

The Research on Metaphors of Expert Teachers in Mathematics Classroom

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Metaphor is the main representations of teachers' practical knowledge, which can help students to understand mathematics better. Through the recording and quantitative analysis of video cases of expert teachers in mathematics classroom, there are some results after analysis:

- 1) Teachers use many metaphors in the classroom and most of that are structural-ontological metaphors, which takes a certain period of time.
- 2) Teachers use the metaphors mainly in the teaching process of introduce and explore by the form of question-answer.
- 3) During the process of concept teaching, the metaphors from the real-world examples can promote the students have more motivation to study. During the process of procedure teaching, the metaphors from similar materials can promote the students to understand the operational skill better.

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1. INTRODUCTION

Mathematics comes from real life, which is the high enrichment of life experience. The outstanding feature of mathematics is abstraction and it's also one of the main

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reasons that made it hard for students to learn mathematics. In order to help students understand mathematics better, teachers usually use metaphors to show the process of knowledge production. The metaphor is not only the main representation of teachers' practical knowledge, but also the empirical terminology (Jiang, 2008, pp. 155–156). It endues the teachers with an imaginative description of mathematics and help students experience the intellectual avenues that help them gain experience in mathematics.

Teachers often use metaphors to help students understand mathematics in the classroom teaching through their teaching practice, life practice and students' have gained experience in mathematics (Jiang, 2008, pp. 155–156). Through the recording and quantitative analysis of video cases of expert teachers in mathematics classroom, this research tries to search for the application conditions of metaphors in the classroom teaching (*cf.* Font, Bolite & Acevedo, 2010).

2. DEFINITION

The research focuses primarily on expert teacher and metaphor.

2.1. Expert teacher

The expert teacher familiar with the mathematics specialized knowledge and the teaching method, they systematically reflect their teaching and promote themselves through that. Moreover, they pay much attention to students and lead them to study. In China, the particularly outstanding teachers between middle and primary school may be designated as “special-grade teachers” (特级教师), they are the models for professional ethics and education, and also the experts in teaching. Therefore, the “special-grade teachers” is defined as the expert teacher.

2.2. Metaphor

Metaphor is one of rhetoric, which means a word or phrase used in an imaginative way to describe sb/sth¹ else, in order to show that the two things have the same qualities and to make the description more powerful. “Metaphor” and “Simile” are both belong to comparison, but they have some difference, “Metaphor” seeks to the similarity in essentiality and “Simile” seeks to the similarity in appearance.

Metaphor has always been a central area of interest and research in linguistics. Rarely, however, has the role of metaphor in learning been examined from an educational angle (Danesi, 2007), probably because it did not catch the attention of educators until after the

¹ somebody or something

publication of Lakoff and Johnson's highly popular and widely influential book *Metaphors We Live By* (Lakoff & Johnson, 1980)². They not only free metaphor from literature and rhetoric, and also bring it into the new field of cognitive theory. People use metaphor to understand and experience one concept by some things that we have known, which is essentially as a cognitive tool. It is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature (Lakoff & Johnson, 1980).

Lakoff & Johnson (1980) believe that there are three kinds of metaphors: structural metaphors, orientational metaphors and ontological metaphors. Structural metaphors means to comprehend one aspect of a concept in terms of another (*e.g.*, comprehending an aspect of arguing in terms of battle) will necessarily hide other aspects of the concept. Orientational metaphors arise from the fact that we have bodies of the sort we have and that they function as they do in our physical environment, most of them have to do with spatial orientation: up-down, in-out, front-back, on-off, deep-shallow, central-peripheral (*e.g.*, I'm feeling up today). Ontological metaphors can be divided into entity and substance metaphors and container metaphors. Entity and substance metaphors means understanding our experiences in terms of objects and substances allows us to pick out parts of our experience and treat them as discrete entities or substances of a uniform kind (*e.g.*, The mind is a machine). Container metaphors means we are physical beings, bounded and set off from the rest of the world by the surface of our skins, and we experience the rest of the world as outside us. Each of us is a container, with a bounding surface and an in-out orientation. This allows us to be quantified in terms of the amount of substance they contain (*e.g.*, The Mayflower is coming into view) (Lakoff & Johnson, 1980).

On the one hand, in view of "structural metaphors" and "entity and substance metaphors" are both used to comprehend one aspect of a concept in terms of another, this study grouped two specimens together as structural-ontological metaphors. On the other hand, orientational metaphors and container metaphors in relation to the positional concept, so we grouped these two specimens together as orientational metaphors.

3. PROCEDURE

3.1. Purpose

Through the recording and quantitative analysis of video cases, we are trying to explore the application of metaphors of expert teachers in mathematics classroom, and then

² *cf.* <http://theliterarylink.com/metaphors.html>

find out the value of using metaphors in classroom and how to use that effectively.

3.2. Participants

There were two expert teachers in this study, they were from T Middle School and C Middle School of Zhejiang Province, both of them had more than 30 years teaching experiences. We coded them as Teacher A and Teacher B. The content of their teaching was: "Combine like terms".

3.3. Procedure and method

The TIMSS Video Study and Video Case Study were used for reference in this study. We quantified and classified the video recordings of the teaching in two classrooms, and then compared with the metaphors including the time and frequency that teachers used in two classes, thus drawing some conclusions and inspiration.

4. RESULTS AND FINDINGS

4.1. Teachers used many metaphors in the classroom and most of that were structural-ontological metaphors, which took a certain period of time

Table 1. Metaphors in class

	Teacher A			Teacher B		
	Frequency	Time	The percentage of time	Frequency	Time	The percentage of time
Structural-ontological metaphors	5	8min 19sec	16.63%	5	5min 32sec	14.56%
Oriental metaphors	1	28sec	0.93%	0	0	0
Summary	6	8min 47sec	17.57%	5	5min 32sec	14.56%

We can see from Table 1 that teachers played great emphasis on metaphors in class (Teacher A is 6 and Teacher B is 5), most of them were structural-ontological metaphors, which took a certain period of time (Teacher A is 17.57%, Teacher B is 14.56%). Structural-ontological metaphors were used to comprehend one aspect of a concept in terms of another. Mathematics is an abstract of real life, metaphors can help students experience and understand the process of the formation and development of the mathematics through their life experience and knowledge that students had acquired. So we can certainly get to

know that expert teacher value teaching process very highly.

4.2. Teachers used the metaphors mainly in the teaching process of introducing and exploring by the form of question-answer.

Metaphor is pervasive in everyday life, not just in language but in thought and action. In the class, metaphors helped students understand the new knowledge — “Combine like terms” better through guiding something that students were familiar with. Table 2 shows that teachers used the metaphors mainly in the teaching process of introducing and exploring by the form of question-answer. Students are the subjects in the class, so in the effective classroom teaching teachers should tried to bring that into effect, should give prominence to students’ thinking development, and meanwhile encouraged students self-motivated, creative, quick to learn and result oriented by the inquiry — based teaching.

In order to help students develop correct learning style in the class, teachers usually used the form of question-answer to guide students experience the necessity and effectiveness of “Combine like terms” from their life and learning experience.

Through analyzing teachers’ questions in these two classes, we found that indicative questions and understanding-based questions were mostly used when teachers using the metaphors. But Teacher A spent more time in metaphors with questions than Teacher B, and there were some difference in students’ answers, the answers to Teacher A’s questions were understanding response and memorizing response, but the answers to Teacher B centered upon “silence”.

Table 2. Time and form of metaphors in class

Teaching	Teacher A		Teacher B	
	Time	Form	Time	Form
Introduce	5min22sec	question-answer	2min48sec	question-answer
Explore	2min26sec	question-answer	1min39sec	question-answer
Example	0		0	
Practice	0		1min5sec	explain
Summary	59min	question-answer	0	

4.3. Metaphors in the process of concept teaching and procedure teaching

The real line in Figure 2 and Figure 4 means the relation between example and abstraction, which is comparative. For instance, metaphor 3³ was the example of “Combine

³ “Metaphor 3” means this is the third time that teacher uses metaphors in this class. “Metaphor 1” to “Metaphor 6” means in a same way to this study.

like terms”, at the same time, “Combine like terms” was the example of multiplicative axiom. The dash line in Figure 2 and Figure 4 means the similarity between two objects. The arrow is pointing the teaching sequence.

“Like terms” and “Combine like terms” were the principal points in this lesson. Figure 1 and Figure 2 show that Teacher A educed concept of like terms with two metaphors. This related to students’ experience and had the similarity between them.

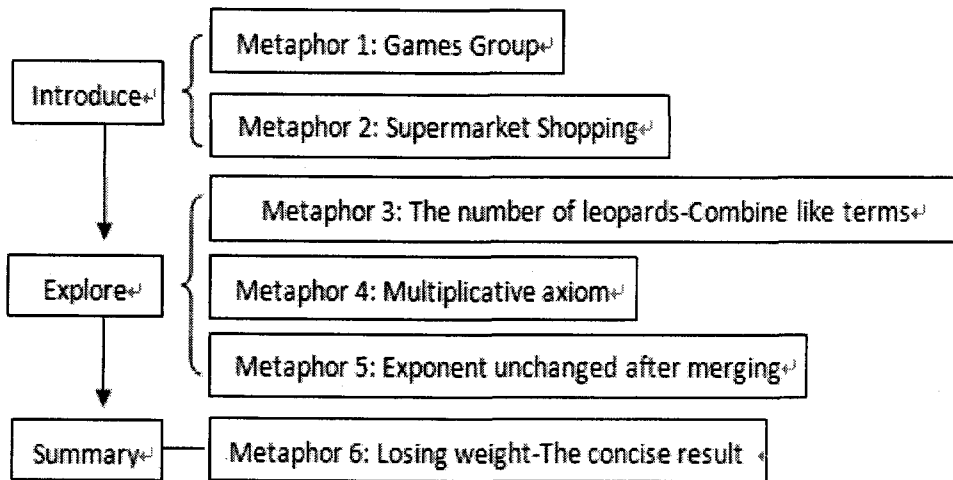


Figure 1. Teacher A using metaphors in teaching processes

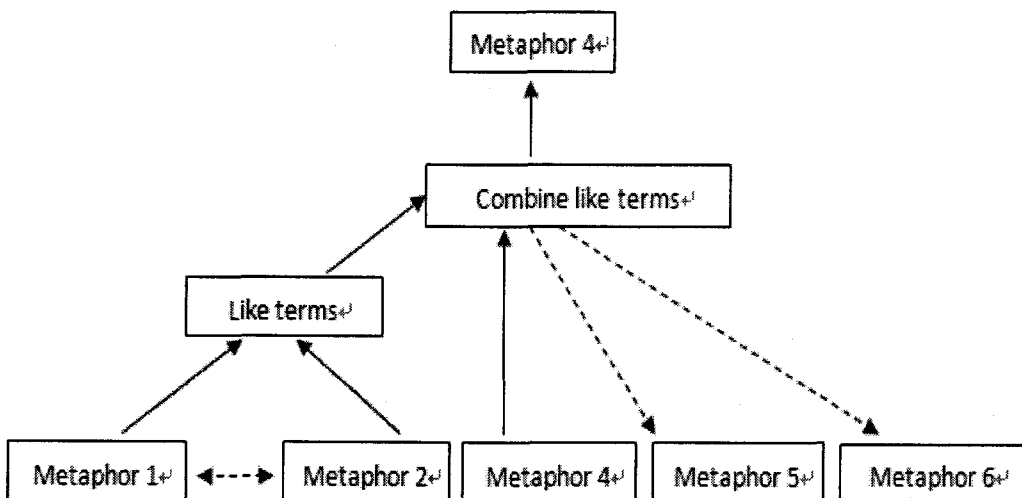


Figure 2. Teacher A using metaphors in each knowledge point

Two metaphors

Teacher A: We had a sport meeting not long ago. Well, you did very well. It was amazing. But did you think about the question that why boys and girls were not assigned in the same group?

Student: There are differences in physical between boys and girls.

Teacher A: Well done. In the supermarket, we can find that the same items are put together, and also the like items, do you know why?

Student: We can find what we need more convenient.

Teacher A: OK, so can the categorical thinking be used to classify monomial expressions that in the polynomial expression? Can you try it?

“Like terms” was the abstract generalization of these examples. Then Teacher A introduced how to combine like terms with metaphor 3 and revealed the essence of combine like terms with metaphor 4 (multiplicative axiom).

Metaphor 3

Teacher A: OK, let’s see this polynomial expression $2x^2 + 3x + x^2 - 3x^2 - 2x + 2$, if we take x^2 as a leopard, how many leopards can we get?

It is worth noting that the abstract level of metaphor 4 is higher than “Combine like terms”. At last Teacher A explained the result of “Combine like terms” with metaphor 5 and metaphor 6, which were the concepts that have similarity with “Combine like terms”.

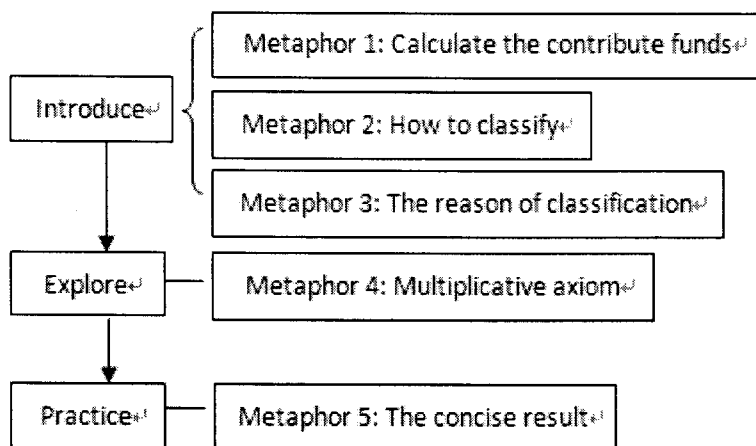


Figure 3. Teacher B using metaphors in teaching processes

Figure 3 and Figure 4 display that Teacher B got the concept of “Like terms” with metaphor 1, which was an example of “Like terms”, in the meantime, he explained how to classify and why with metaphor 2 and metaphor 3. Then in order to deepen students’ understanding of “Combine like terms”, Teacher B revealed the essence of that by the same way as Teacher A. Lastly Teacher B used a similar concept to explain the conciseness of result of “Combine like terms” with a metaphor, which can help students understand the necessity of combine like terms better.

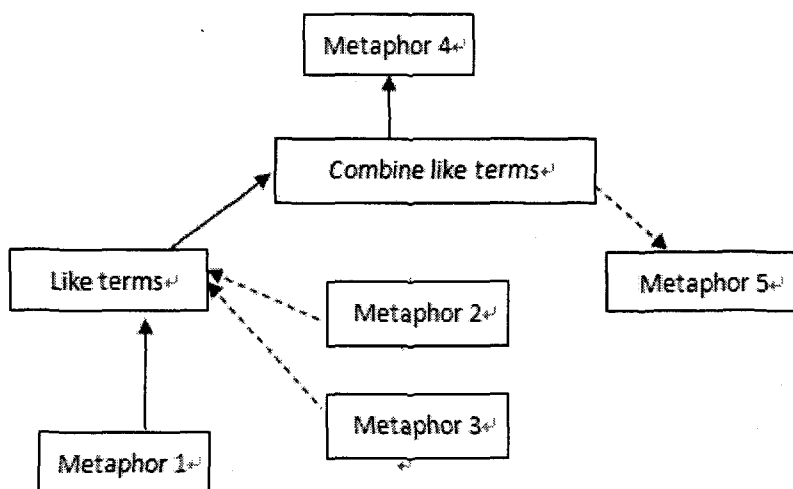


Figure 4. Teacher A using metaphors in each knowledge point

We usually use metaphor to understand and experience one concept by some things that we have known. From Figure 1 to Figure 4, we can conclude that during the process of concept teaching, the metaphors material usually from the real-world examples, and during the process of procedure teaching, the metaphors material usually from similar materials. At the same time, we also can use the concept whose abstract level is higher than the concept we need to learn.

5. SUMMARY

Teachers used many metaphors in their classes, most of them are structural-ontological metaphors, which mainly in the teaching process of introducing and exploring by the form of question-answer (Table 2 shows). Furthermore, there were more examples from real life and the similar materials that teacher used in the class, the answers to Teacher A’s

questions were understanding response and memorizing response, but the answers to Teacher B centered upon “silence”. Consequently, during the process of concept teaching, the metaphors from the real-world examples can promote students more motivation to study. During the process of procedure teaching, the metaphors from similar materials can promote students to understand the operational skill better.

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