

Development of a Conceptual Framework for Capturing Mathematics Teachers' Professional Knowledge Creation through Lesson Study

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ABSTRACT

Professional knowledge of mathematics teacher(s) is one of important elements to be considered in order to pursue new professionalism of mathematics teachers. While previous studies conceptualized mathematics teacher(s)'s professional knowledge from both static and dynamic perspectives. However, it is also important to consider a collective perspective since as individual mathematics teacher's knowledge is influenced by community's knowledge which community created. Previously, the interaction between an individual teacher and community was pointed out in the practice of lesson study. Therefore, this research aimed to develop a conceptual framework for capturing mathematics teachers' professional knowledge creation through lesson study. The Author reviewed literatures from the perspectives of professional community and situated learning, mathematics teachers' professional knowledge, and mathematics teachers' professional knowledge creation. Thereby, a conceptual framework for capturing mathematics teachers' professional knowledge was developed. Professional knowledge creation was illustrated as one of the elements embedded within dynamic interaction of each component in an individual level and group level. Besides, interactions of different ontological levels can be created by lesson study which has SECI Model within. In order to clarify the process of mathematics teachers' professional knowledge creation, further considerations was expected from the both theoretical and empirical perspectives.

Keywords: Mathematics teachers, Professional Knowledge Creation, Lesson Study, Professional Community, SECI Model

INTRODUCTION

International trends towards pursuing quality of education evoked much attention for the new professionalism of a mathematics teacher that is demanded by today's rapidly changing society. ^[1] In order to explore new professionalism, one of the most indispensable aspects needed to be discussed is teachers' professional knowledge.

In terms of static categorization of teacher's knowledge, Shulman ^[2] ^[3] proposed seven categories which is included pedagogical contents knowledge (PCK). Especially, the concept of PCK has been highly recognized it has influenced subsequent research on teacher's knowledge. However, it is also important to pay attention not only static categorization of teachers' knowledge but also its dynamic aspects such as a situation and a context. ^[4]

In mathematics education research, mathematics knowledge for teaching (MKT) model ^[5] illustrates static conceptualization and classification of mathematics teacher's knowledge from a cognitive perspective. On the other hand, there are also several studies on mathematics teacher's knowledge which focus on the relationship between context-specific knowledge and teacher's belief, ^[6] and the context of teaching. ^[7] These studies have contributed to conceptualize a dynamic aspect of the mathematics teachers' knowledge.

While previous research has investigated static and dynamic aspects of the mathematics teachers' knowledge, it is still insufficiently discussed from a

collective perspective, such as how mathematics teachers' knowledge is created and shared within a community of mathematics education research. Regarding to the collective perspective, Shulman [3] claimed that there is a "Resource" of a teacher's knowledge. Specifically, the "Resource" of PCK is so called "Wisdom of Practice". "Wisdom of Practice" is cultivated and accumulated through teachers' practices collectively through; it has not been codified yet.

In order to investigate nature of individual mathematics teacher's knowledge, "community" is obviously crucial. In this research, lesson study is proposed as one of the potential methods to bring the concept of community for discussing individual and collective teacher(s)'s knowledge creation. Lesson study is generally defined as teacher-led collaborative research on lesson which originates in Japan. [8] It has been widely spread and attracted many attentions internationally since publication of "The Teaching Gap". [9]

Based on above recognitions, this research aims to develop the conceptual framework for capturing mathematics teachers' professional knowledge creation through lesson study. Firstly, the concept of "community" and its learning will be reviewed based on the literature review related to social learning theory and lesson study. Secondly, the consideration of definition of mathematics teachers' professional knowledge and its remaining issue will be discussed. Thirdly, the theoretical consideration for the mathematics teachers' professional knowledge creation based on the organizational knowledge creation theory will be described. Lastly, the conceptual framework for capturing mathematics teachers' professional knowledge creation through will be proposed.

LITERATURE REVIEW

(1) Professional community and situated learning

The social theory of learning, "situated learning theory" [10] has been used to refer in previous studies to discuss teachers' community and learning. [11][12] "situated learning theory" defined learning in the context of social collaborative participation, rather than the acquisition of propositional knowledge. In other words, this theory problematizes social relationship which gives appropriate context in which learning occurs.

According to Lave&Wenger, [10] situated learning has the process of legitimate peripheral participation (LPP) and full participation (FP). LPP is an initial process in which learners acquire knowledge and skills through participating "communities of practice (CoP)", and newcomers are gradually involving the CoP as FP. This process of transformation from LPP to FP generates identity of community as well as identity of individual. Wenger [13] defined CoP as "a group of people who share interests, problems, enthusiasm, etc. on a subject and deepen their knowledge and skills in the field through sustainable interaction" (p.11).

In the field of mathematics education research, Baba& Oyunaa [14] mentioned that a mathematics teacher gains knowledge, skills and value which developed by the professional community through participating professional community. Besides, Turner also [15] pointed out that participation of professional community influences the formation of a teacher's knowledge. In this way, professional learning of the mathematics teachers also occurs within the professional community as "Situated Learning", rather than an isolated learning in a classroom or a single teacher. It can be assumed that professional learning of individual teacher and professional learning of the community are interacted each other, and such interactions influences mathematics teacher(s)'s knowledge.

In terms of realization of such interactions of individual and community, Baba&Oyunaa [14] argued that teachers

create and share their knowledge, skills, and values not only as an individual but also as a group through lesson study. Lewis [16] also stated that lesson study would change (1) teachers' knowledge and beliefs, (2) teachers' professional community and (3) teaching learning resources. In that sense, it can be interpreted that interactions between individual and community can be substantiated through lesson study.

Lesson study in mathematics education is used to be conducted along with the collaboration of teachers and researchers. [17] Hence, the notion of professional community could be included not only teachers but also researchers. Depending upon the role of each people, they deepen their learning by participating professional community through lesson study.

Based on above discussion, in this research professional community which mathematics teachers and researchers belong to, is stipulated as "a group of people who share interests, problems, enthusiasm etc. on mathematics education and deepen their knowledge and skills in a field of mathematics education through lesson study".

(2) Professional knowledge of mathematics teachers

Schwab [18] mentioned that teachers use arts of the practical which can be only spoken by teachers. Hence, teachers' knowledge was described as practical knowledge or craft knowledge which can be captured the tacit nature of the knowledge. [19] [20] [21] On the other hand, as the research on the teacher's knowledge base, such as Shulman [2] [3] and Ball et al. [5] claimed that a teachers' knowledge can be explicitly categorize and conceptualize. In this sense, when a nature of the teachers' knowledge is concerned, there are two different fundamental interpretations of the teachers' knowledge, whether explicit like or tacit like in the epistemology.

These different interpretations could be expressed as the gap between a

researchers' knowledge and a teachers' knowledge. For example, Hiebert et al. [22] pointed out that knowledge base gained from researchers in pedagogy has little impact on the teachers' practice improvement. Hence, they proposed to focus on the practical knowledge that is possessed by individual teacher, and it is necessary to transform an individual practical knowledge into professional knowledge that can be accessed and shared by community. In his word, professional knowledge is, "must be public, it must be represented in a form that enables it to be accumulated and shared with other members of the profession, and it must be continually verified and improved." (p.4)

When the uniqueness of a mathematics teacher's knowledge is concerned, the characteristics of the mathematics teachers' practical knowledge is different from other subject teachers. Arai [4] argued that the practical knowledge specific to mathematics teacher has characteristics as explicit knowledge such as PCK, subject matter knowledge, curriculum knowledge, and it can be expressed in lesson plan. In other words, when practical knowledge specific to a mathematics teacher is captured in the epistemology, it has the nature as explicit knowledge at the planning stage. While the practical knowledge specific to mathematics teacher has an explicit nature at the planning stage, it has intuitive, implicit characteristics during the implementation of the lesson. Practical knowledge observed during implementation of the lesson is highly influenced by the practical knowledge explicitly observed in the planning stage. [4] Therefore, it can be assumed that practical knowledge specific to mathematics teacher is strengthened the tacit nature or explicit nature depending upon the situation. Theoretically speaking, when the transformation of the practical knowledge of non-mathematics teacher into professional knowledge is occurred, explicit knowledge is created from tacit knowledge. [22] However, when it is for mathematics

teachers' transformation of practical knowledge into professional knowledge, the hypothesis is, explicit knowledge is created from "tacit knowledge with the background of explicit knowledge". Although literature review may support to discuss the theoretical hypothesis of mathematics teachers' professional knowledge, further consideration is needed to concretization and conceptualization.

However, in this research, professional knowledge of mathematics teachers is defined as follows for now; "mathematics teachers' professional knowledge is true belief created through dynamic process [23] in which an individual's belief is justified to truth by other professionals of mathematics teaching and learning, and it is something which could be public explicitly, and be accumulated, continuously verified and improved in the professional community of mathematics teachers and researchers". [22]

(3) Mathematics teachers' professional knowledge creation

History of mathematics education in Japan tells the trajectory of the continuous endeavors which have made by teachers, and researchers since it had been started as an adaption of western ideas of teaching and learning during the Meiji Restoration. [24] Professional community had attempted to internalize exogenous ideas for the context of Japan. It even created knowledge, skills, values, and identities through interactive practices, for example lesson study. [24]

In the field of management studies, "Organizational Knowledge Creation Theory" [23] is recognized as the theory which captures the creation of knowledge which is possessed collectively in a group and organization. In this theory, knowledge exists in the two dimensions such as epistemological dimension and ontological dimension. The epistemological dimension is categorized into the tacit knowledge or explicit knowledge, and the ontological dimension is categorized into an individual,

a group, organization, and multiple organizations. (Fig.1)

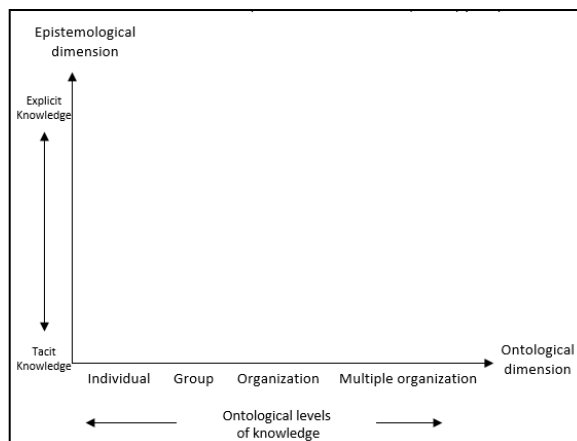


Fig. 1 Two dimensions of organizational knowledge creation [23]

The key component of organizational knowledge creation theory is the four modes of knowledge transformation such as "Socialization, Externalization, Combination, and Internalization", is so called SECI Model (Fig.2). (1) "Socialization" is the process of creating tacit knowledge such as mental models and skills by entering other person's process of thought through co-experience; (2) "Externalization" is the process of expressing tacit knowledge in the form of metaphors, analogies, concepts hypothesis, models, etc. through dialogues and collaborative thinking; (3) "Combination" is the process of creating a body of knowledge by combining concepts; and (4) "Internalization" is the process of incorporating explicit knowledge into tacit knowledge. These four modes are not isolated by single step, rather it is a continuous cycle of creating knowledge organizationally.

Recently, the concept of SECI Model influenced research on the school education, especially in the context of lesson study. For example, Cheng [26] [27] applied SECI Model to explain how teachers share tacit knowledge and explicit knowledge through lesson study. The main intension of Cheng was focus on the

improvement of school management within a school.

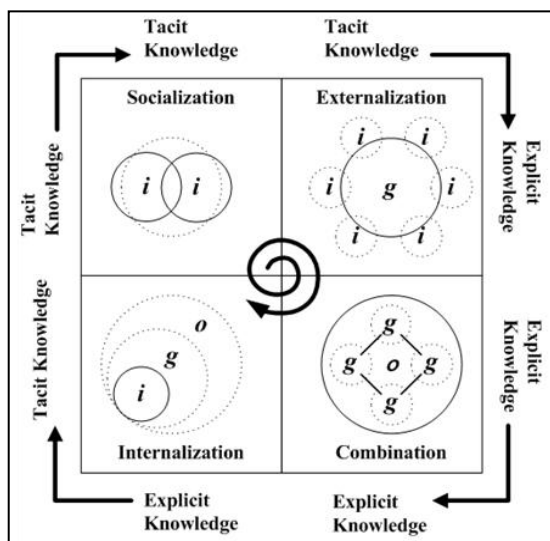


Fig. 2 SECI Model [25]

What if it is reconsidered from the perspective of mathematics education? For example, how SECI Model is seen in the mathematics lesson study, how an individual mathematics teacher, group of mathematics teachers and mathematics education researchers and its organization is interrelated, and what kind of professional knowledge of mathematics teachers is created.

In this research, based on Nonaka & Takeuchi, [23] The definition of mathematics teachers' professional knowledge creation through lesson study is proposed as follows for now; "a process of crystallizing mathematics teachers' professional knowledge organizationally as a professional community, by amplifying the practical knowledge which initially created by an individual through dialogues, discussions, sharing experiences or observing each other with participating lesson study."

(4) Development of Conceptual Framework

Professional knowledge of mathematics teachers exists in the interaction between an individual, a group and organization. In order to capture this

relationship, the framework which proposed by Shulman&Shulman [28] provides insights. They placed the teachers' learning within a community and a context, and proposed the conceptual framework in the different levels such as individual and a community and interrelated them.

This framework has been derived the features of individual level and community level based on the following elements such as "Ready, Willing, Able, Reflective and Communal". It is proposed based on the recognition that "An accomplished teacher is a member of professional community who is ready, willing and able to teach and learn from his or her teaching experiences" (p.259) [28]

By this framework, it was clarified that an individual is embedded and interacted within a community, however it also posed the question, for example, what kind of activities creates and enhances the interaction between individual level and community level. In addition, when it is focused on the elements "Able", which is cognitive attributes, individual knowledge has been mentioned based on the examples of Shulman's conceptualization of teacher's knowledge. [2][3] However, the knowledge base which is seen as the community level was not clarified its aspect well.

In this research, mathematics lesson study is proposed as a potential method which makes interaction between individual and community. Besides, the characteristics of lesson study are illustrated as four modes of knowledge transformation in SECI Model. Through the process of SECI Model in the lesson study, professional knowledge creation is occurred so that professional community possesses and shares professional knowledge. This professional knowledge could be inherited and disseminated from generation to generation, and one place to another place. Hence, it is significant in terms of developing historicity and spatial expansion. It can also be regarded as generation of time axis and space axis of a community. Based on the above considerations, the conceptual

framework for capturing mathematics teachers' professional knowledge creation in through lesson study is proposed as below. (Fig. 3) Thereby, the professional knowledge creation can be captured as the one of the elements in this framework,

which is embedded within dynamic interaction of each element in the individual level and group level. Besides, these interactions of different ontological level, is created by lesson study which has SECI Model within.

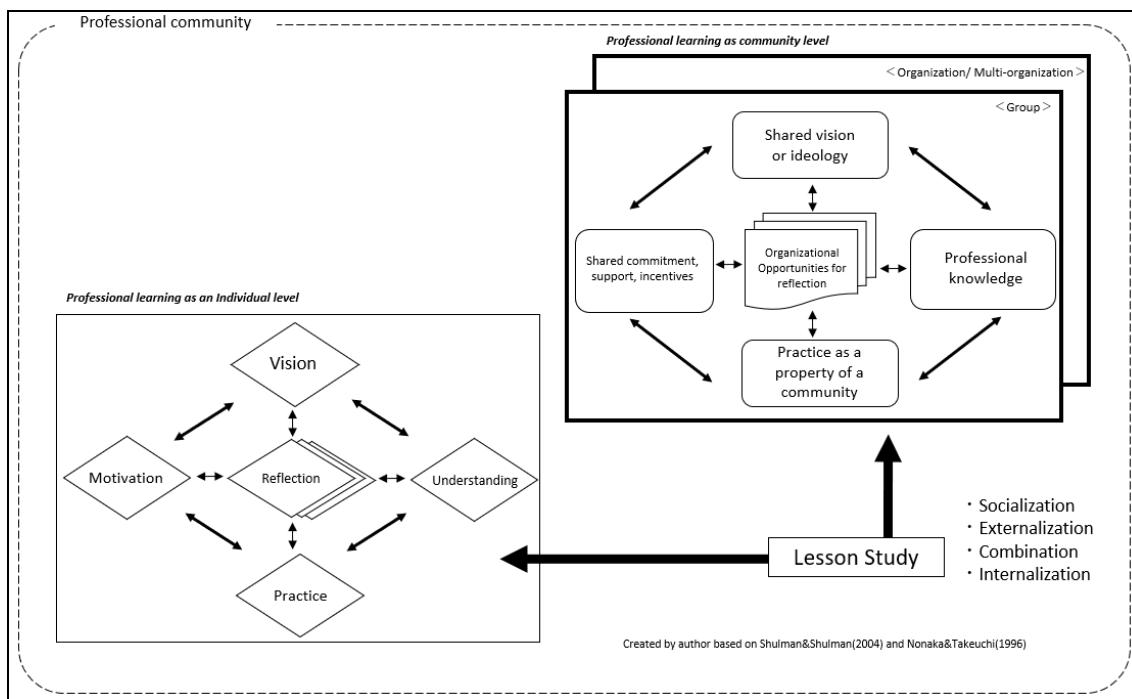


Fig. 3 Conceptual framework for capturing mathematics teachers' professional knowledge creation through lesson study

CONCLUSION

Since today's changing society demands to pursue the new professionalism of mathematics teachers, it is essential to consider how it can be created within the community of mathematics teachers and researchers, and organization. When the endogenous development [29][30] of mathematics education is set as an ultimate objective for development of mathematics education in the era of globalization, lesson study may give an opportunity to seek the alternative development of mathematics education. Subsequently, lesson study itself will also be, and needed to be developed through integration into each different society and culture.

Since the nature of mathematics teachers' professional knowledge is unique, it is necessary to consider further for clarification of its nature and its substantiation. Based on those, it is expected to explore a process of mathematics

teachers' professional knowledge creation through lesson study from both theoretical and empirical perspectives.

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