

## EXPLORE TEACHERS' COLLECTIVE LEARNING THROUGH LESSON STUDY FROM A PERSPECTIVE OF NETWORKING THEORIES

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*Although the effects of Lesson study (LS), a teacher collaborative professional development approach, on teacher professional learning and students learning have been widely documented, the theories for understanding of LS has just emerged as a research field. Interconnected Model of Teacher Professional Growth (IMPG) and Documentational Approach to Didactics (DAD) have been used individually to document teachers' professional learning. In this study, a networked framework is proposed by locally integrating these two theories. A lesson study facilitated by a researcher was conducted in Shanghai China. The data sets including all videotaped meetings and research lessons are collected and analyzed. The results show that the teachers' resource system evolved from adoption to adaptation with consideration of student learning. This study contributes to networking theories and its usefulness in LS context.*

Keywords: Professional development, Teacher educators, teacher knowledge and beliefs.

### Introduction

Lesson study (LS), a collaborative teacher professional approach, originated in Asia, has been adopted around the world (e.g., Huang et al., 2019). Although the effects of LS on teacher professional learning (knowledge, beliefs, disposition), teacher professional learning community, and students learning have been widely documented (Cheung & Wong, 2014; Willems & Bossche, 2019), the theories for understanding of process and products of teacher learning through LS have become an emerging research field (Huang et al., 2019; Lewis et al., 2009); Specifically, various theories have been utilized to frame and understand LS (Borko & Potari, 2020). Yet, most previous studies use a single theoretical lens for understanding LS (Widjaja et al., 2017; Clarke & Hollingsworth, 2002; Pepin et al., 2017; Trouche et al., 2019). Due to the complexity of teacher professional learning in collaborative LS settings, a networking theories approach may provide an alternative way to deepen understanding of the complex phenomena (Prediger et al., 2008; Shinno & Mizoguchi, 2021; Trouche et al., 2019). In this study, we aim to frame our study from a networking theories approach through which the Documentational Approach to Didactics (DAD) model (Trouche et al., 2020) is enriched by incorporating the ideas from Interconnected Model of Teacher Professional Growth (IMPG) (Clarke & Hollingsworth, 2002).

### Research Background and Theoretical Framework

#### Chinese lesson study and teacher learning

Chinese LS has some unique features (Huang et al., 2017), including (1) the repeated teaching of the same content to different students, with immediate feedback from their colleagues and knowledgeable others; (2) a focus on refining the teaching of particular content or improving teachers' particular instructional skills; and (3) knowledgeable teaching researchers' involvement who are officially responsible for organizing school-based teaching activities and evaluating teachers' teaching and students' learning. Overall, Chinese LS provides a platform for improving teaching practice (Chen, 2020; Wei & Huang, 2022), developing teachers (Fang,

2017), implementing new curriculum (Qi et al., 2021), and linking theory and practice (Huang et al., 2016).

### **Theoretical framework**

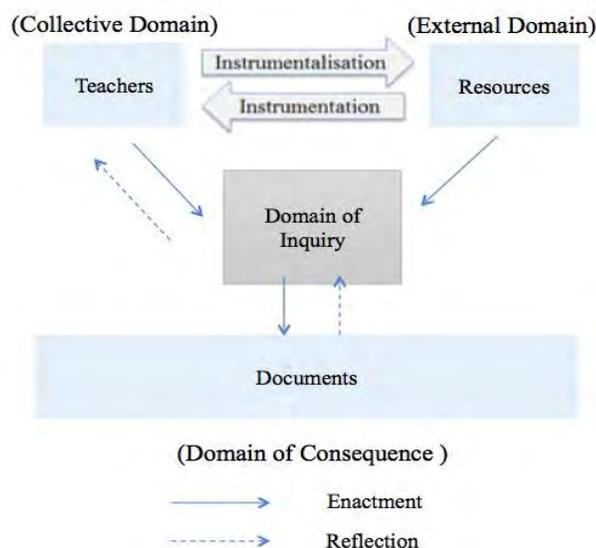
Both DAD and IMPG models are rooted in the sociocultural perspective. They have been used to capture different aspects of teacher learning (Clarke & Hollingsworth, 2002; Trouche et al., 2019).

**DAD theory.** Resources refer to what has the potential of ‘re-sourcing’ teacher activity (Adler, 2000) at the core of instruction. To capture the features of mathematics teacher professional development through the lens of their interactions with resources, a specific conceptual framework, named Documentational Approach to Didactics (DAD) has been developed over the past decade (Gueudet & Trouche, 2009; Trouche et al., 2020). This study focuses on dialectical relationship between the teacher and the resources: the teacher permanently adapts the resources s/he is working with (this is the *instrumentalization* process), while these resources, their constraints and affordances, contribute to configuring teacher’s activity (this is the *instrumentation* process). In DAD, a *document* is defined as the outcome of joint resources combined with knowledge guiding usage, and the process of developing the document is called documentational genesis (Pepin et al., 2013), which occurs through iterative processes of preparation/design and enactment (Trouche et al., 2019). Understanding teacher’s documentation work needs to consider resources evolving process through successive implementations for addressing different issues which is named as *documentational trajectory* (Trouche et al., 2020).

**IMPG model.** Situated in a social and cultural perspective, the IMPG model (Clarke & Hollingsworth, 2002) posits that teacher change happens through enactment and reflection in four domains: Personal Domain (PD), Domain of Practice (DP), External Domain (ED), and Domain of Consequence (DC). PD includes teacher knowledge, beliefs, and attitudes and/or orientation, DP refers to teacher’s experimentation (classroom practices), ED involves the external source of information or stimulus, and DC refers to the salient outcomes of experimentation perceived by the teachers. To emphasize collaborative learning during professional development programs, Prediger (2020) proposed an adapted IMPG model for portraying teacher professional development in collaborative contexts. In her model, the Personal Domain is extended to a Collective Domain (CD, Shared practice and orientation) and the Domain of Practice is extended to a Domain of Inquiry (DI, collective inquiry of new teaching practice).

**A way for networking the two theories.** We use integrating locally as a strategy for networking the theories of DAD and IMPG. The DAD model portrays the dynamic relationship between teachers and resources to generate documents, but the mechanism of documentational genesis remains unknown. The feature of IMPG model which emphasizes the dynamic among the different domains including the collective domain and external domain could be integrated into the DAD model to strengthen the model. Yet, based on the modified IMPG model by Prediger (2020), the documentational genesis can be seen as a dual process between the Collective Domain and Resources (External Domain, and Domain of Consequence) through Domain of Inquiry. Thus, we proposed a model for networking DAD and IMPG (see Figure 1): Teachers in the DAD theory are regarded as the collective domain from the IMPG perspective and resources in the DAD theory are the same as the External Domain (ED) and Domain of Consequence (DC), which includes textbooks, online resources, concrete models, students’ performance in pretest, as well as advice and materials provided by researchers outside the teacher community.

Documents in the DAD theory are regarded as the outcomes (resources and ways of using them) of Domain of Inquiry, which mainly include the agreed ideas in meetings and resulting products of lesson plans and enacted lessons. The Documentational Genesis in the DAD theory therefore triggered by the dynamics (enactment and reflection) between the Domain of Inquiry and other three domains. The Domain of Inquiry is a collective and collaborative process during lesson planning meetings, research lesson observation, and post-lesson debriefing meetings in an LS Group.



**Figure 1. An Adapted DAD Model by incorporating IMPG ideas**

From this adapted framework, this study aims to explore how teachers' growth by their documentation works by addressing the following research questions:

- (1) How does the documentational genesis work through the enactment and reflection between the Domain of Consequence and the others?
- (2) How does teachers' document system develop during the lesson study process?

## Methods

### The participants and the process of the LS

The researcher, Dr. Huang, from a teacher education university and seven mathematics teachers in an urban elementary school in Shanghai form an LS group. Dr. Huang works with pre-service mathematics teacher education program and research on mathematics teacher professional development, and teachers are from a Teaching Research Group (TRG, an institutionalized Chinese teacher professional learning community, see Yang, 2009) in the school. Mrs. Miao, the lead designer of teaching plans and enactor of research lessons, and the other six teachers Mr. Bao, Mr. Tan, Mr. Li, Mrs. Ji, Mrs. Wen, and Mrs. Zhao were all experienced teachers with teaching experience from 6 to 15 years. This lesson study went through four phases over four weeks. The first phase-*study* (29 April, 2021) involved the researcher and his graduate students sharing relevant research literature and the presentations of angle measures in different mathematics textbooks with the teachers. The teachers discussed the possible and specific content and task design on the size of angles. After the meeting, the

researcher designed a pretest for the teachers to understand their students' learning readiness and provide the foundation for designing the lesson. The second phase-*plan* (6 May, 2021) began with a brief presentation by the researcher on students' misconceptions about angles and the size on the pretest and their strategies for comparing angle size. Then, Mrs. Miao presented her lesson plan and the TRG discussed the lesson plan. In the third phase -*teaching and reflection*, based on the feedback from the LS group, Mrs. Miao revised the lesson plan and enacted the lesson in her own class (12 May, 2021). The researcher and other teachers in the LS group observed the lesson. A post-lesson discussion followed immediately. The teachers and the researcher evaluated the enacted lesson and identified issues that occurred and provided specific recommendations for improving the lesson. In the fourth phase – *re-teaching and reflection* (19 May, 2021), Ms. Miao again enacted the lesson in another class, which the researcher and other teachers observed together. The post-lesson reflection followed. Finally, a post-test was conducted for students' learning outcomes in the second class.

**Data sources.** In this study, the data consisted of three components. The first is the four videos of teachers' group meetings; the second is the two videotapes of enacted research lessons; and the third is the lesson plans and slides designed by teachers before the lesson study, and the lesson plans and slides developed during the lesson study.

**Data analysis.** Teachers' lesson plans and slides and the meeting videos at each stage were used to analyze and describe teachers' document system and paint documentational trajectory. Based on the research questions and the adapted DAD model, Dr. Huang generated an analytical frame for identify participating teachers' documentational genesis. The frame focuses on the actors' roles in meetings and classrooms (researcher, teachers, and students) surrounding the interactions (enactment or reflection) between the Domain of Inquiry and each of other three domains. Four research assistants watched the videos (meetings and lessons) and took notes independently. After watching each video, the researcher and the assistants had a group meeting to identify the major features of document work and document system at each individual phase. Any disagreements during the meeting were resolved through extensive discussion. The documentational genesis is summarized in a Table 1. The same process was applied to analyze all the videos in different stages. Finally, a diagram for presenting teachers' documentation work during the LS (Trouche et al., 2019) was created, which includes five major stages for the teachers' documentation works in line with the four phases of the LS. In the Results that follow, the document system and documentational genesis will be presented in narrative and documentational trajectory development over the stages will be summarized.

## Results

The results are presented in five stages in line with the four lesson study phases. These are: 0)(pre-lesson study): Previously developed materials by TRG and e-resources identified by the teachers to support their inquiry into lesson design before the lesson study; 1): the resources provided by the researcher and misconceptions occurred on the pretest promoting the teachers' consideration of concrete manipulatives used for developing a lesson plan; 2): The resources used to produce and revise the lesson plan through the collective inquiry, and the questions from the researcher eliciting the teachers' rethinking about learning goals of the lesson; 3): The enactment of research lesson facilitating the teachers' reflections on students' learning, resulting in further refinement of the lesson plan; 4): Reenacting the research lesson facilitating the teachers' reflection on how to use students' misconception as teaching resources. The following narratives demonstrate how the results are supported by empirical data.

**Stage 2: The resources used to produce and revise the lesson plan through the collective inquiry, and the questions from the researcher eliciting the teachers' rethink the lesson goals.**

**Documentational genesis.** At this stage, the researcher's ideas (ED) impacted on the teachers' inquiry. The researcher questioned whether recognizing acute, right and obtuse angles should be included as one of the learning objectives in this lesson. He believed that the most challenging part is to establish the concept of the size of the angle, which lays the foundation for comparing the size of the angle and identifying acute, right and obtuse angles. Inspired by the researcher's question, the teachers further discussed and agreed that after developing the concept of the size of the angle, angles could be compared, and acute and obtuse angles could be developed through comparing with right angles. Mr. Tan believed that students could perceive that the size of angle is related to the openness of the angle but are difficult to understand that it is irrelevant the length of the two sides. They finally agreed on the use of strips to construct angles and to help students develop the concept of the measure of angles through manipulative activities: (1) using the strips (with same length) helps students to experience that the rotation of one side of an angle creates different angles, and to recognize the two perspective toward an angle: a shape (formed by two rays from the same vertex, static) and a rotation (process of generating the angle, dynamic); (2) using the strips with different lengths to construct angles with in the same and/or different sizes to help students realize that the length of the sides of angle is nothing to do with the measure of the angle.

In summary, the triggered by the researcher's questioning, the teachers collectively discussed their ways of helping students' development of the concept, finally resulted in a new design of lesson plan. Thus, the collective domain (teachers' knowledge and beliefs about teaching the topic) changed and the domain of consequence developed, which contributed to the development of their document systems (see Table 1).

**Table 1. The teachers' documentational genesis during the Stage 2**

Documentational Genesis			
Domain of Inquiry (DI)	Teacher (CD)	Reflection	The teachers' inquiry facilitated them to develop their knowledge of the measure of an angle and beliefs concerning with teaching and learning of the topic.
	Resource (ED)	Enactment	The researcher's question resulted in the teachers' inquiry into the objective of the lesson. The concrete model also impacted teachers' inquiry into designing tasks for student learning
	Document (DC)	Enactment	The teachers' inquiry resulted in the new design of the lesson plan (new objectives of learning and newly designed tasks).

**Document system.** In this stage, the analysis of documentational genesis (Table 1) shows the teachers' documentation work. Firstly, there is the *instrumentation* process, where the researcher's question as a Resource directly triggers the Domain of Inquiry (of the LS group), and then Domain of Inquiry facilitated the teachers' rethinking and reflection. Second, it is the *instrumentalization* process, where Mrs. Miao with her colleagues further improved their documentation system with refining the lesson plan. In the revised lesson plan, the learning goals of the lesson focused on recognizing and comparing the size of angles only while removing the

content of acute, right and obtuse angles to the next lesson. Correspondingly, they modified the activities to explore the size of the angle based on a more refined learning progression, i.e. from constructing angles in different sizes through manipulatives, to comparing two angles that are close in size using concrete tools.

**Summary.** Based on the adapted DAD model, this study paints the learning of a group of teachers in a lesson study as the process of their development of document system and uncovers their learning mechanism through documentational genesis. The results show that the teachers' documentational trajectory went through four stages. Teachers become active resource adapters and producers. The teachers' document system has been developed through the reflections and enactment. Both the *instrumentation* and *instrumentalization* process are reflected during the dynamics between the Domain of Inquiry and the other three domains. Overall, the teachers' document system developed from adopting traditional resources (e.g., the textbook and shared materials in TRG) with a focus on delivering of subject content to designing the lesson creatively by adapting both traditional and additional online resources (e.g., online videos and manipulatives) with a focus on student-centered active learning.

### **Conclusion and discussion**

In the section, we highlight the contribution of this study in three aspects as follows:

#### **Document system and its development as an effect of LS**

The Chinese LS process provide an effective mechanism for teachers to develop their capacity in instruction design through the enrichment and refinement of their document system as demonstrated in this study. Thus, this study contributes teachers' learning through LS by extending their learning as document system development. Moreover, this study also demonstrates the critical roles played by the researcher. For example, how to provide the resources (both ideas and resources) with teachers, and how to facilitate teacher discussion and reflection by raising meaningful questions. This finding about the critical role of knowledgeable others played in the lesson study is aligned with other studies (Gu & Gu, 2016; Li, 2019).

#### **Enrichment of DAD by uncovering the documentational genesis process**

According to DAD, teachers' learning is regarded as the development of document system through the interactions between teachers and resources. The interactions are featured by *instrumentation and instrumentalization* process. Although DAD's theory recognizes a collective perspective and explores the development of teacher document systems within a community of practice (Wenger, 1998), the process of interaction between teachers and resources are not appropriately explored (Trouche et al., 2019). In this study, we examined documentational genesis as a process of enactment and reflection between Domain of Consequence and the other from the IMGP perspective. With the cycle of LS, the documentation genesis process is described in detail, thus, both document system and its development through lesson study are revealed vividly. Therefore, his study contributes to enriching DAD by illustrating the documentational genesis.

#### **Networking theories by locally integrating two theories**

The strategies of synthesis and local integration focus on developing theory by combining a small number of theoretical approaches into a new framework (Prediger et al., 2008). In this study, we adopted a locally integrating strategy by incorporating the interactions among four domains in the IMPG model into DAD theory to explore the mechanisms of documentational genesis. As demonstrated in this study, by employing the adopted DAD model, teachers' learning through LS has been extended and described in great detail. Therefore, the locally integrating framework in this study could, on the one hand, explain the mechanisms of teacher

documentational genesis and, on the other hand, describe teachers' professional development through the changes of the document system.

### Limitations and further studies

Since there is no follow-up data (after the lesson study) nor interviews with the teachers, we are unable to make any claims about how teaching this specific topic can sustain the teaching of other topics. In further studies, these two data sets should be purposefully collected and analyzed to explore teacher document system development through LS.

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