Engaging Teachers in Reflective Practice:
An Activity Theory Approach from Hong Kong

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1. Context of Educational Change

Educational change and innovations have been characterized by their orientations towards the needs of a contemporary society in which equality among those who have and those who have not, fraternity between those who hold in one belief and those who hold another belief and liberty from being dominated economically or ideologically have been highlighted as the key values underlying the assumptions of many proposed innovations (Hargreaves et al., 2005; Wallace, 2005). Changes in education necessarily require changes in professional qualities of the teaching force and its organizations — schools which become the focal point of many planned departures from the traditional role of being teaching communities towards communities which engage actively themselves in searching for improvement and enhancement (Benham & Murakami-Ramalho, 2010; Day, 2000; Garet et al., 2001; Knight & Wiseman, 2005; McCormick et al., 2011; Stoll, 2009; Stoll & Louis, 2007; Walker, Edstam, & Stone, 2007; Zeichner, 2005). This radical reorientation of the role of the schools as a learning community as well as a community for social reconstruction together with the expectation of teachers being reflective practitioners has been recently received in the last thirty years in the West (Campbell & Groundwater-Smith, 2010; Hargreaves & Shirley, 2008, 2009; Hord, 2009; Hord & Sommers, 2007) and it has become more familiar with the countries in the East (Chan & Pang, 2006; Lee & Feng, 2007). However, little is known about how schools and teachers should respond to these changes and their concomitant challenges. In particular, the additional responsibilities to the schools and the teachers have been subversive to their traditional roles, being conservative and instrumental to the building of the society and its economy in the Asian context (Hopkins, 2007).

2. Research Design and Data Collection

The original project was started in 2004 and completed in 2006 in a Hong Kong elementary school. Its goal was to develop the curriculum leadership skills among elementary schoolteachers in order to enhance the

capabilities of the schools and their teachers. The project was exploratory and design-based and tried to incorporate the key features from the contemporary literature on teacher development and learning. The following is a summary of the key features of the effective models for teacher learning.

a. Actively engaging teachers in curriculum decision making processes (Hoban, 2002; Hopkins, 2007; Rogers, 1996; Rogers & Horrocks, 2010; Papa & Papa, 2011);

b. Teachers working in teams of colleagues preferably within their own subject teaching in the initial stage before moving to a more collaborative and integrative approach across subjects in the school curriculum (Borko & Putnam, 1998; Shulman & Shulman, 2004);

c. Teacher activities should be action oriented with reflection on practical experiences on innovative pedagogical strategies (Schön, 1983, 1987; Elliott, 1991; Stringer, 2007);

d. A team approach based upon "flattened" or "distributive" leadership allowing sufficient space for actualization of individual experimentation (Chrispeels, Castillo, & Brown, 2000; Gronn, 2000, 2002; MacBeath, 2005; Spillane, 2006; Spillane, Halverson, & Diamond, 2001, 2004).

Following this line of thinking, the project organized the intervention activities in the schools in the following ways:

a. Various curriculum development teams were formed on the subject base of the participating teachers, three subject based teams in the first project and two subject based teams in the replication study. The purpose is to orientate the focus of the activities and the contents of the discourses in the communicative networking systems of each team (Bernstein, 1999; McCormick et al., 2011);

b. Each team comprised teachers of various types of backgrounds such as experience, age and gender. The purpose is to recreate situations in which potential "information gap" would encourage exchanges and possibly create tensions for problem solving (Groundwater-Smith & Campbell, 2010; Stein, Silver, & Smith, 1999); and

c. Leadership was rotational and therefore, effects of power types would impact on the human relationship among members realized in the discourses of the meetings (Engeström, 1999a, 1999b, 2001). This time, no external consultant from the education faculties was invited so that more internal interaction was expected without external intervention.

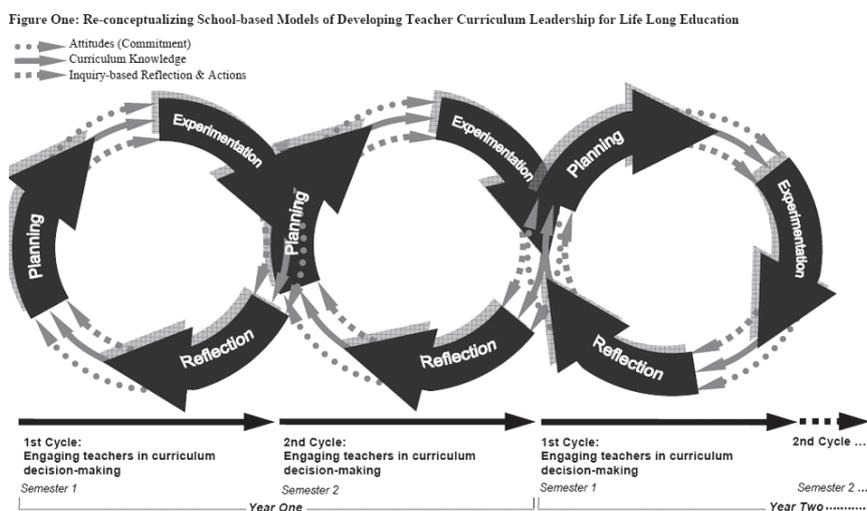## 3. An Effective Model of Teacher Learning in Schools

Different models of teacher development and change have been proposed and debated in the last thirty years besides the critical features of the necessary conditions for effective teacher learning that have been outlined in the above section. However, our PER model (Planning, Experimenting & Reflecting) is a simple

and convenient model that has encompassed all essential features of the effective teacher learning, engaging teachers in a series of spirally cyclical actions upon planning, experimenting and reflecting upon the pedagogical innovations in the school settings. Embedded in this PER model is our futuristic view about the role of schools as a learning community for students as well as for teachers. The following table summarizes the key activities at each stage of the cycle:

A Cycle of Action:
Planning, Experimentation, Reflection Model

Stage	Aims	Teacher Activities
1. Planning Stage	To identify a goal for innovation	•SWOT Meetings •Whole School Conference •Action Planning Meetings •Collaborative Lesson Preparation •Meetings Production of Materials
2. Experimentation Stage	To put the plan in action	•Trialling •Peer observation and Evaluation
3. Reflection Stage	To review actions and plan for future actions	•Post Observation Conference •Completion of Feedback Sheets

As we said early, this model of engaging teachers in a series of processes in making pedagogical and curriculum innovations assumes a holistic and continuous approach adopted in schools to engineer a learning culture among teachers. The following graph depicts the holistic strategy underlying this model of engineering changes among teachers.

Figure One: Re-conceptualizing School-based Models of Developing Teacher Curriculum Leadership for Life Long Education

4. A Theoretical Framework of Analysis

Different models or frameworks have been proposed to understand the process of knowledge creation and its realization in human practice. These various models are derived fundamentally from different conceptions about human learning. The most influential two are Piagetian and Vygotskian models of human learning. The former focuses on the cognitive transformation of an object of learning being assimilated from external sources (internalization) to the realization of that object of learning in actual human activities in response to various types of stimulations and challenges in order to maintain a state of being equilibrium psychologically (Piaget, 1953; Vygosky, 1978). The latter model emphasizes, however, the socio-cultural aspects of human learning and the functions of the various types of "artifacts" in mediating the effectiveness and the nature of the object of human learning (Gee, Michaels, & O'Connor, 1992; Engeström, 1987, 1990, 1992, 1994, 1999a, 1999b; Yamagata-Lynch, 2010). Both of these major models have generated many sub models of human learning situated in various types of human practices (Lave & Wenger, 1991). Dewey proposes a theory of human learning based on the needs of the human beings to solve practical problems in human activities. The process of solving problems generates new knowledge and innovative ideas in practice (Bereiter & Scardamalia, 1993; Dewey, 1968; Scardamalia & Bereiter, 1994). Carr and Kemmis propose a similar model of creating new knowledge by engaging teachers in a series of reflective activities in planning, experimenting and reflecting upon planned innovations in school situations (Carr & Kemmis, 1986). Engeström's activity theory, in particular the model of expansive learning cycles based upon the social nature of human practices, specify the functions of conflicts and tensions embedded in human practices in generating the needs (objects) for the search for new solutions (Engeström, 1987). In particular the functions of various types of human artifacts such as symbols and tools in the achievement of the object mediate the process as well as the realization of the object within the activity system which could be a team of teachers with a specific organizational goal or any other human organizations. This paper will use the key concepts of 'expansive learning cycles', 'mediation' and 'artifacts' in the analysis of the data with a purpose to uncover key and critical features in the process of creating and generating human knowledge and therefore shed light upon a practically theoretical model of teacher learning in school based innovations.

5. Findings and Discussions

The analysis follows the sequence of Engeström's theory of expansive learning cycles and applies the key concepts like 'mediation', 'artifacts', and 'perspectives' in the organization of the analysis. The purpose of the analysis is to show what the critical features of knowledge creation are in teacher situated learning

5.1. Stages of knowledge creation

5.1.1. First stage: questioning, challenging, criticizing and rejecting

The key features of this stage are the ongoing processes of challenging the traditional practice and rejecting some aspects of the accepted practice.

"We have no answer, we sit together now to discuss, the pedagogy is not important but the content issue, generally people would respond the emphasis is on the content, not talking about the method, if we have problems with the methods, people have talked about all these long time ago, mathematics has been well established for many years, we all talked about all methods, if we are involved in methods, we have difficulties."

(Literal translation: reading 0.30-1:15, co-planning meeting of the second innovation cycle, 12 April 2005)

The consultant questioned the traditional wisdom and practice of the educators and teachers, arguing with simple logic to him that the key issue is with the learning content, not with the pedagogy since mathematics educators have been talking about all sorts of methods of learning for many years. They should have been exhausted. The consultant here clarified the issues, identified the fundamental problem, established the direction of the discussion and clarified therefore the object of the activity system.

"Most importantly, based on your years of experiences, identify what is the real problem of learning with the students. For example, you talked about the comparison of fraction, we then had to think what is our priority to establish among students, afterwards, we decide what activities to play, without the clear concept of the object of learning, we ask students to fold the papers, divide something, these are superficial, after play, nothing gains. No concept is established among students, if the project leader Miss Wan does not specify what we do, we shall plan and decide freely..."

(Literal translation: reading 1:20-1:35, co-planning meeting of the second innovation cycle, 12 April 2005)

5.1.2. Second stage: analyzing the problem using historical-genetic and actual empirical approaches

This time the consultant resorts to the assistance of the historical power of experience among the participating teachers, establishing the groundwork for moving the focus of the exploration of the learning issue to a mathematical problem in the curriculum — identifying the real object of learning in the mathematics curriculum. This "search" for the object of learning becomes the real object in the activity system established by the consultant and constituted by the participating teachers

In activity theory, Engeström (1999b, p. 381) suggests four types of artifacts which serve as the meditational functions in the process of achieving the object of the activity system. These four types of artifacts can be identified in the meeting discourse.

5.1.2.1. Use of four types of artifacts in mediating the achievement of the object of the activity system

(a) First, "What" Object:

> *"Methods are not important but the learning content, the content first in our search"*
>
> *(Literal translation: reading 4.12-4:55, co-planning meeting of the second innovation cycle, 12 April 2005)*

"What" object here indicates that the realization of the object of the activity system among the teachers is the search for the focus of the learning content for the students.

(b) Second and third, "Why" and "How" Objects:

> *"You teach the value of fractions from the first lesson, before that, you have already taught about fractions? Then why do you want to choose to teach comparing the value of fractions?"*
>
> *(Literal translation: reading 2:25-2:45, co-planning meeting of the second innovation cycle, 12 April 2005)*

Here the consultant diagnoses and explains the potential properties of the learning content which therefore shapes the direction of the "object" of the activity system but at the same time, guides and directs processes and procedures of the activity system in "search" of the learning content. He switches between historical and actual empirical dimensions in his analysis.

(c) Fourth, "Where" Object:

> *"We are not talking about what methods to use, but a "concept" of learning, can each one of you talk about your view first?"*
>
> *(Literal translation: reading 3:15-3:55, co-planning meeting of the second innovation cycle, 12 April 2005)*

The focus of the discussion therefore is changing from the instructions given by the consultant upon the search for the direction of the discussion to the practical issue of realizing the "search" (object of the activity system) in meeting discourse. The object of the activity system is moved from "searching the focus of the discussion" to "finding out the object of learning for the students on the topic of fraction". This moves the development of the object to a new dimension.

Changing thematic development of the discourse in the meeting is as follows:

Theme 1: (the consultant) Deciding the protocol or direction of the following discussion (Procedural)
(Utterance 1- 9)

Theme 2: (the team) Following the decision and engaging in the exploration and identification of the focus of learning content (Substantive)
(Utterance 9- 30)

Theme 3: (the consultant) Re-orienting reflection upon the relationship between pedagogical strategies and the

focus of learning content

(Utterance 31-33)

One must note that in theme 1, the "how" artifact mediates the discussion on the clarifying and identifying the object of the activity system which guides the discussion, while in theme 2, the "what" artifact mediates the discussion on the clarifying and identifying properties of the learning object for students. In the process of analyzing the situational issues with the learning object, both "historical-genetic" and "actual-empirical" approaches are used. On one hand, the evolution of the real problem with learning is documented and its origin is dated back to the misconception about learning. The consultant clarified the misconception and pointed out the real problem should not be with pedagogical strategies being employed but with the identification of the learning content — misplacement of the real learning focus. Then he moved his analysis of the problem to the inner systemic relations between simple fraction learning and comparison of the value of fractions. The following excerpt showing an analysis of the problem with the learning object is illustrative of the application of the historical traces and empirical experiences to the origin of the real problem with the learning object.

"Before we calculate the fraction, but with comparison, it seems difficult. When students compare fractions with different (not common) denominators, you normally give them worksheets with blocks. I like to ask you what you did before you asked them to do the worksheets with blocks. Why did you want them to fill the blocks in the worksheet? Each of us talks about how you taught the concept of fractions. Are your methods the same? It could never be the same, I think."
(Literal translation: reading 4:25-5:35, co-planning meeting of the second innovation cycle, 12 April 2005)

Both the historical events (historical-genetic) about teaching the topic fraction and the empirical experiences of using worksheets (actual-empirical) have been used as the basis in achieving the object of the activity system which is the identification of the real learning object in learning the values of fractions decided in theme 1. The discussion continues and the object of this activity system (team of teachers) continues being the focus of the discussion — searching the real focus of learning. In the process, various types of artifacts continue appearing in the discourse and mediate the realization process of the object in the activity system.

5.1.3. Third stage: modeling the new solution

The discussion on deciding the focus of the learning content continues. However, the discussion switches between the application of appropriate methods and strategies in teaching fractions and the conceptual issues with learning fraction and its concomitant concepts. The following lists summarize the discussion contents of the meeting discourse in theme 2 which is about determining the focus of the learning content. The tension between pedagogical strategies and content knowledge continues between the consultant and the other members of the team.

(a) Pedagogical issues with effectiveness
Using empty blocks, dividing a cake, counting apples, folding paper, cutting pizza, categorization

(b) Concepts relating to fraction learning
'One', 'whole', values of fractions, equal division, equal fraction

The following excerpt illustrates the tension on deciding the focus of the learning content between the consultant and the teachers.

> *Consultant: "...dividing requires many methods...you may ask pupils to use their own methods to equally divide something...you could have some variations on the same learning concept...you should highlight the same concept with various methods, this helps, for example, giving students ten pieces and ask them to divide among 5 children, this is about concept learning."*
> *Teacher S: "We do not have time...can let them try to fold..."*
> *Consultant: "...must think about how to help students to establish concepts..."*
> *Teacher M: "dividing a cake... how to divide..."*
> *Teacher S: "Let them divide, and ask them to put them on whiteboard about how to divide...then they learn the concept..."*
> *(Literal translation: reading 42:25-43:35, co-planning meeting of the second innovation cycle, 12 April 2005)*

The teachers in the team often switch the focus of identifying the real learning content for the lesson to the methodological issues with learning fraction. It seems that they "reject" subtly the agreed object of the activity system in theme 1 of the meeting discourse.

The solution becomes:

1. The team decides not to teach the values of the fractions with different denominators. They are too complicated for the students without firm foundations on various concepts basic and prior to learning the values of fractions.
2. The team decides retreating to the teaching of the basic concepts of fractions in the traditional practice. This is a compromised solution to the real issue of identifying the learning content established in Theme 1 at the very beginning of the meeting.

Up to this moment, the object of the activity system, determining the learning content for the lesson, is faced with the real difficulties discovered in the team discussion. The perspectives of the participating members

of the team which serve the functions in the various forms of artifacts, 'what', 'how', 'why' and 'where', suggested by Engeström, shape and mediate the course of the discussion, reconstructing the initial proposal by the consultant. The early proposal of focusing on learning content on fraction seems too difficult for the students at this stage in the judgment of the teachers. The conflicting views on the object of the activity system on both sides still persist. The emergence of an initiative (focus of the learning content) has undergone a series of changes in its process of development and ended in a compromised form without changing the original nature of it.

5.1.4. Fourth stage: examining the new model

The second planning meeting confirms that the focus of the learning content is about fraction learning and its basic concepts. The development of the initiative proposed by the consultant, i.e. the problem of learning is with the misconception about learning content, ascends from an abstract idea (knowledge content) to concrete ideas in fraction learning (knowledge content in concrete forms in mathematics). However, one should note that this solution is a retreat by the team to the more fundamental learning issues with fraction. These issues are conceptual in nature. The following excerpt illustrates the nature of the discussion.

Consultant: "Do you give them examples how to do division in equal proportion? For example, slicing a cake diagonally? Sometimes, pupils do not feel they are of equal share?"

Teacher I: "Let them observe more, ask them which one is of equal share."

Teacher G: "Or we can focus on two equal shares?"

Teacher K: "more is better."

Consultant: "Regardless of the number of divisions, the sum is one."

(Literal translation: reading 30:15-32:24, co-planning meeting of the second innovation cycle, 25 April 2005)

This illustrates the team is examining in detail the compromised solution to teach pupils the basic concepts of fraction.

5.1.5. Fifth stage: implementing the new solution

This stage has two different sets of data. The first is the two lesson plans designed by the two participating teachers in the team. The second is the two video-taped practice lessons. These two sets of data illustrate how the compromised solution has been realized in the form of lesson plans and in practice lessons respectively.

Two lesson plans were designed by two teachers in the team on the basis of the agreed learning content — basic concepts of fraction. The first lesson plan demonstrates that the key concepts of fraction are included. For example, what is fraction? How is it expressed in number? To consolidate learning, pupils are asked to use a paper and divide it into equal shares. Coloring a share shows the meaning of fraction in concrete terms. A

rectangular shape is given and pupils are organized in groups to design a method to divide it in equal shares. In the email exchange between the consultant and the teacher, it is shown that additional suggestions were given on more variations in the representation of the fraction. Another lesson plan is different. To motivate pupils to think deeply, a pupil is asked to divide a sheet of paper into two. Then two other pupils are invited to choose one piece and each will be awarded a present in accordance with the 'size' of the paper. The class is asked whether this is fair. The class responds negative. This shows the importance of equal share. Then the teacher would ask the pupils to color one piece and show the meaning of fraction. Then in practice activities, pupils are given different shapes of paper to design how they could be divided equally. More activities of this nature follow to complete the lesson. These two lesson plans show that the compromised solution of focusing on the basic ideas of fraction is well conceived by the team and implemented in its realization process in planning and in design. In the email exchange, the consultant commented on the features of the learning content in contrast with the previous one though the difference is the emphasis on different conceptual issues in fractions.

In the two practice lessons, both teachers used different pedagogical strategies such as folding paper into equal and unequal shares to teach children the basic concepts of fraction. However, the first teacher did not relate coherently between the teaching of "less than one" and the subsequent activities on "dividing a piece of paper into equal shares". The second teacher had similar problems with the conceptual issues of 'fraction'. She asked a student to cut a piece of paper into two unequal halves which were then used to exchange for presents of unequal sizes to show the functional value of "equal parts". The conclusion to her was that unequal parts for different students mean inequality.

5.1.6. Sixth stage: reflecting on the process

A reflection meeting was conducted on 19 May 2005 after the two practice lessons. In the meeting, the tension between the consultant who insists on the key mediating artifact in determining the quality of teaching and learning is the lack of clarity with the learning content 'fraction' and the teachers who are overwhelmed with the issue of pedagogical variations. This conflict in 'perspectives' of the two parties persists and seems the practice lessons do not assist them to move from their well established beliefs about effective learning. The following are excerpts of the consultant to illustrate his beliefs about effective learning in mathematical concepts.

Consultant: "Yes, they do not understand the request from the question..In fact they may not master solidly the key concept of 'fraction'..You expect the students to fold the paper correctly in order to show the accurate mastery of the key concept, you did demonstrate how, but they failed again.. What does this show?"

(Literal translation: reading 7:42-8:15, reflection meeting of the second innovation cycle,19 May 2005)

Consultant: "You give details in the lesson plan, but you did not teach clearly the concept, you use 'about

half', or 'less than half', and therefore, the students follow your pattern of expressing these concepts. However, you insist on accuracy later and this distract the focus of the learning content... we must ask what you want the students to learning from these 'activities' of folding paper etc."
(Literal translation: reading 11:23-12:45, reflection meeting of the second innovation cycle, 19 May 2005)

The consultant's line of thinking about the distinction between pedagogy and content knowledge has not changed in the whole process of the PER (planning, experimenting & reflecting). He kept raising these questions in the reflection meeting and posed them face to face with the teachers.

Responses from the teachers are interestingly distracting from the perspectives of the consultant. The defense mechanism is realized in interactional mode of discourse, moving away from the real substance of the transactional mode. For example, distracting strategies include:

Teacher O: "Breakdown of computers in class" (to excuse from being responsible for students' mistakes)
(Literal translation: reading 3:10-3:12, reflection meeting of the second innovation cycle, 19 May 2005)

Teacher O: "The limit of the paper." (to give reasons why the students failed to fold the paper correctly)
(Literal translation: reading 4:05-5:10, reflection meeting of the second innovation cycle, 19 May 2005)

Teacher G: "My class was astonished to see the video camera. They would not be so quiet in class." (to explain why her students were quiet and lack of reactions in her class.)
(Literal translation: reading 15:22-15:24, reflection meeting of the second innovation cycle, 19 May 2005)

The consultant is persistent in pursuing the clarification of the key concepts around 'fraction' in the learning activities. He continued but faced with another teacher strategy of eliminating the persuasiveness of his arguments.

Consultant: "...Sometimes, you say the same 'size' but then you say 'the same shape', therefore what do you refer to when you say 'equal fraction'. Is it about size or shape? Normally, when two shapes overlap exactly, they are of equal share. After being divided into eight parts, the shape of each part changes. The students could not understand."
Teacher G: "They are ONLY primary three."
(Literal translation: reading 20:13-22:05, reflection meeting of the second innovation cycle, 19 May 2005)

The conflicting perspectives between the two parties are clear and obvious. Therefore, do we have evidence that the 'compromised solution' with the emphasis on conceptual learning gain grounds in the practical minds of the teachers?

5.1.7. Seventh stage: consolidating the new practice

Here as we can see from the planning and experimenting stages, the 'solution' is not something concrete but it is a 'strategy' of emphasizing in classroom pedagogy one perspective of teacher action and student learning, rather than a tactical teacher action. This 'solution' becomes the object of the activity system in the early stage of its development but is transformed to function as the mediating 'artifact' in shaping the new second activity system in its process of development. However, the vagueness of this solution allows flexibility and individual manipulation on the part of the teachers. It is hard to say whether this pedagogical strategy of emphasizing the priority of the clarity of the fraction concepts has taken root in teacher practice. However, we have more evidence on this real issue with the theories of expansive learning cycles and other knowledge creation models such as action research and problem solving approaches. What is the new knowledge being gained by the teachers or being generated collectively by this team in the process?

5.2. Teacher journals after reflection meeting

In the individual journals written after the reflection meeting, one teacher wrote she learned using different approaches to teach 'equal fraction' and the various mathematical concepts related to fractions. Another teacher wrote that she learned about the possibility that the teachers misunderstood the conceptual complexity of certain key concepts which looked simple to them. She also learned the variations in terms of pedagogical strategies in relation to the abilities and uniqueness of different classes. The third teacher wrote she learned how to help students to establish 'concepts'. All these claims are explicitly written in the journals while one should note that in the planning and reflection stages, teachers have engaged themselves in 'a tug of war' (implicitly embedded in negotiation of meaning) with the consultant. In other words, teachers are well aware of the issues with the conceptual clarity in the focus of the learning content as it is shown in the journal writings (being conscious) while these issues have been implicitly 'mediated' or 'rejected' in the negotiation processes.

5.3. Teacher interviews before and after practice lessons

The teacher interviews are important data to uncover whether there is evidence in the 'perspectives' of each individual teacher upon the key issue here – the conflicting views about the role of pedagogy and learning content of the consultant on one side and the teachers on the other side since the 'compromised solution' has its root in the tension between these two conflicting views in achieving the object of the activity system. We put aside the complaints from the teachers about time, workload, stress, operational efficiency and organizational issues but focus our observations and discussions on the 'perspectives' of the teachers on the conflicting issues about the focus of the learning content.

Teacher S, the team leader, expressed explicitly his view about the function of the consultant in being assertive and being probing. He uses the word 'inch' to label the critical and uncompromising style of the

consultant in 'questioning' and 'challenging' the traditional practice of the teachers. The message in the interview also reveals a teacher dimension on maintaining social coherence in the team showing that the 'style' of the consultant violates this important interactional principle among teachers. However, the mediating function of the perceived intellectually superior status of the consultant forces the teachers to succumb. After the practice lesson, his view on the role of pedagogy and learning content in effective learning and teaching has moved to another stage, discovering that the students could be very creative beyond their imagination when the teachers are forced to vary their pedagogical approaches. He is also aware of the role of the importance of the mastery of the concepts in effective learning.

Consultant: "This time, we want them to learn fraction, at the beginning, we want them to learn how to compare the values of fractions, this is a comparison, have activities, have fun, have activities and it would work well, we want them to establish the concept of fraction… But the consultant says if the students are confused with the concepts of 'fraction', they would find comparing different values of fraction even more difficult. Then we work again on the mastery of fraction concepts…then we should use two pedagogical strategies which stretch us to think about alternatives, one uses 'cutting pizza' (circle) while the other uses 'cutting different shapes like rectangle and square'. How to divide them into equal shares? Some students use 'wrong' methods, with wrong results. This helps us to think?... using different strategies means using different learning methods… this helps us…" (Literal translation, reading: 40:13-42:05, individual interview with Teacher S, May 2005)

Consultant: "…asking students to fold papers in order to divide it into equal shares…they fold in different ways with different shapes that we never imagine before…thinking carefully, they are right…we can see students think creatively…" (Literal translation, reading: 43:12-44:21, individual interview with Teacher S, May 2005)

Consultant: "…see students understand the concepts in the activities…except one or two who fails…but they heard about the concepts…because we had more content in this lesson…we should deduce the learning content…see students have deep mastery of the learning content…the correct mastery of the fraction concept is clear to them…"
(Literal translation, reading: 45:06-47:11, individual interview with Teacher S, May 2005)

Teacher M, the panel head, thought that she could not imagine the collaborative lesson preparation leads to the emergence of many creative ideas among teachers. However, she also explicitly expresses her concern about the theoretical perspectives to the issue of teaching fraction. This may be her response to the consultant's orientation towards issues with the focus of the learning content.

Teacher M: "… in operation we are able to know concretely what to do, we collect our views, views on strategies… but if we move to a theoretical perspective, I do not know what to say…"
(Literal translation 001, reading 6:07 – 6:58, individual interview with Teacher M, April 2005)

Teacher M: "… different pedagogies lead to the different learning goals and outcomes… this is mathematics."
(Literal translation 002, reading 7:13 – 7:56, individual interview with Teacher M, April 2005)

She is also well aware that different pedagogical approaches may lead to the mastery of different learning contents in mathematics.

Teacher M: "… the consultant suggests the using different strategies leads to the achievement of different learning outcomes… indeed 'equal fraction' is to 'take a half' of something… 'taking a half' has many methods of division, before, we take it for granted that a half of a circle, indeed it is not always the case… taking a half from many other shapes gives you surprises… students can create their ways of dividing equal shares… traditional practice is that the teacher folds paper… teachers do for the students… but now we let the students do…"
(Literal translation 003, reading 13:05 – 14:02, individual interview with Teacher M, April 2005)

Her views about the issue of learning fractions seem to be aligned closely with the consultant. However, we have no evidence to establish the relationship between the two.

Teacher M: "… indeed, teachers can discard the traditional practice and views… in particular I taught so many years and I had my own practice, after this experience, I discover we can take different views and approaches. Or some approaches have never been considered and imagined by me… I would change myself…"
(Literal translation 004, reading 5:13 – 6:07, individual interview with Teacher M, May 2005)

Teacher M: "… how does a fraction emerge? Indeed, it appears when something is 'less than one', in other words, different classes learn fractions, but one learns about how to divide, how to divide 'equal shares' and others learn what fractions are."
(Literal translation 006, reading 9:26– 10:08, individual interview with Teacher M, May 2005)

The interview of Teacher M has shown that she is well aware of the issue with the learning content and the relationship between pedagogical variations and the learning outcomes. One should note that the interview questions remain open-ended without any hints about the direction or the expected contents of her response.

She has chosen to focus on the content issue with learning, rather than the pedagogical issues.

Teacher O is one of the two teachers who implemented the newly revised lesson plan with the focus on the 'compromised solution' – reorienting the focus of the practice lesson on the mastery of the basic concepts of fraction. In the interview before the practice lesson, she was well aware of the problem with the conceptual issues that were raised by the consultant.

Teacher O: "Textbook suggests we should explain the origin of fractions… Then ask students to color the appropriate portions of the picture etc…give them a picture and ask them to color only, but the new method focuses on the origin of the equal fraction, or through folding paper…or I have misconceptions about the mathematical issues, my first degree is not mathematics."
(Literal translation, reading 17:15 – 18:06, individual interview with Teacher O, April 2005)

After the practice lesson in the interview, she explicitly confessed that she learned she should stimulate student thinking by asking open ended questions in her teacher training program but she simply forgot to switch to the 'espoused theory', still sticking to the 'theory-in-practice' without her consciousness. (Paraphrase from the original 002, reading 3:09 – 3:52, *individual interview with Teacher O, May 2005*) She is also conscious and explicit about the function of the consultant, being an outsider who has little concern about the socio-political relationship among the teachers who know each other so well. Maintaining the positive social relationship in the team becomes a priority in our discourse. (Paraphrase from the original 003, reading 6:17 – 6:58) Her reflections in the interview focused mainly on the pedagogical strategies until the last monologue she gave the interviewer:

Teacher O: "I would find examples from daily life about the concept of 'less than one', using fractions or the other methods to express this concept…then we introduce the concept of equal fraction, distributing different shapes, asking them how they could divide them into four or eight equal shares...let them clarify their mind with some practice activities…the students failed to divide the shapes, they do not understand clearly, I should teach again in the next lesson."
(Paraphrase from the original 008, reading 25:03-25:56)

She appreciated the opportunities to conduct peer observation, becoming more aware of the problems the teachers faced.

Teacher G is another teacher who conducted the second practice lesson. Before the practice lesson she was already aware of the problem with the conceptual clarity in learning fraction. (Paraphrase 001, reading 1:05 – 1:56)

Teacher G: "Indeed, we may be aware of the potential problem with the focus of the learning content, but we do not know what it is. But after the explanation of the consultant, the problem may originate from the weak mastery of the basic concepts of fraction which affects the effective learning of the comparative values of fraction…"

(Literal translation 002, reading 3:36 – 4:28, individual interview with Teacher G, April 2005)

After the practice lesson, the conceptual mastery is considered being related to the pedagogical strategies used differently in the two practice lessons. One practice lesson adopted a traditional teacher talk approach while the other practice lesson adopted the activity approach giving students to fold different shapes of paper in order to move student conceptualization from concrete experiences to abstract level of understanding the concepts of fraction. (Paraphrase 001, reading 10:19 – 12:08) The students also tried out different types of 'folding' the paper without teacher instructions because the activity allowed students to adopt a new approach to a common task of folding paper assigned by the teacher. (Paraphrase 002, reading 12:19 – 13:07)

Teacher G: "… the conceptual issues cannot be solved in one lesson. We could not solve them. But after the discussion with the consultant about how to tackle these conceptual problems with learning fraction, we think students may still have problems with the basic concepts of fraction. If we teach them another new concept about fraction such as 'equal fraction', they may still have problems. The consultant reminds us of the coherence and sequence in learning concepts in mathematics."

(Paraphrase 003, reading 15:07-17:18)

This is essential because it relates to the real issue about the relationship between pedagogy and content knowledge, appropriate sequence in learning a series of mathematical concepts about fraction (Shulman, 1986).

5.4. Student interview before and after the practice lessons

In the student interview before the practice lesson, the 3D class students appreciated the pedagogical variations in Teacher O's lessons. (Paraphrase *001*, reading 20:23 – 21:15) They found them interesting and motivating. When they were asked about the practice lesson, they had the following views:

Interviewer: "What did you learn in the practice lesson?"

A student: "Fraction, percentage."

Interviewer: "Fraction, denominator, nominator."

A student: "These concepts have not been taught."

A student: "Square, histogram."

A student: "I made a mistake, one over two, I colored two, instead of one half

A student: then I colored them all, and no fraction, we had fraction with circle."

(Paraphrase 002, reading 12:32 – 14:08)

This categorically shows the student had the real problem with fraction and the various pieces of activities and actions in the practice lesson. Some of them could hardly find linkages and meanings among various types of actions and learning activities assigned by the teacher. In another class 3C, the students expressed their preference over learning activities. They liked games. After the practice lesson, some students expressed having difficulties in understanding fraction.

A student: "I do not understand fraction and division bar, because a denominator carries a numerator and then one is 'bigger' than the others."
(Paraphrase 003, reading 4:48 – 5:32)

A student: "The triangle, folding, but not many students are able to fold successful, only a few were successful."
(Paraphrase 004, reading 15:42 – 16:13)

The students who were interviewed showed that the two practice lessons were far from being successful in 'teaching' the concepts of fraction. This observation could possibly be aligned with the concern expressed by the consultant that the real problem of learning lies in the conceptual clarity of the learning content, rather than the pedagogical variations that both practice lessons had shown.

6．Discussion and Conclusion

The knowledge creation models in teacher situated learning argue that the engagement process allows emergence of new ideas and innovations. The application of the expansive learning cycle and the key concepts of activity theory in the analysis of the data derived from a teacher leadership project is our first attempt to uncover the layers of meanings in understanding the complexity of the emergence and development of new and innovative ideas in subject based curriculum development teams in schools. Three observations are significant to the theories of knowledge creation. First, the recreation of the situated learning opportunities in teams shows the emergence of the compromised solution (new ideas to the teachers) embedded in the planning meetings which were filled with tensions and conflicting views 'softly mediated' by the team's efforts to maintain social coherence, rather than the search for the real problems with effective learning. The divergence in views about the identification of the focus of the learning problem between the consultant and the rest of the team members show vividly the huge gap in 'perspectives' between the two camps. The 'compromised solution' was tried out in two practice lessons without much success in leading students to master the key concepts of fraction despite the use of various pedagogical strategies by the teachers. Second, the failure of the two practice lessons in

achieving its pedagogical goal in the clarification of the fraction concepts, in particular with the teachers being aware of the alternative approaches used by some of the students in folding paper, allows teachers to be aware of the priority of the learning content in effective learning. Third, the claim that the knowledge creation models lead to emergence of new ideas and innovations should be qualified with due consideration about the effects of the mediating artifacts such as 'divergence in perspectives', 'priority of maintaining social coherence in teams', and 'historical-genetic experiences embedded in traditional practice' upon shaping the form and the substance of the 'newly compromised solution'. Fourth, the Asian culture of the priority of maintaining social coherence shows its effect in the reflection meeting. The domination of the interactional mode of the discourse indicates the transactional function has been subsumed and mediated mildly. However, when the priority of the social coherence disappears as it is the case in individual teacher interviews, the preference of the transactional mode re-appears among all four teachers. The interviews show explicitly the reflective and apologetic tone of the teachers in the recognition of their inadequacy in teaching the conceptual distinctions among fraction related concepts in the practice lessons. This awareness of the conceptual issues in the learning content and the appropriate pedagogical manipulations may become the achieved object of the activity system in the innovation project. The empirical study here with the assistance of the activity theory illustrates that the complexity of the knowledge creation models in teacher situated learning is mediated (or facilitated or constrained) negatively or positively by various artifacts such as 'cultural preference over social coherence' ('how' artifact), 'divergence in perspectives' ('what' artifact), 'recognition of the issues with conceptual clarity' ('where' artifact) and 'student failures in folding paper and students' new initiatives' ('why' artifact). There is good reason for educators to revisit the established procedures and practices of these knowledge creation models in organizing teacher development and learning activities.

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