Thinking, Semiotic Analysis, Open Approach

Introduction

One of the raising up issues in mathematics education reform today is the need to better understand and support discourse in classrooms (NCTM, 2000). Many researchers have attempted to explore the relationship between classroom discourse and students' mathematical thinking (Cobb et al., 1997, pp. 258-277). Although the idea of discourse is not a new one, but it is hard to establish in classroom.

The standards have drawn attention to the critical role that discourse plays in mathematical learning. Many scholars have studied the way that teachers facilitate discourse (Ball, 1993, pp. 44-48; Hufferrd-Ackles, 1999; Kazemi, 1999, pp. 410-414). There showed specific instructional techniques that seem to support the development of classroom discourse. For example, revoicing student's ideas helps other to follow along. Moreover, some studies have described classroom discourse as an instructional resource for teachers and students (Cobb, 2000; Lampert, 1990, pp. 29-63). These studies identified particular discourse structures that are used as students explain, ask questions, and communicate with one another about their solutions to mathematical problems and situations. Explaining one's thinking and being able to participate in productive discussions of mathematical ideas are important learning goals of mathematics education reform (NCTM, 2000).

This research addresses some aspects of reforming communication in a mathematics classroom innovated by Lesson Study and Open Approach, which considered classroom mathematics learning as social endeavor in which students come to learn and do mathematics through participating in communicative activity within a community of mathematical discourse (Van Oers, 2000; Sfard, 2002). This research employed Vygotsky's Theory (Vygotsky, 1929, 1978) which assumed that the development of the child's higher mental processes depends on the presence of mediating agents in the child's interaction with the environment. Vygotsky himself primary emphasized symbolic tool-mediators appropriated by children in the context of particular sociocultural activities, the most important of which he considered to be formal education

(Kinard & Kozulin, 2008). As Van der Veer and Valsiner (1991) mentioned, Vygotsky identified culture as sign systems-writing systems, counting systems, and language.

Based on Vygotsky's cultural- historical perspective discussion above, psychological tools like a language play a crucial role in human behavior and cognition by "transforming the natural human abilities and skills into higher mental functions" (Vygotsky, 1978). Semiotic activity (Van Oers, 2000) is one of higher mental activity of inventing symbols and attributing meanings explored by the children already from an early age. Van Oers defined the term semiotic activity as "the (inter- or intra) mental activity of creating meanings and signs, by reflecting on the interrelationships between (changes in) signs and (changes in) their corresponding meanings, and of adjusting signs and meanings accordingly". Semiotic activity (Van Oers, 2000) in young children is one of mediated activity focused on supporting student to get involved in mathematical activity with the help of appropriated language as a psychological tool. It was his belief in primacy of language as a mediating tool that drew our attention to classroom discourse as one way to explicate the development of semiotic activity. Moreover, concerning the role of language in the development, Vygotsky reasoned that language is its self-subject to mediation.

To identify the nature of classroom discourse, the researcher used Lotman' s (1988, pp. 52-58) argument that proposed that text (e.g. discourse) has a dualistic structure. First, text may serve as a passive link in conveying some constant information between input (sender) and output (receiver)" (p.36), a nature that Wertsch and Toma (1995) describe as univocal. In this, text is treated as information to be received, encoded, and stored. Consequently, any discrepancy between what is transmitted and what is received is attributed to a breakdown in communication. In contrast, text may also serve as s "thinking device" so that, rather than being interpreted as an encoded message to be accurately received, the utterances serve to generate new meaning for the respondent. Wertsch and Toma describe discourse as dialogic, is evidenced when a participant actively interprets text by questioning, validating, or even rejecting it. In this study has focal point on multiplicative discourse that means the communication channel for discussing ideas of multiplication and related with multiplicative thinking. The definition of discourse proposed by Lotman' s (1988, pp. 52-58) and Wertsch and Toma (1995) were employed for identify and analyze multiplicative discourse because it is suitable for the character of dualistic discourse in learning multiplication.

In this study, the mathematics classroom chosen as target is the one of mathematics classroom innovated by 'Lesson Study and Open Approach' (Inprasitha, 2010) in Thailand. The open approach as a teaching approach (Inprasitha, 2010) used in this research was incorporated in the process of lesson study, the core professional development process that Japanese teachers use to continually improve the quality of the learning experiences they provide to their students (Yoshida, 1999). In Thailand, Lesson Study and Open Approach is becoming an innovation for Thai teacher professional development that help teachers recognize the aspects of students' mathematics learning. The Open Approach is a "problem solving approach" used in Japan. Isoda (2010) mentioned that the approach is one shared theory for developing children who learn mathematics by/for themselves in Japan. It includes teaching about learning how to learn. The students often gain opportunities to learn mathematics with understanding and meaningful.

In Thailand, Inprasitha (2010) has conceived that the 'Open Approach' is a teaching approach used in cooperated with lesson study to design learning units and lesson plans. The open approach is consisted of 4 steps as follows:

1. Posing open-ended problem situations
2. Students' self-learning
3. Whole-class discussion and comparison, and
4. Summarization through connecting students' mathematical ideas emerged in the classroom.

The steps are presented in the following diagram:

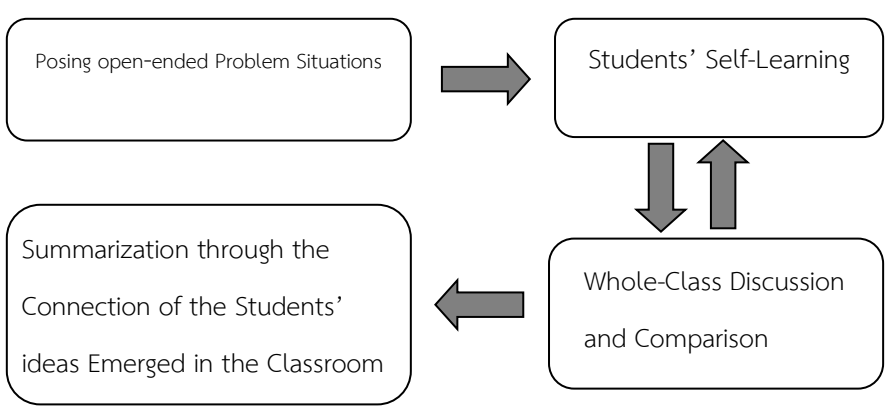

Figure 1 The four steps in the open approach as a teaching approach (Inprasitha, 2010)

In order to understand how student learn multiplication and construct pattern in multiplication table as a tool for learning multiplication, we can study by focusing on the nature of multiplicative discourse through semiotic activity related to the role of classroom discourse in each steps of open approach. In this study, our curiosity centers on understanding the nature of multiplicative discourse for making patterns in multiplication tables in classroom taught through open approach.

Research Method

The research was carried out in one second grade mathematics classroom including 28 students aged 7-8 years with lesson study team composed with two school teacher and two internship student. The mathematics classroom was chosen to be target group is the one of classroom in Ban Mae Sa school, elementary school in Chiang Mai province, which participated in the "The Project for mathematics teacher professional development innovated by lesson study and open approach in northern educational service areas" since 2009 academic year.

Data were collected during November-December in the second semester of 2016 school year and consist of daily videotaped recording of 15 lessons in each class on multiplication in second grade mathematics classroom made by two cameras. During each classroom teaching, one camera focused on interaction between teacher and student, especially in whole-class discussion. The second camera focused on students' group working. Moreover, 11 lesson plans on multiplication, students' written works, daily field notes that summarized classroom events and student ways of thinking and audiotaped of teacher interview were used as research data. The data from the video recordings of each class were transcribed into protocol. The data were analyzed by protocol analysis with semiotic analysis and presented the result in narratives.

Research Results

The research result show what and how multiplicative discourse of students and teacher played a major role for two topics: meaning of multiplication and discovering pattern in multiplication tables in each steps of open approach as a teaching approach.

1. Meaning of Multiplication

In open approach classroom teaching, the students learned meaning of multiplication, word language of multiplication and multiplication symbolic expression from problem situations that needed to think about the total amount of things when they were looking

for the same number of one set of things. Most of students use counting with the same number, it is easy for explore the total number. After that they used written language represent the meaning such as *"....on each dish, for...dishes, make...."*. It leaded to understand the meaning of multiplication as the calculation that is used for finding a total number when there is that same number for each one set and know the number of sets. The strategies students used were one – to-one counting and counting with number of things in each set. It is indicated that students have multiplicative reasoning. From the data analysis above, students make the meaning of multiplication that transform from one-to-one counting to additive composition before develop understanding of idea of unit or set of number of thing for getting the total number which is the way of many-to-one counting.

2. Discovering patterns in multiplication tables

The lesson that researcher has selected for analysis aimed students to be able to construct multiplication table of 2 from a problem situation. The situation was *"2 children are in each boat. Be calculate the total number of children as the number of boats increasing from 1 to 5 and 6 to 9"*. When teacher posed the figure of boat on blackboard, students were able to speak to represent the understanding of situation such as *"2 children on each boat, for 1 boat, it has (or become) 2 children"* and they wrote symbolic expression *"2x1= 2"*. After teacher posed the figure of 2 boats, student spoke immediately that *"2 children on each boat, for 2 boat, it has (or become) 4 children"*. Teacher asked students to write down the symbolic expression of multiplication and rearrange in proper pattern, they set the expression 2x1=2 2x2=4 2x3=6 2x4=8 ... 2x12= 24 in vertical form. The study found that students often observe the figure of problem situation and change word language expression they were using to symbolic expression of multiplication and were speaking aloud. Students executed the product of multiplication each equation by adding by two and looking for possible relationships. Students were able to conclude that when the multiplier increase by 1, the product will increase by 2. Moreover, they also looked for the relationship of the product of multiplication that can be done from additive thinking to multiplicative thinking and represented the relationship in various ways. From the classroom analysis, to complete the multiplication table of 2, multiplication discourse changed through the idea of additive composition to looking for multiplication relation in various ways and use the above invented ideas as learning tools for make multiplication table of other numbers. They made multiplication relations in form of pattern and leaded it to operate on operator on

multiplication table more complex patterns. It represented the multiplication discourse in idea of *"operating on operator"*. It showed the relations that the product increase by 2 equivalents with multiplicand by using arrows to represent it. Additionally, they did not use addition by two in making multiplication table, but they write the number on one place of 2x1 to 2x10 in one place of 2x11 to 2x20. Also, they were able to construct pattern for making multiplication table of other number in complex way as shown in figure 2.

Figure 2 Various patterns in multiplication tables

Conclusion and Discussion

From the analysis can be concluded that in mathematics classroom taught through open approach, students learned multiplication from transforming additive thinking to multiplicative thinking. As teacher posed an open-ended problem situation with the real world that sensible idea of multiplication to students. The students could be solving the problem by expressing various ways of students' multiplication thinking as they endeavored to make sense of the multiplication sign, and to formulate the meaning of multiplication. The learning process begin from one-to-one counting to compositive addition with the same number of multiplicands before expressing thinking as many-to-one counter with multiplier which is multiplicative counting.

The students constructed the multiplication tables and also a set complicated pattern in every multiplication table they made. Univocal discourse like "number set", "adding it up", "multiplier increases by 1" and "answers increase by..." were played an important role in drawing arrows to represent various way of algebraic pattern after making multiplication by themselves. Moreover, dialogic discourse as teacher's revoicing of students thinking in classroom discussion and comparison in open approach helped students to reflect and adjust the interrelationship between complex schematic algebraic pattern and meaning for making multiplication. The findings of the study led to draw a construction of a semiotic system of multiplicative thinking through multiplication discourse included a set of multiplication signs, rules of multiplication sign production and relationship between the signs and their meanings in which relevant concept of multiplication and pattern in multiplication table students made were embedded.

From the research results above, students' multiplicative thinking emerged as representation of multiplication representing same unit or set and increasing with the same number through making sense of multiplication by grouping, schematizing, writing and speaking ideas and describing reason that students made, it indicated that they have made sense of multiplication as the calculation that is used to get a total when there is the same number for each set. When they solve problem involving multiplication, they choose multiplication as an operator to find the answer without repeated addition. The reason for doing that, repeated addition is just one way to execute the answer for getting the total number. Repeated addition could not help students make sense of multiplication directly if the multiplier is large number. It causes students often face difficulty and use long time to find the answer by addition. It is indicated that repeated addition is not an effective tool for finding the product of multiplication.

Although the research result showed various way of students' multiplicative thinking, students need helping from teacher for promoting and engaging in learning activities for solving problem by themselves. By teaching through open approach, teacher have a crucial role in supporting student learning by themselves (Isoda, 2010; Sangpom, 2015, pp. 210-215; Sonpang & Sangpan, 2017, pp. 65-77; Suttiamporn, 2015, pp. 93-103) and reasoning as much as possible. The important aspect for learning multiplication and making multiplication table is supporting discourse for discussion the meaning and calculation. It leads student to construct multiplication table of other numbers easily.

The multiplication discourse described significant semiotic activity of learning multiplication. It stated the importance of creating opportunities for students' development of multiplicative thinking (Jacob & Willis, 2001). Through the step discussion inn open approach with discourse of multiplication originated by interaction with teacher and students and among in whole class, they have learned mathematics with understanding and meaningful.

Suggestions

1. Multiplicative thinking has importance role for learning multiplication and developing conceptual understanding on multiplication by themselves. Mathematics teacher should have a crucial role for promoting multiplicative discourse related with students' multiplicative thinking in their classroom.

2. Open approach is a teaching approach focusing on problem solving that teach can be learn to teach by using open approach with concerning the real world that can be useful for designing the problem situation and focusing on the way of student thinking any topic the student have learned.

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