

THE EFFECT IMPROVING TEACHERS' KNOWLEDGE OF PRACTICE: CONCEPT-MAP IMPLEMENTATION IN THE MATHEMATICAL TEACHER PROFESSIONAL DEVELOPMENT COMMUNITY

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Abstract This study focused upon the effects of implementing the concept-map learning method among math educators. It is believed that this method is effective in assisting teachers during lesson content and activity design and reflection of teaching practice. This research found that the concept-map learning method was effective in different experience levels of teachers range from master-level to student teachers. The effectiveness of this method was found in assisting teachers when communicating teaching ideas during professional development discussion groups. This method also greatly aided in strengthening their knowledge of teaching practice.

Keywords: concept map, mathematical teacher professional growth, cognitive apprenticeship.

1 Introduction

The enactment of Taiwan's nine-year plan has been elevating teachers' role from knowledge deliverers to instructors, curriculum designers, and action researchers. The question in many minds was what effect does this change have had among teachers. More specifically, what effect did this change have upon math teachers? Leinhardt & Smith (1985) considered teaching as a cognitive activity within a complex cognitive skill. Shulman (1986,1987) suggested that teaching expertise should be described and evaluated in terms of pedagogical content knowledge (PCK), and Cochran, DeRuiter & King (1993) modifying Shulman's concept of PCK, emphasized the importance of teachers' knowing about the learning of their students and their environmental context in which learning and teaching occur. In contrast with rote learning, Novak (1984) adopted Ausubel's theory and proposed that meaningful learning concerns on individuals must choose to link new knowledge to relate concepts and propositions they already know. According to Novak, Concept maps allow both students and teachers to learn small number of key ideas they must focus on for any specific learning task. They present meaningful relationship between concepts and propositions, and provide a schematic summary of what has been learned.

This study focused upon a community (the Mathematics Teacher Professional Development Community -- MTPDC) of 13 math teachers in order to find out how concept maps had affected their knowledge of practice. This community consisted of six junior teachers (less than three years experience), and seven senior teachers (more than three years experience). These teachers were divided into four groups. Once groups formed, teachers were given concept-maps and directed to use them when designing learning activities, lesson content, and personal reflection of teaching practice. Four dimensions of teachers' knowledge of practice (1) teaching activity design, (2) learning content design, (3) implementation in practical teaching, and (4) reflection of teachers will be discussed in the rest of this research.

2 Theories

Shulman(1987) suggested that pedagogical content knowledge is the category most likely to distinguish the understanding of the content specialist from that of the pedagogue. Cochran et al. (1993) modifying Shulman's concept of PCK, emphasized the importance of teachers' knowledge regarding the learning of their students and the environmental context in which learning and teaching occur. The development model of PCKg for teacher preparation includes four components of understanding pedagogy, subject matter, students, and environmental context.

According to Novak (1984), Concept maps works to make clear to both students and teachers the small number of key ideas they must focus on for any specific learning task. Novak (1996) suggested that concept maps serve to show relationships between concepts, and it is from these relationships that concepts derive their meaning...with growing attention in schools to effective teaching and learning, concept mapping has been found to facilitate cooperative learning and other kinds of group work.

Collins, Brown, Newman (1989) proposed “cognitive apprenticeship” to rethink teaching and learning in the school. According to Collins et al., cognitive apprenticeship involves the development and externalization of a producer-critic dialogue that students can gradually internalize. The framework describes four dimensions that constitute any learning environment: content, method, sequence, and sociology.

Researchers conducted the teachers’ knowledge of practice in the study with Shulman’s PCK framework and Cochran’s PCKg framework. Teachers in the Mathematics Teacher Professional Development Community (MTPDC) was guided under cognitive apprenticeship and learned to design the teaching activities and learning content with concept maps. The purposed of this study is to explore the effects on improvement of teachers’ knowledge in practice after they learned concept mapping.

3 Design and Procedures

This study adapted qualitative approach and the design of this research is divided into four sections as follow:

3.1 The condition of the study

Members in the MTPDC were supported by the Compulsory Education Advisory Group of the Kaohsiung Municipal Department of Education came from different secondary schools in Kaohsiung City of Taiwan. It is a project focused on continuous training and improvement of teachers’ expertise. There were six junior teachers (less then three years experience), and seven senior teachers (more then three years experience). Researchers divided members of the community into four groups including four kinds of teachers. One professor from National Kaohsiung Normal University was invited as an advisor. In the beginning of the study, the MTPDC sessions has been holding for five month. Teachers in the sessions discussed about teaching knowledge, and felt mix-up in their action research of teaching. The advisor provided the concept-map method to help teachers clarifying their confusion and solving problems.

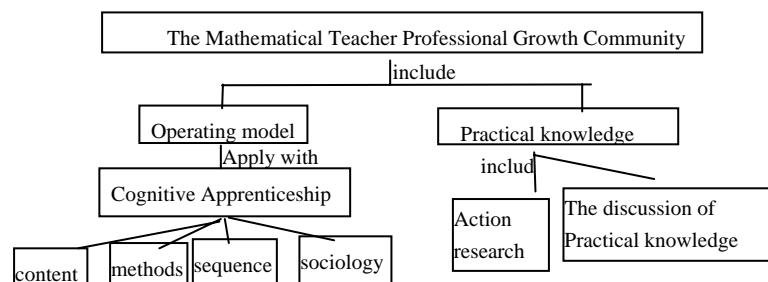


Figure1: Concept map of the Mathematical Teacher Professional Growth Community

3.2 Researcher’s role

The researcher who is a member of the Compulsory Education Advisor Group of the Kaohsiung Municipal Department of Education is one of the conductors of the community. At the same time, researcher also attending sessions of the community with teachers and perform as a participatory observer.

3.3 Data collection

There data collection procedures were: observation, face-to-face interviews, interaction at the sessions, documentations, diaries of teachers, video tapes, and open-ended questionnaires.

3.4 The concept map of the framework the teachers' knowledge of practice

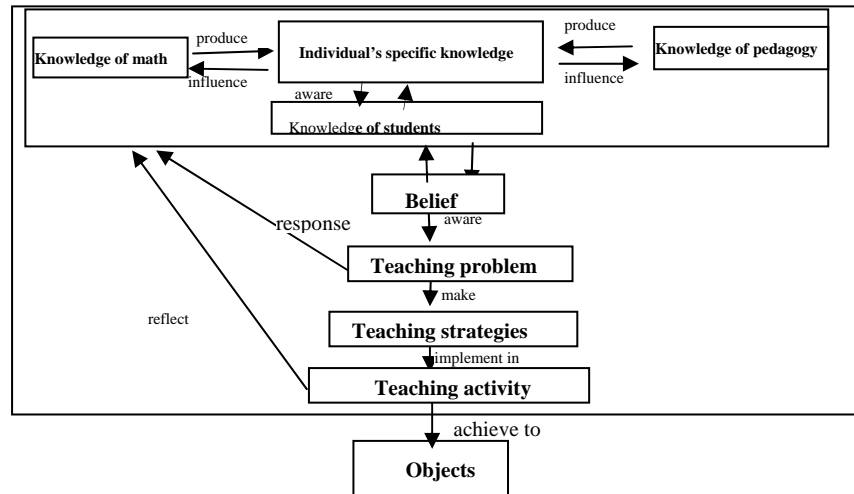


Figure 2: teachers' knowledge of practice

4 Findings

4.1 Teaching activity design

Finding I: Concept maps method was helpful in clarifying mazy thoughts and easy to capture the objective of activity with less intervention when designing teaching activity with concept maps. Teachers can design a clear sequence of teaching activities and choose proper assessments quickly.

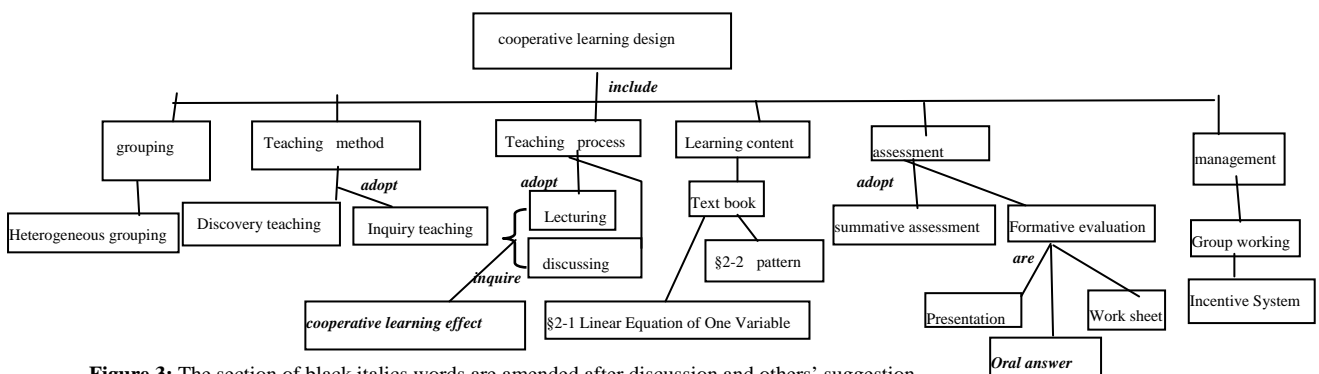


Figure 3: The section of black italicized words are amended after discussion and others' suggestion

Finding II: Discussing the linkage of the map with others helping teachers integrating their thoughts after repeatedly generate concept maps several times. For example, Teachers tend to design teaching content, assessments, and teaching methods individually at the beginning of the process. However, after meetings of discussions, they constructed the cross-connected line of the map, and consider content, assessment, and method as a whole and start to move towards systematic design.

Finding III: Teachers often forgot to state the linkage between concept nodes when they start to construct the map. It is difficult for them to state the relationship of two concepts, especially for feature teachers and initial teachers. However, teachers agreed that the relationship among concepts

were like bridges to connect and combine different levels of concepts, and to make teaching procedure smoothly.

4.2 Learning content design

Finding I: Creating concept maps for the learning content design help teachers to organize and reconsider the levels of math concepts in order to match up with students' prior knowledge. Teachers discovered this phenomenon by discussing the misconceptions between nodes.

Finding II: Teachers design learning content according to the textbooks at the beginning. However, after discussing with each other and implementing teaching in practice, they soon switched the levels of the material according to students' various pace.

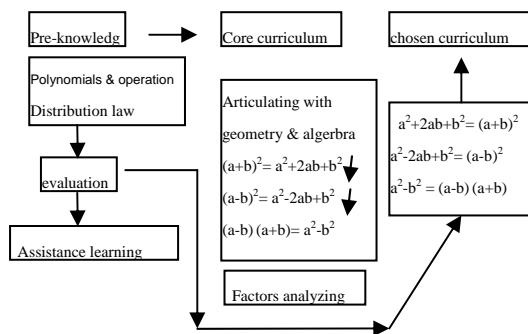


Figure 4: before discussion

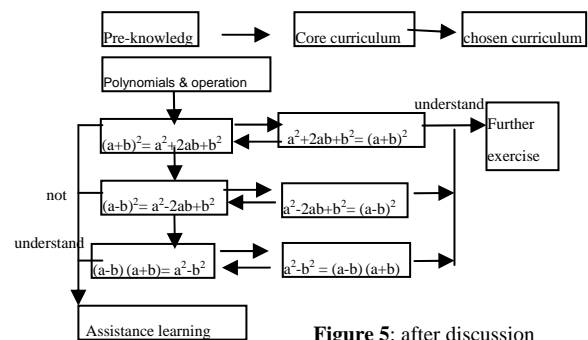


Figure 5: after discussion

Finding III: Teacher presents deep interest in the context of the learning content, especially in the sequence of math concepts. After discussions, they found that the sequence was depending on students' prior knowledge and the objective of teaching.

4.3 Implementation in Practice

Finding I: Teachers tried to use concept map for course preparation before teaching. Senior subjects tried to apply it in the class to make the content clear when they teach multiple formulas in one unit. They agreed that concept maps strategy is useful in integrating students' thinking and reduce their confusions.

Finding II: A senior teacher tried to teach students to draw the concept map with group working. She found that students reconstructed what they had learned and make that learning meaningful.

4.4 Reflection of teachers

Finding: Reflection with concept map force teacher constantly checking their project step by step, and discovered their defects easily. They can modify their teaching quickly through the map and improving the results of teaching.

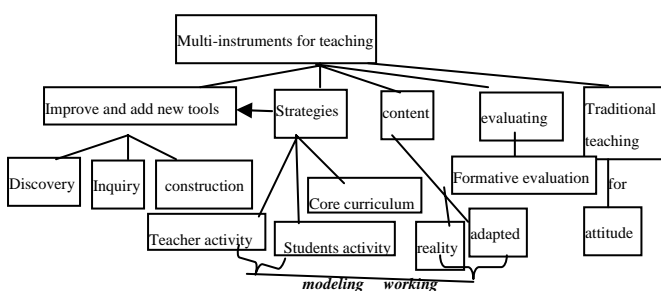


Figure 6: Modify in discussion

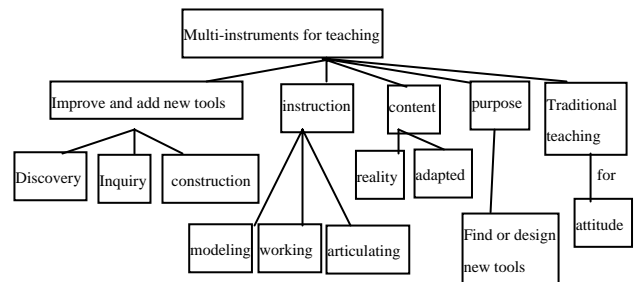


Figure 7: Modify after reflection

5 Conclusion

Exploring the effect improving teachers' knowledge of practice when they learn the concept-map method in the Mathematical Teacher Professional Growth Community is the objective of this study. The problem of the study was to find out how to use the concept map to improve teachers' professional knowledge, and what was helpful for teachers to use it. Upon the findings, we found out that a concept map was a good tool for teachers to prepare and design the learning activity systematically, and to reflect for further modification of teaching. It's a good guideline to clarify confusion of concepts and integrate teachers' experiences in the discussion or group working. Learning concept-map methods is helpful for teachers to improve teachers' knowledge of practice.

Finally, we concluded for four dimensions of teaching activity design, learning content design, implementation in practice, reflection of teachers as follows.

1. A concept map is a good tool for teachers to prepare and design their teaching activity systematically. It enhances teachers as a good curriculum designer.
2. Discussion on the topic of concept map in the MTPDC enable teachers to communicate their thinking regarding teaching and learning content. It is an useful method to integrate teachers' experiences in the discussion or group working.
3. Concept maps strategy allows teachers to continuously reflect, reconsider, and modify their teaching. It is helpful for teacher to be a good action researcher.

6 References

- Cochran, K. F. , DeRuiter, J. A. & King. R. A. (1993). Pedagogical content knowing: An Integrative model for teacher preparation. *Journal of Teacher Education* , 44(4).
- Collins A. & Brown J. S. & Newman S. E. (1989) Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In LB Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Leinhardt, G. & Smith, D. (1985). Expertise in mathematics instruction: Subject matter knowledge. *Journal of Educational Psychology*, 77, 247-271.
- Novak, J. D. & Gowin, D. B. (1984). *Learning How to Learn*. Cambridge, England: Cambridge University Press.
- Novak, J. D. (1995). Concept mapping: Strategy for organizing knowledge. In S. M. Glynn & R. Duot(Eds.), *Learning Science in the Schools : Research Reforming Practice*. (pp. 229-245). Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Novak, J. D. (1996). Concept Mapping; A Tool For Improving Science Teaching and Learning . In D. F. Treagust, R. Duit & B. J. Fraser (Eds.), *Improving Teaching And Learning Science and Mathematics*. New York and London: Teacher College Press.
- Shulman, L. S. (1987) Knowledge and Teaching: Foundation of the New Reform. *Harvard Educational Review*, 57,(1)1-21.