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# Classroom Discourse and Its Role in Students' Development of Semiotic Activity in Mathematics Classroom Taught by Open Approach

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**Abstract**

The aim of this study was to investigate classroom discourse and its concomitant role in students' development of semiotic activity in mathematics classroom taught by Open Approach. The research was carried out in one first grade classroom in the project school innovated by Lesson Study and Open Approach in Thailand. Ethnographic methods were employed for collecting and analyzing data through classroom observation on 17 consecutive lessons on addition. Discourse analysis was employed for analyzing classroom transcripts according to each steps of teaching in Open Approach. The results revealed that the classroom discourse which played role in development of semiotic activity in solving addition problems can be characterized as univocal discourse and dialogic discourse. In the beginning step of Open Approach, univocal discourse like "combine" and "make ten" played a role in "drawing" as initial semiotic tool for representing decomposing and making ten strategies in later. In whole class-discussion and lesson summing up session, dialogic discourse as teacher's revoicing helps students to reflect and adjust the interrelationship between more complex addition problems and schematic diagram they used as strategies in solving the problem. Through the lesson students could come up with some conceptions or specific approach on solving addition problem.

**Keywords:** Classroom discourse, Semiotic activity, Lesson Study and Open Approach.

## 1. 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, Boufi, McClain, & Whitenack, 1997). Although the idea of discourse is not a new one, but it is hard to establish in classroom. Reform recommendations (NCTM Standards, 2000) have emphasized the importance of discourse to all mathematics classrooms. NCTM (1981) defined discourse as following:

Discourse refers to the way of representing, thinking, talking and agreeing and disagreeing that teachers and students use to engage in those tasks. The discourse embeds fundamental values about knowledge and authority. Its nature is reflected in what makes an answer right and what counts as legitimate mathematical activity, argument, and thinking. Teachers, through the ways in which they orchestrate discourse, convey messages about whose knowledge and ways of thinking and knowing are valued, who is considered about to contribute, and who has status in the group. (p.20)

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, 1991; Hufferrd-Ackles, 2000; Kazemi, 1999). 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 (Michael & O' Conner, 1996). Moreover some studies have described classroom discourse as an instructional resource for teachers and students, and in doing so have document how it might play out in particular classroom (Cobb, 2000; Lampert,1990). Specifically these researches identifies 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 (Hiebert et al., 1997; NCTM, 2000).

This research address 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 student come to know 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 (1929, 1986) which assumed that the development 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, 1986, p.xxv). Semiotic activity (van Oers, 2007) is one of higher mental activity of inventing symbols and attributing meanings explored by the children already from an early age. van Oers (2000, p.147) 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 involve in mathematical activity with the help of appropriated language as 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, I used Lotman' s(1988) argument 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 (Blanton et.al, 2001). 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, the mathematics classroom used for analyzed 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 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 teacher recognize this aspects of students' mathematics learning. The Open Approach as "problem solving approach" used in Japan that 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:

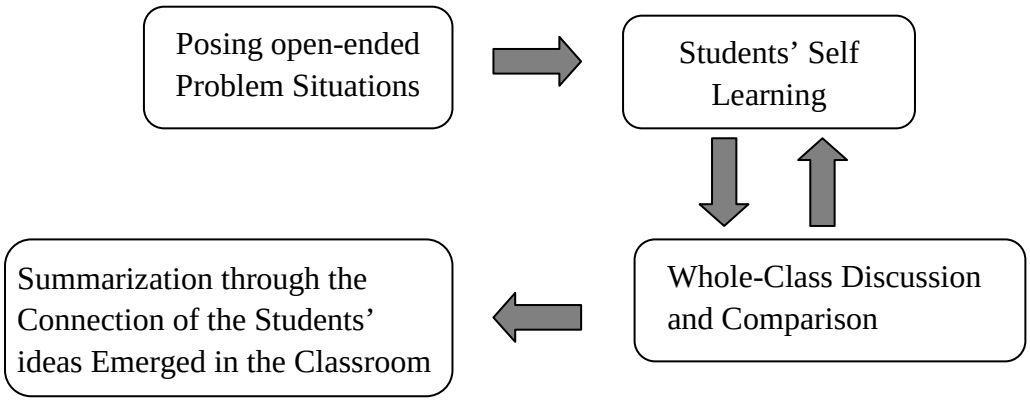



**Figure 1:** The four steps in the open approach as a teaching approach (Inprasitha, 2010)

As such, this context invites intense scrutiny in order to understand the development of student' s semiotic activity related to the role of mathematical classroom discourse through the step of Open Approach. In this study, our curiosity centers on understanding the nature of classroom discourse and its concomitant role in first grade students' development of semiotic activity in mathematics classroom taught by Open Approach.

## Research Method

The research was carried out in one first grade mathematics classroom including 32 students aged 6-7 years old and one student teacher who was classroom teacher. The mathematics classroom was choose to be target group is the one of classroom in Ban Nam Prae school, an elementary school in Chiang Mai province, which participated in the "Project for mathematics teacher professional development innovated by lesson study and open approach in northern educational service areas" since 2009 academic year. The project was conducted by the Center for research in mathematics education, Khon Kaen University and the mathematics education program, faculty of education, Chiang Mai University.

Data were collected during November-December in the second semester of 2010 school year and consist of daily videotaped recording of 17 consecutive lessons on addition in first grade mathematics classroom made by two cameras. During in each classroom teaching, one camera focused primary on interaction between teacher and student, especially in whole-class discussion. The second camera focused on students' group working. Moreover, documentation consists of 17 lesson plans on addition; students' written works; daily field notes that summarized classroom events and student ways of thinking; and audio taped interview with the teacher. The data from the video recordings of each class were transcribed into protocol to be used for video analysis and discourse analysis to analyze the classroom discourse and its role in development of semiotic activity based on cultural-historical theory.

## Results

From the analysis, in each lesson of the mathematics classroom taught by Open Approach as a teaching approach has 4 steps as 1) posing open-ended problem situation 2) students' self learning 3) whole discussion and comparison and 4) summary the lesson through connecting students' ideas emerged in the classroom. Three lesson (2/17, 4/17,10/17) of a series of seventeen addition lessons were choose to evidence the origin and development of semiotic activity with the help of psychological tool. In the beginning of the lesson, the teacher typically started with the presentation of the problem situation by telling a story along with the real world objects and picture in an attempt to motivate the student to learn about addition according to the meaning of addition as "altogether" and "increasing". The task for first lesson, teacher ask student to express the addition sentence and think about how to add the two number (the number of all children in play ground) in various way as followings figure 2.

**Figure 2:** Problem situation for lesson "9+4" (Gakkho Tosho, 2005)

**Problem:** Nine students are playing with the sandbox and four ones are playing on a slide. How many students are there in all?

Tasks:

1) Write mathematical sentence

2) Show how to calculate this

Through this lesson, in the step of posing problems situation, teacher engaged students to talk about the situation as following;

| | |
|---|---|
| Teacher: | So, we have nine students playing with the sandbox (write "9 students" on blackboard), what problem we can make for the situation, we have 4 students are playing on a slide and 9 students are playing with the sandbox and then... |
| Student 1: | We have students ah ah… |
| Student 2: | *Together, how many students?* |
| Teacher: | Together, right? |
| Students: | 13 |

Teacher: How to think about how many students are there?

In the step of problem posing as shown above, it shows the way developing semiotic activity through the discourse of addition. One student came up with the word problem using the term 'together' to convey and stimulate the classmates to come up with the word problem to fulfill the task posed. The teacher urged the students to find a way to think about it. Being led to the problem situation through their examination and using numeral to represent the children figures' number, the students were able to signify the number (9 and 4) embedded in the problem situation and also led to the decision to express addition sentence (9+4) from the discourse of "*together*" mutually communicated among the students. Such expression leads students to come up with the mathematical sentence in a meaningful way which could be inferred from their referring to the problem situation. In this sense, the discourse of "together" can be characterized as an "univocal discourse". It revealed that the word student use has intention to send message directly to teacher and other students about the meaning of addition situation. At the same time, the teacher revoicing "together" to the class in order to make a shared meaning about the situation.

Then, in step of student's self learning, children used units block and base-ten blocks that teacher provided as thinking tool for solving the addition problem by "decomposing and composing strategy". Then, they drew picture and wrote up sentences that show the process illustrated their action in thinking about adding how to solve 9+4 as figure 3.


I put blocks on the students picture. Then, I take one block away into block roll. I draw it and express the way that I think.

**Figure 3:** Student's drawing showing using unit blocks as a tool for decomposing

The student reflected his thinking imagining using the number blocks and drew them up as shown above. The student took out one single unit block and used arrow to transfer it to lining of 9 blocks and finally showed the product of 10 to be combined with the rest 3 blocks making the final solutions that is 13. The drawing was a psychological tool for developing semiotic activity showing the thinking process using the blocks, which served as the signifiers (meaning of addition) and the signified (using the block in order to make ten).

Moreover, in the lesson 4/17 on the activity- "Adding 8+3, I can do it" the students used the idea discussed in the previous lesson in solving addition problem 8+3 from which the teacher had taken the students' idea accumulatively added up and connected it with the thinking tools such as unit blocks and base-ten block. The process further led to the development of semiotic activity through discussion on discourse of how to think about calculation of 8 + 3 such as diagram which is the psychological tool as suggested by van Oers (2000) reflected in the following protocol and the figure 4 (a-b) below.

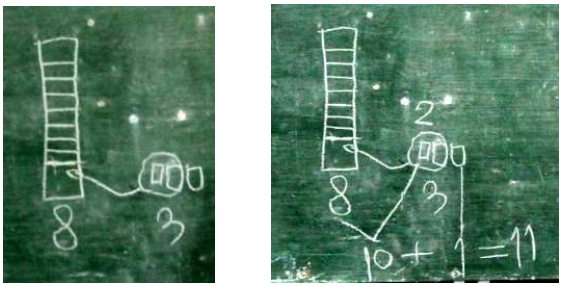



**Figure 4:** Student's drawings showing thinking process on 8 + 3 and drawing of the teacher extending the students' thinking

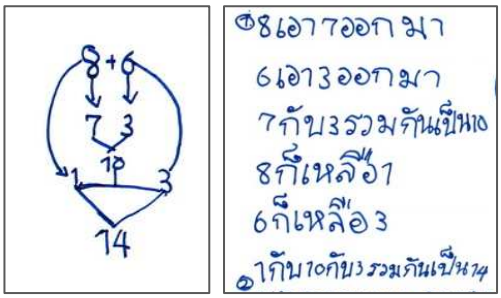
| | | |
|---|---|---|
| Student 2 | : | This one has only 8, not yet full. Find 2 more to fill it up. |
| Teacher | : | I see. Class, student 2 told us that there were only 8 blocks. There were none here. Two are left out. Ice then took two from there… |
| Student 2 | : | Yes…to there. |
| Teacher | : | Oh, yes. Two are placed here making it…. (Turned to other students) |
| Students | : | Ten |
| Teacher | : | Making it ten. When we put two blocks here, (wrote 2 on the two blocks). Two and 8 (drew the line between number 8 and the 2 blocks and drew the arrow down) making it…… |
| Students | : | Ten |
| Teacher | : | Make it ten now (writing 10). Here, the remaining is…. |
| Students | : | One |
| Teacher | : | There is only one left (writing 1). And now ten and one… |
| Student 2 | : | Combined and become 11. |
| Teacher | : | Combined both to make….. (writing "+" sign between 10 and 1.) |
| Students | : | Eleven ( the teacher wrote equal sign followed by 11) |

From above protocol, it show how the teacher led students into a semiotic activity in adjusting the sign (drawing with block) invented by children in the previous lesson to more abstract one as diagram. This process indicated that children' semiotic activity has transformed through the process of internalization from manipulative tool and discussion to inner psychological tool.

In addition, through the lesson the students were able to refine the diagram by themselves. We can see that the process of creating and adjusting sign or in here the schematic diagram along with the linking of the meaning through the use of arrows and operation in each of the steps had been originated with the language interaction between the teacher and the students in discussing and comparing done together in the classroom.

From analyzing data above, this lesson showed the nature of classroom discourse both of univocal and dialogic discourse in mathematics classroom taught by open approach. The written language like a "take away" and "make ten" used in step of posing problem can be characterized as univocal discourse. It conveyed the meaning embedded with manipulative activity referring to decomposing number strategy. Revoicing students' speech on decomposing strategy for making ten by teacher can be inferred as dialogic discourse. Teacher revoiced students' voices like a "becoming ten" "make ten, then it remain.." and "...combine...makes..." during comparing and discussion in order to extend students' ideas on calculation of addition using by decomposing and make ten strategies aimed at constructing shared meaning of calculation of addition in whole classroom. It plays a crucial role in making a sign and symbol for representing initially schematic diagram for addition.

In the next lesson with more complex problem, we found that the students used diagramming as the tool to solve addition problems and refined the diagram to represent the variety of thinking about how to make ten from decomposing the number during the process of solving the addition problems easily and skillfully. The teacher encouraged the students to communicate their thinking with written explanation of their diagram as shown in Figure 5.




I take 7 from 8 that leave 1.
I take 3 from 6 that leave 3.
7 and 3 makes 10.
1 and 10 and 3 makes 14.

**Figure 5:** Schematic diagram with their language use in explanation of solving addition Problem

## Conclusion and Discussion

The results revealed that the classroom discourse which played role in development of semiotic activity in solving addition problems in mathematics classroom taught by Open Approach can be characterized as univocal discourse and dialogic discourse.

1. Univocal discourse in spoken or written forms used by the students to communicate their understanding of the problem situation and their problem solving strategies with the teachers and the classmates used mostly during the stages of posing open-end problem and students' self learning but used less at the stages of whole class discussion and comparison, and

2. Dialogic discourse in spoken or written forms used by the students and teacher in communicating, responding, and exchanging ideas and methods of problem solutions in which the teacher had crucial role in this discourse by revoicing and expanding the students' univocal discourse to assure the collective understanding on the contents and strategies in solving mathematics problems found at the stages of whole class discussion and comparisons, and at the stage the summarization through connecting students' mathematical ideas emerged in the classroom.

The results indicated that in teaching mathematics by Open Approach especially in young child level, the learning and instructional materials like unit blocks and base–ten block and drawing schematic diagrams with students' language use are psychological tools that play a crucial role in development of first grade students' semiotic activity in solving addition problems. In their development of semiotic activity in solving addition problems, students used units blocks and base-ten blocks to operate addition with two numbers by decomposing and making ten strategies and drew iconic sign according to the action of decomposing number. Then, students drew schematic diagrams as symbol with their words to represent how to add two numbers corresponds to the meaning and the strategies they used. This finding supports van Oers (2010)'s suggestions that young children were able to reconstructed symbols according to their intentions, gradually shifting to more abstract symbolizations.

From the interpretation, in conclusion, the development of a child's semiotic activity start out from the operating with manipulative materials and discussing in whole- classroom with the language into the children's own schematic representation and helping them to improve these representation for the use of solving more complex problems, children are personally involved in the construction of psychological tools (drawings, diagrams). Consequently, the

research results confirm to van Oers (2010)'s mentions that the children learn to carry out semiotic actions with the help of these psychological tool as authenticated action of themselves. Moreover, developed semiotic activities of solving addition problem mediated by schematic diagram with the use of language helped students to learn a real concept of addition. The classroom discourse described is significant in that it stress the importance of creating opportunities for students' development of semiotic activity when they learn any topic in mathematics. Through discussion with discourse originated by interaction with teacher and students and among student in whole class, they have learned mathematics with understanding and meaningful and they have learnt how to learn mathematics for/by themselves (Isoda, 2010).

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