Doctoral Dissertation

Identifying Mathematics Teacher Educators' Professional Learning and Issues in Lesson Study Approach in Laos

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March 2020

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D172002

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A Dissertation Submitted to
the Graduate School for International Development and Cooperation
of Hiroshima University in Partial Fulfillment
of the Requirement for the Degree of
Doctor of Philosophy in Education

March 2020

We hereby recommend that the dissertation by Mr. SOMMAY SHINGPHACHANH entitled "Identifying Mathematics Teacher Educators' Professional Learning and Issues in Lesson Study Approach in Laos" be accepted in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY IN EDUCATION.

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ACKNOWLEDGEMENTS

First, I would like to express my sincere appreciation to my supervisor, Professor Takuya BABA, who has guided, encouraged, and directed me academically and professionally during my three years as a Ph.D. student at Hiroshima University. Without his persistent support, I would not have the opportunity to explore my academic journey, professional development, professional learning, and would not be accomplished in my research work.

I would like to offer my special thanks to the Japanese government, specifically the Japanese Grant Aid for the Human Resource Development Scholarship (JDS), and all JICE staff members that provided any valuable support during my academic life in Japan. Without their support, I would not have had the chance to receive the best education in my chosen field at Hiroshima University, and my study would not have been possible.

I would like to express my deepest gratitude to the government of Laos, especially my workplace, Khangkhay Teacher Training College, which allows me to continue my professional learning in Japan. I would also like to show my special thanks to the seven Teacher Training Colleges in Laos for their kind cooperation and collaboration during my data collection, without which the important and necessary data would not have been successfully collected.

I would like to extend gratitude to all of my lab mates (Baba-Lab members) who continuously share academic perspectives, constructive comments, sincere suggestions, and beneficial feedback, as well as share in my social life by having fun together in and outside school activities to release our tension. Your friendly involvement and support fill my days with memorable moments, happiness, and meaningfulness.

I would like to show special thanks to my sub-supervisors (Prof. Kinya SHIMIZU and Prof. Takayoshi MAKI) and external examiners (Prof. Yasushi MARUYAMA and Prof. Maitree INPRASITHA) for their professional feedback and contribution toward refining the content of this dissertation to scientifically and academically improve its professionalism.

I would like to express my special thanks to Prof. Max Stephens for his generosity giving some constructive feedback and suggestions regarding my research.

I would like to express my whole-hearted love to my family: my wife, Phouvone Chanthavong; my son, Sitthiphone; and my daughter, Melisa, for their encouragement and constant mental support throughout this endeavor.

Abundant thanks to all of my friends and everyone involved in my research, in both Japan and my home country. Without your help, this work would not have been possible.

In this special regard, I wish for all professors at Hiroshima University, my dear friends in the same and other laboratories, my dear friends in Laos, my beloved family, and everyone that I know to have a prosperous life, bright future, and success in all of your dreams.

LIST OF ABBREVIATIONS

BEQUAL:	Basic Education Quality and Access in Lao PDR
JICA:	Japan International Cooperation Agency
KCS:	Knowledge of Content and Students
KCT:	Knowledge of Content and Teaching
Lao PDR:	Lao People's Democratic Republic
MKT:	Mathematical Knowledge for Teaching
MoES:	Ministry of Education and Sports
MTEs:	Mathematics Teacher Educators
PCK:	Pedagogical Content Knowledge
RECSAM:	Regional Centre for Education in Science and Mathematics
SEMEO:	Southeast Asian Ministers of Education Organization
TTCs:	Teacher Training Colleges

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ABSTRACT

Lesson study is an effective approach for the professional learning of teachers and teacher educators. The objective of this research was to identify Mathematics Teacher Educators' (MTEs) professional learning and issues that emerged through the actual lesson study approach in Laos. The researcher developed a conceptual framework and four levels (levels 0, 1, 2, & 3) of professional learning to identify the emergence and depths of the MTEs' professional learning and the related issues. Level 0 was the superficial professional learning, while level 3 was the advanced phase. This main study collected data from 34 respondents (30 MTEs, 3 primary school teachers, and 1 secondary school teacher) from three Teacher Training Colleges (TTCs) within two months (February to April 2019). Each TTC conducted two lesson study practices for approximately two weeks. Multifaceted data were collected through video recordings, observations, interviews, and documents. The protocol discussions during each step of the actual lesson study practices and the interviewed data were qualitatively analyzed which guided by some theories of thematic analysis, content analysis, grounded theory, and basic category construction. Simultaneously, the licensed software, MAXQDA 10, was utilized to manipulate and analyze these qualitative data.

The study revealed that, as the role of teachers, the emergences of the MTEs' professional learning were evidenced and scattered in the subject matter knowledge and curriculum knowledge, students' conceptions, teaching-learning resources, instruction and collaboration. While as the role of teacher educators, the emergences of the MTEs' professional learning were evidenced by the curriculum knowledge, the teaching-learning resources, and the instruction. However, of these two roles, the level 1 is still regarded as the highest level of the MTEs' professional learning because the MTEs put emphasis only on commenting and describing those emergent domains; while a lot of issues hindered the effectiveness of the lesson study approach were found. These issues included the situation of using superficial checklists, lack of analysis of the main mathematical content, lack of analysis of the connection of the curriculum, lack of analysis of learners' mathematical thinking, and lack of connection of student mathematical thinking with the mathematical concept in a broader aspect. This study suggested using questions instead of checklists to guide the focal points when conducting lesson study. MTEs should focus deeply on learners' mathematical thinking, analyzing, making a connection of mathematical concepts, and correlate with a theory or theorizing their own teaching theory in order to reach high-quality of the lesson study practice. Furthermore, the study suggested MTEs be able to supervise both schoolteachers and colleagues constructively and professionally. The study also recommended the MoES to consider revising the lesson study guidelines and including lesson study as a subject in teacher education.

CHAPTER ONE: BACKGROUND AND OBJECTIVES OF THE STUDY

This chapter provides background information about professional learning and lesson study following the lesson study situation in Laos, problem statements, research objectives, research questions, significance of this study, and definition of terms.

1.1 Background of the study

Professional learning is needed for professionalism when people are engaged in a specific career. It is essential to be continuously learning and advancing in our professions (Johnston, 1998, as cited in Schalkwyk, Leibowitz, Herman, & Farmer, 2015). Informally, this professional learning is embedded in daily communications with colleagues, peers, book reading, etc. Formally, it can be developed through lesson study, collaborative community of practice, workshops, seminars, teaching conferences, and trainings, among others (Schalkwyk et al., 2015; Meissel, Parr, & Timperley, 2016). In an educational context, there may be many models of professional development activities for teachers and teacher educators' professional learning enhancement, such as research in the education field. Commonly, researchers design studies based on their areas of research interests. Other research activities in the education field include action research aiming to solve the problems of participants in the school context, learning studies that test "different instructional designs to find the relationship between how content is handled and student learning," "teaching research groups," and lesson studies integrated to improve teaching and learning in everyday teaching work (Holmqvist, 2017). However, the activities for teachers' professional learning may vary by country. For example, there is Keli in China ("action education" that includes lesson planning, teaching lesson, post-lesson reflection and re-delivery the lesson (Huang & Bao, 2006)), district-led professional development programs and conference presentations in the United States, and lesson study in Japan (Akiba, 2015). By continuously engaging in those professional learning activities, teachers' instructional practice and student learning will be improved (Akiba, 2012), because professional learning is underlying the change of teaching and assessment for the quality of student learning enhancement (Schalkwyk et al., 2015). Although the literature may describe professional learning diversely, it is best through in-depth group discussions and reflection as it focuses on the content of subject matter and students' ability to learn that content. Teachers and teacher educators have opportunities to learn through observation—external or their own—discussion and feedback, and their knowledge and belief in policy consistency (Meissel et al., 2016). Therefore, those characteristics of professional learning are significantly associated with the practice of lesson study that many countries globally are attempting to introduce and experiment with for both novice teacher educators and teacher educations of all levels (Quaresma, Winsløw, Clivaz, Da Ponte, Shúilleabháin, & Takahashi, 2018).

Lesson study, or "Jugyokenkyu," means a research or study lesson (Fernandez & Yoshida, 2011, p. 7). It is an effective activity for teachers' professional learning and "a core professional development activity" currently being implemented in various subjects. Lesson study is not only enhancing teaching skills and improving learning materials but also forming an identity of teachers (Akita & Sakamoto, 2015). Lesson study develops student thinking, teachers' pedagogy, and content knowledge. It improves teaching materials and builds professional community among teachers (Lewis, Perry, & Hurd, 2009), also improving teaching approaches, focus on student learning, and learners' outcomes in a positive way (Norwich & Ylonen, 2013). Through repetition, lesson study promotes the teaching profession and practice development. Teachers benefit from not only individual progress but also the quality of classroom teaching and learning (Xu & Pedder, 2015, P. 49-50). When teachers conduct lesson study, they are expecting students to interact with the designed learning tasks while they are "thinking more about how the children are thinking and learning" (Leavy & Hourigan, 2016). Those concerned thoughts are subsequently expressed in the post-lesson discussion. Nonetheless, the depth of the lesson study discussion is sometimes influenced by guidance during the observation. Typically, lesson study with guidance for observation tends to have a discussion "on students' solution strategies, information organization, and types of errors." Observation without guidance tends to have comments regarding general issues if students engage in the tasks and its success (Lewis, Rebecca, Hurd, & O'Connell, 2006). Therefore, the depth of teachers and teacher educators' professional emerges through their critical discussion based on their own outlook regarding the teaching, lesson, and students' learning.

This study regards lesson study as a method or approach to capture teacher educators' professional learning. This lesson study approach refers to 5 steps as defined by Fujii (2017, p. 93). These steps, briefly, include goal setting, lesson planning, research lesson, post-lesson discussion and reflection. The goal setting is to set long-term goals for student learning while the lesson planning is to plan and design a research lesson collaboratively to address the goals. The research lesson means to teach the lesson in order to collect data of teaching and student learning. Whereas the post-lesson discussion is to give some feedbacks and share data from the lesson to illustrate student learning, discrepancies in content and issues in teaching - learning. And the reflection is to document the cycle to consolidate and carry forward learnings as well as new questions for the next cycle of lesson study.

Lewis and Takahashi (2013, as cited in Lee, 2015) defined lesson study as having four levels. Level 1 is the "school level that focused on a shared wide research theme, observed and discussed by the teachers and administrators in the school." Level 2 is the "district- level, participated in lesson study group focus on specific subject matter, meet once a month, conduct semi-annual research lesson and open to all teachers within school district." Level 3 is the "national-level, teachers from national schools, universities in large public research lessons," and level 4 is an "associated-sponsored lesson study, annual meeting where the conference was observing and discussing live research lesson." Stigler and Hiebert (1999, pp.112-116) stated that lesson study has eight steps, as follows: (1) defining the problem, (2) planning the lesson, (3) teaching the lesson, (4) evaluating the lesson and reflecting on its effect, (5) revising the lesson, (6) teaching the revised lesson, (7) evaluating and reflecting again, and (8) sharing the results. Nonetheless, it was later summarized that "teachers come together to share their question regarding their students' learning, plan a lesson to make student learning visible, and examine and discuss what they observe" (Murata, 2011, p.2-3). Similarly, lesson study has a simple cycle— "PLAN, DO, and SEE"—with a long-term goal for teacher professional development (Ebaeguin & Stephens, 2013). These three components are associated with the "study of teaching materials, experimental teaching, and lesson discussion meeting" (Baba & Kojima, 2004).

In this research, the term "teacher" refers to who is teaching at primary and secondary schools, while the term "teacher educator" refers to "those who teach in higher education and in schools who are formally involved in pre-service and in-service teacher education" (Murray, Swennen, & Shagrir, 2009, p. 3). Teacher educators are those responsible for training pre-service teachers. Their major roles include preparing future teachers and implementing educational policy, and they are responsible for improving themselves as professionals. Teacher educators are instrumental in improving educational quality and the quality of prospective teachers. Indirectly, they influence the children's and teenagers' learning results (Hadar & Brody, 2017). The difference between teachers and teacher educators is that the teachers are supposed to create and teach a good lesson, increase professional knowledge (i.e., knowing students and how they learn, knowing the content and how to teach), professional practice (i.e., planning effective teaching and learning, assessing, providing feedback, and report on student learning) and professional engagement (i.e., engagement in professional learning with colleagues, parents, and community) (AITSL, 2018). Regarding the teacher educators, they are supposed to work on meta-level to enable teachers to realize about those professional areas. The teacher educators encourage and stimulate teachers to be good teachers and be professional in teaching, subject matter knowledge, pedagogical content knowledge, dispositions, and belief. When necessary, teacher educators can also play the role of teachers. This study keeps this difference throughout the entire research.

In Teacher Training Colleges (TTCs) and universities, the work of teacher educators requires certain skills, knowledge, and an attitude to support in-service teachers as well as develop their own professions in the field (Ping, Schellings, & Beijaard, 2018). In the Lao context, teachers and teacher educators closely relate to the same level of professional knowledge, lesson study understanding, and experience with lesson study implementation. In some cases, their skills may worsen—especially for the newly appointed—because of the weakness of the teacher educators' induction system. Therefore, continuously participating in professional learning activities such as lesson study is essential for both teachers and teacher educators, specifically within the Lao context. In this research, the terms "teacher educator," "teacher trainer," "teacher of teachers," and "teacher in higher education" may be used interchangeably.

1.2 Country profile and education in Laos

Lao People's Democratic Republic (Lao P.D.R), or Laos, is situated in the Southeast Asia region surrounded by China, Vietnam, Cambodia, Thailand, and Myanmar. Laos became independent in 1975 with a population of 7,186,217 people as of 2019 ("World population review," 2019). The country has 18 provinces, with Vientiane as its capital. In 1971, Laos was placed on the United Nations' Least Developed Countries list among 47 countries in the world. The country has an opportunity to graduate from the list in 2021 if it meets the thresholds under these two of three criterions (i.e., a per capita income, human assets, and an economic income vulnerability criterion ("United Nations," 2018).

Currently, Laos has only five universities throughout the country that are responsible for higher education, including the National University of Laos and University of Health Sciences in Vientiane, Souphanouvong University in Luang Prabang Province, Savannakhet University in Savannakhet Province, and Champasak University in Champasak Province ("Lao Statistics Bureau," 2019). Each university, except for the University of Health Sciences, has a Faculty of Education that is responsible for teacher education. Laos also has 12 TTCs throughout the country, eight of which are responsible for training both pre- and in-service teachers from the technical level through the bachelor's degree. However, four TTCs differ from the aforementioned eight as their trainings consist of music, arts, Sangha, and physical education. Two Sangha colleges, Sangha Ongtue and Champasak Sangha, are schools specifically for monks (MoES, 2018). Moreover, students who do not have an opportunity to study at those universities or TTCs can continue their studies at one of the 40 public and 62 private colleges in Laos that are available alternatively.

In 2018, the general education statistics reported 8,604 primary schools and 1,756 secondary schools, both public and private (MoES, 2018). Before 2010, general education in this country followed the 5-3-3 system, namely, 5 years in primary school, 3 years in lower secondary school, and 3 years in upper secondary school. From 2010 onwards, however, the general education system has expanded to the 5-4-3 system. Therefore, the total schooling in general education is 12 years, with compulsory education through Grade 9. Regarding curriculum reform, Lao does not have an exact time interval for school curriculum revision. Since 1975, school curriculum has been revised six times—in 1976, 1994, 2000, 2006, 2009 (Khanthavy, Tamura, & Kozai, 2014), and 2019. Currently, the primary textbook is being revised or replaced with curriculum, instructional materials, teacher education, and a student assessment system. This is possible with governmental support from Japan, through JICA, and Australia, through the BEQUAL project. In September 2019, a new textbook was implemented nationally for primary school Grade 1, while the textbooks of other grades remain in the revision process (MoES, 2017). According to the statistics of 2018, Lao has 786,246 primary students from Grade 1 to Grade 5 in both public and private schools, with a Gross Enrollment Rate of 110.6 % and Net Enrollment Rate of 98.8 %. Although the enrollment rate in primary education is high, there is a dropout rate of 4.1 % and repetition rate of 4 %, respectively. Between these, Grade 1 is dominant with the highest rates for dropout (5.8%) and repetition (8.8%), while the lowest repetition rate is in Grade 5 with only 0.8 % (MoES, 2018).

Teacher education in Laos has several systems, namely 5+3, 5+4, 8+1, 8+3, 11+1, 11+2, 11+3 (Benveniste, Marshall, & Santibañez, 2007, p. 27). The numbers 5, 8, and 11 in the front represent the school years in general education, whereas 1, 2, 3, and 4 are the numbers of years in pre-service training within TTCs. After the school education system was changed, the teacher education system in TTCs was also modified. Now, there are more options, such as 9+3, 11+1+2, 11+1+3, 11+3+2, 11+3+1+2, 12+2, 12+2+2, and 12+4, distributed in those 12 TTCs (MoES, 2018). Students from Grades 9 or 12 who are enrolled in a TTC can receive a diploma from one of these systems. However, each system also has several different specific subjects and grade levels. For example, the 12+2 system has both pre-service training for kindergarten and primary school; the 12+4 system has training for kindergarten, primary, lower secondary, and upper secondary school training levels.

1.3 Lesson study practice in Laos and problem statements

The concept of lesson study approach may have first been introduced in Laos in 2002 through the training on integrated approach (Open Approach teaching method and lesson study approach) to mathematics and science teachers at Minsai Center in Laos (Inprasitha, 2007, p. 192). In 2004, the concept of lesson study was then introduced in TTCs through the "Improving Science and Mathematics Teacher Training (SMATT)" program supported by JICA. This project was for the "development of teaching materials, teaching aids, establishment and accumulation of lesson study, design and teaching plans, and study of teaching methods" (Saito, 2007, pp. 210-211). Nonetheless, as the author and his colleagues experienced, this was not realized as lesson study, rather generally called the "JICA approach." During the period of the project in 2006, more than 50 teacher educators from TTCs were supported to acquire training in the JICA approach in Japan, prior to its end in 2008. During these periods, action research was also introduced in Laos in 2000 through the donor project (Stephens, 2007, as cited in Bounyasone & Keosada, 2011), became known in the TTCs in 2003, and was later included as a subject in teacher education in 2006. Consequently, lesson study might be considered supplementary compared to action research because of its late introduction. Nonetheless, from 2010 to 2013, JICA started another project, called ITSME (In-service Teacher Training for Science and Mathematics Education), to improve lesson quality in the targeted provinces (i.e., Khammouane, Savannakhet, and Champasak), as well as teaching methodology of mathematics and science via lesson study in the prioritized primary schools (JICA, 2013). Yet, lesson study was not recognized among teachers nationwide. Additionally, the ITSME project has made a little movement in lesson study because the model lesson plans developed for internal supervisions have become an optional lesson plan model in teacher education.

JICA has made continuous efforts pushing the quality of teaching and learning in Laos through the concept of lesson study. However, there is still much to do to advance the movement of education regarding teaching and learning. Most Lao teachers have limited opportunity to engage in professional training activities to improve their professional knowledge and skills. As a result, teachers' teaching practices remain in a traditional mode. Theoretically, problem-solving and thinking skills are greatly emphasized in Lao teacher education, but how to practice such a concept has yet to be effectively defined. Therefore, in the practical situation, teachers use “frontal lecturing, copying lessons on the blackboard, and encouraging recitation and memorization” as a primary method. This situation causes Lao students to lack opportunity engaging in “practical exercises or application of knowledge” but are rather “passive recipients” (Benveniste et al., 2007, p. 86). This report of teaching in Laos suggested equipping and using a student-centered teaching approach for pre-service and in-service teacher training curricula to enhance and overcome such a critical situation of teaching and learning within the country.

The progress of lesson study in Laos has been improving slowly but is promising. It has gradually emerged in the Lao educational context. In 2015, lesson study was officially included in the Lao educational development plan, clearly stating (1) to establish professional networks between nearby schools and teachers and (2) to introduce school-based training and cluster levels for improving teaching and learning through lesson study (MoES, 2015, p. 59). Consequently, the MoES developed a lesson study handbook or guideline. From July 12th to 16th, 2016, the first lesson study training was conducted with representatives from each educational sector at the district and provincial levels, including eight TTCs throughout the country. The training had 89 participants (23 national trainers, including committees, 32 prospective trainers for provincial level from TTCs, and 34 prospective trainers for district-level from the teacher development divisions in the provincial education and sports) (S. Lengmingkham, personal communication, November 2, 2018) (see Figure 1). Those participants were expected to be the key trainers in their workplaces and take responsibility for disseminating and supporting their colleagues to practice lesson study.

Figure 1. (a) Trainers at provincial and district levels; (b) Trainers at national level

Conceptually, Mathematics Teacher Educators (MTEs) in Laos acquired some lesson study training and encouragement from the MoES to utilize it within each TTC. Practically, however, they are reluctant to apply the gained knowledge and experiences of lesson study to improve their mathematical teaching. This relates to their beliefs in the effect of lesson study, how they perceive its benefits, and their recognition of the importance of the lesson study, as well as the system to support such a practice in the TTCs that may not be well functioning yet. Based on the lesson study reports, MTEs in some TTCs intermittently practiced lesson study based on their supervisors' guidance and the lesson study guideline. Some reports were from the Khangkhay, Dongkhamxang, and Bankeun TTCs (see Table 1).

Table 1. Lesson study reports from some TTCs

TTC	Title	Year
Khangkhay TTC	1. Lesson study: development of mathematics learning skills by connecting gender equality of mathematics pre-service teachers, 12+4 system	2014-2015
	2. Lesson study on teaching general mathematics I of year 2 primary pre-service teachers, 9+3 system	2015-2016
Dongkhamxang TTC	1. Lesson study report on teaching-learning mathematics in primary school grade 2, lesson 25: subtraction without borrowing	2017
	2. Lesson study: study on teaching-learning about fraction of year 1 primary pre-service teachers, 12+4 system	2017
Bankeun TTC	1. Development of 1st year secondary school students' learning plant classification through lesson study	2016-2017

However, regarding content, those practices were conducted in a superficial way with a shallow focus because it was majorly relying on the checklists to check teacher educators' behavior (see Table 2). They conducted lesson study to increase students' and student teachers' test scores by employing the same lesson and test several times with the same learners. This relatively relates to the lack of understanding of the essential concept of lesson study and the lack of professional knowledge, such as mathematics subject knowledge, methods of teaching mathematics, and students' comprehension of the subject (Hunter & Back, 2011).

Table 2. An example of checklists exempted from a report

No	Content of checklists
1	Teacher educator dresses appropriately
2	Teaching materials match the lesson content appropriately
3	Appropriate student teachers' group setting
4	Time management is appropriate
5	Questions for evaluation are appropriate

Source: (Phongsamouth, Philaphet, & Tongxua, 2017, p. 11)

Insufficient content knowledge, pedagogical knowledge, and misunderstanding lesson study became major obstacles for high-quality lesson study practice (Yoshida, 2012). The discussions in the lesson study process was minimal and superficial because of "the lack of experienced practitioners to play the role of knowledgeable others" and "inadequate knowledge" of reflection (Lim, Teh, & Chiew, 2018, p. 53). Teachers or teacher educators may misunderstand lesson study; they considered students were initially insufficient in mathematics knowledge and skills but improved following the lesson study practice (Bruce, Flynn, & Bennett, 2016). This implied that teachers and MTEs perceived lesson study as a "strategy to increase the academic achievement of students in low-performing schools" (Lim et al., 2018, pp. 54-57). There is always a challenge to urge teachers to voluntarily participate in lesson study because of a lack of awareness concerning the importance of professional development. Subsequently, "teachers who participated were identified and put forward by their principals" (Lim et al., 2018, p. 53). Under these situations, it is vital to research lesson study in Laos, especially among MTEs who are the key individuals and playing the role of knowledgeable others of lesson study. It is essential to enlarge the existing phenomena of those limitations to find the potential for the MTEs' professional learning, depth of the practice embedded in the lesson study procedure, and issues hindering the progress of the lesson study approach in Laos.

1.4 Research objectives

The overall objective of this research is to identify MTEs' professional learning and issues in the lesson study approach in Laos. This objective is divided into 3 sub-objectives:

a) to develop a conceptual framework of professional learning through lesson study;

b) to investigate the depth of MTEs' professional learning in the actual lesson study practices;
c) to determine the issues within the actual process of lesson study practices.

1.5 Research questions

a) What does MTEs' professional learning emerge during the actual process of lesson study practices among Lao MTEs?
b) How deep is the emergence of the MTEs' professional learning in actual lesson study practices among Lao MTEs?
c) What are the issues occurring in the actual lesson study practices in Lao TTCs?

1.6 Significance of the study

There were numerous studies regarding the lesson study with primary teachers and pre-service teachers. There were, however, very few studies focusing on teacher educators, especially of mathematics. Considering the wide range of this research, it is significant in three main ways. First, it will add to the body of scientific knowledge of the discipline or field of lesson study (Wiersma & Jurs, 2005; Bridges, 2015) for other researchers who are interested in the professional learning of teacher educators through this collaborative approach. Second, Lao teacher educators in eight TTCs are instrumental in instructing others in teacher education for training both pre- and in-service teachers for all provinces throughout the country. Thus, identifying and discovering the essential professional learning, issues, and depths of their learning will be a significant piece of evidence for further improving the quality of lesson study application in Laos, because MoES regards TTCs as the best place to disseminate pedagogical content knowledge into local primary and secondary teachers in their communities using lesson study. Third, MoES has conceptualized a long-term goal to improve teaching-learning activities through school networks and use lesson study as an important approach to improve individual teaching, school-based training, and provincial and national level training. Therefore, it is believed that the results of this research project can form the central ideas in understanding the lesson study concept and its benefits based on evidence found for "providing necessary information for decisions" (Wiersma & Jurs, 2005, p. 11), proposing that MoES persuade all teacher educators in each TTC to share the same educational goal. This is a promising approach for Lao teachers and teacher educators for life-long learning as well as sustaining the country's lesson study approach.

1.7 Definitions of terms

Collaboration: This involves MTEs working together in lesson preparation, teaching, and post-lesson discussion during the lesson study process. It also refers to collaboration between MTEs and primary or secondary teachers, the support from school principals, and directors of TTCs.

Instruction: “Instruction” and “teaching” are used interchangeably in this research. It is a teacher’s practice in the classroom involving the teacher’s skills, techniques, methods for encouraging students, and use of media and technology (Ishii, 2015). It is the practice indicating content and pedagogical knowledge under “which content knowledge and pedagogical knowledge skills are situated” (Wright, 2009). This will be further defined in the conceptual framework.

Issue: This is used to define any difficulty or problem faced by a teacher educator during the actual lesson study practices, including a lack of understanding, insufficient knowledge, and certain abilities.

Knowledge: This refers to knowledge of subject, pedagogical content (Ball et al., 2008), and curriculum (Shulman, 1986).

Lesson study: A lesson study is a process in which teachers collaboratively design lessons, teaching materials, observe research lessons, and reflect on teaching and students’ learning.

Lesson study approach: It includes goal setting, lesson planning, research lesson, post-lesson discussion and reflection (Fujii, 2017, p. 93). It is a common term being widely used in the field of lesson study (i.e., Hadfield & Jopling, 2016; Kanellopoulou & Darra, 2018).

Lesson study practice: It refers to the actual practice when the lesson study approach is being conducted or implemented by a group of MTEs in the TTCs.

Mathematics Teacher Educator: This denotes teacher educators who teaches mathematics subject within a Teacher Training College.

Professional development: This comprises “All the activities in which teachers engage during the course of a carrier which are designed to enhance the work” (Day & Sachs, 2004). It refers to a general practice of formal or informal activities for helping teachers develop their professional skills, of which some cases are unhelpful and passive (“Western Governors University,” 2017). This will be further defined in Chapter two.

Professional learning: This refers to individual, collective, or community learning. Teachers or teacher educators learn together while engaged in lesson study practice. It refers to the depth in the active process related to local knowledge creation, practice transformation, and pedagogical shifts and is highly reflexive (Groundwater-Smith & Mockler, 2009, p. 56). This will also be further defined in Chapter two.

Pedagogy: In the dictionary, it is defined as "the art or science of teaching; instructional method. It is the method and practice of teaching." It is "those practices of knowledge (re)production…. concept-framing word that brings together theory and practice, art and science" (Ahluwalia et al., 2012, p. 5). Therefore, pedagogy in this research means the theoretical concept of the art and science of teaching and its practice.

Students: It refers to students in primary and secondary schools especially.

Student teachers: It refers to pre-service teachers or prospective teachers in the TTCs.

Teacher: It refers to teacher who teaches in primary or secondary school.

Teacher educator: It refers to the teacher of teachers in the TTCs that has the role not only teaching in the higher education, but also supporting teachers and colleagues for their professional learning.

Teacher Training College: This is a college to train both pre-service and in-service teachers for kindergarten, primary, and secondary school.

Teaching-learning resources: A material used in teaching, "lesson plans that promote student learning," "tasks that reveal student thinking," manipulatives, observation protocol, the content of mathematical tasks, and student worksheets (Lewis, 2006, Lewis, Hill, & Hurd, 2009; Bae et al., 2016). This will be also further defined in the conceptual framework.

CHAPTER TWO: LITERATURE REVIEW

This chapter discusses the difference between professional learning and professional development, teacher educators' professional learning, lesson study adaptation from different international perspectives, lesson study processes, professional learning through lesson study, and the issues within lesson study.

2.1 Professional learning and development

Commonly, the term "professional" refers to the quality of work that people do. It is regarded as representation of competence and expertise in the work. It is the ongoing practice of a profession, serving a community, offering self-regulation for high quality, and contributing to a substantive body of knowledge (Alexander, Fox, & Gutierrez, 2019, p. 2-3). The meaning of professional learning and professional development is still ambiguous, overlapping, and is sometimes used interchangeably. However, professional development seems to refer to certain trainings, workshops, or activities aiming to enhance knowledge and skills. Bohall and Bautista (2017, p. 11) defined professional development as a skill development that is required to understand, complete tasks, and improve performance in a career. In a school context, many activities involve the interaction between teachers and teacher educators. This includes workshops, self-monitoring, teacher support groups, keeping a teaching journal, peer observation, teaching portfolios, analyzing critical incidents, case analysis, peer coaching, team teaching, action research, and perhaps lesson study (Richards & Farrell, 2005, p. 1). Additionally, Hendriks, Luyten, Scheerens, Sleegers, and Steen (2010, p. 63) found that the most common types of professional development include informal dialogue to improve teaching, courses and workshops, reading professional literature, education conferences and seminars, professional development networking, individual and collaborative research, mentoring and peer observation, observation visits to other schools, and qualification programs. Moreover, Mullis, Martin, Goh, and Cotter (2016) noted that ongoing professional development activities in Japan are in the form of courses and workshops, whereas lesson study is regarded as a popular training type to help primary school teachers improve instructional skills, abilities, and educational knowledge development. Similarly, Cooc (2019) defined professional development as formal activities in the form of workshops, courses and training, and informal activities in the form of collaboration with other teachers to develop knowledge, skills, and expertise. Teachers "need more professional development on teaching special learning needs students, ICT teaching skills, student discipline and behavior problems, instructional practices, subject field … student assessment practices, teaching in a multicultural setting, classroom management, school management and administration" (Hendriks, et al., 2010, p. 67). In many European countries, professional development is optional but a professional duty of teachers that is “clearly linked to career advancement and salary increases.” Teachers who complete a sufficient number of trainings are qualified to receive a salary bonus and be considered for promotion (Hendriks et al., 2010, p. 44). Coldwell (2017) also claimed, “There is casual relationship between professional development itself and career development or retention… There are positive outcomes in relation to promotion or orientation towards promotion and school leadership capacity.” Therefore, professional development in this research refers to a general practice of formal or informal activities for helping teachers enhance knowledge and skills for their professions.

Professional learning may be the conceptual effect of those trainings in determining the degree of what can teachers and teacher educators gain or learn from those activities. It is not only accumulating training but also intellectual reflection to deepen understanding that leads to internal change. Yin, To, Keung, and Tam (2019) clearly stated that teacher learning is embedded in the job activity and collegial techniques. Their “professional learning is a product of both externally provided and job-embedded activities that increase teachers’ knowledge and change their instructional practice in ways that support student learning.” Collegial, group, or collective learning promote “both ‘active deconstruction of knowledge through reflection and analysis’ and ‘co-construction through collaborative learning with peers’” (Bolam et al., 2005, as cited in Yin et al., 2019, pp.13-14). Groundwater-Smith and Mockler (2009, p. 56) also clearly stated that professional learning is, in effect, professional development. It is regarded “as a more reflexive, active process in which teachers were engaged in collaboration, self-determination of learning goals and local knowledge creation... It is highly reflexive and differentiated which leads to deep pedagogical shifts and transformation of practice.” In the UK, USA, and Australia, they even used the term “inquiry-based professional learning,” which provides an opportunity for teachers to create knowledge, build authentic collegiality, and develop and hone their professional judgement. While Patterson (2019, p. 11) used the term “enacted personal professional learning” that “relies on understanding perceptions of expertise in teaching, understandings of metacognition and deliberate practice of experts and an appreciation of teachers as learning professionals.” Therefore, professional learning in this research is regarded as a Meta level of MTEs when they engage in the lesson study practice.

2.2 Teacher educators’ works and professional learning

Prior understanding about the professional learning of teacher educators, it is essential to define who a teacher educator is. In this research, the author refers to these individuals as “those teachers in higher education and in schools who are formally involved in pre-service and in-service teacher education” (Murray, Swennen, & Shagrir, 2009, p. 3). They are “teachers of teachers, engaged in the introduction and professional learning of future teachers through pre-service courses and/or the further development of serving teachers through in-service courses" (Murray et al., 2009, p. 29). Teacher educators perform complex and diverse work. In the school context, they are supervisors to empower and support student teachers in classroom teaching practices as well as other aspects of professional work. At a university, they are expected to teach or lecture student teachers, collaborate with mentors and colleagues, design curriculum for their institutions, supervise student teachers' research and thesis writing, and publish their own research work (Swennen, Shagrir, & Cooper, 2009, p. 94). The transition from the status of teachers to teacher educators is to establish professional identities. Previous studies have found that the transition from schoolteachers to teacher educators in the first three years led to professional learning and growth through experience and pedagogical knowledge. Appropriately, this includes learning how to be a teacher educator in higher education, acquiring practical knowledge of the higher education institution and how it operates, enhancing and generalizing their existing knowledge base of schooling, developing ways of working with mentors in school-based settings, and developing an identity as a researcher (Murray & Male, 2005).

What is challenging for the schoolteachers and MTEs is considering how to assist students in understanding mathematics. Therefore, when it comes to the change in nature of mathematics knowledge, MTEs should be able to stimulate (prospective) teachers to understand and learn about mathematics needed for teaching, especially regarding analyzing student solutions and/or modifying mathematical definitions. To teach or facilitate mathematical knowledge to pre-service teachers for higher thinking of cognitive complexity, MTEs should not only possess such mathematical knowledge but also the rich ability to anticipate pre-service teachers' misconceptions, challenges, and potential questions (Superfine & Li, 2014). Thus, MTEs "need to understand mathematical knowledge for teaching for themselves and should be knowledgeable about ways to connect pre-service teachers' mathematical learning to the practice of teaching K-12 students" (Superfine & Li, 2014).

In TTCs and universities, the work of teacher educators requires certain skills, knowledge, and attitudes to support in-service teachers while also developing their professions in the field (Ping, Schellings, & Beijaard, 2018). In England, qualified schoolteachers recruit teacher educators. Teaching experience from primary or secondary school becomes imperative to educate student teachers. In Israel, previous school experience is not necessary, but holding a master's degree and Ph.D. are important. In the Netherlands, however, either is acceptable with previous school experiences or a master's degree in the field of education (Murray et al., 2009, p. 34-39). In contrast to the case of Laos, theoretically, there might be some criterion for selecting teacher educators to work in universities or TTCs. In reality, many student teachers work in higher teacher education immediately after graduating from universities or TTCs. The researcher previously conducted an online survey with 121 teacher educators who were currently working in TTCs. The results showed that 51.2% became teacher educators in TTCs directly after graduation from the universities, and 28.1% became teacher educators in the TTCs directly after graduation from the TTCs; 11.6% moved from secondary schools, and 3.3% moved from primary schools (survey, December 5, 2019). According to the literature, although MTEs and schoolteachers differ concerning the Lao context concerned in this research, their knowledge and experience of school context and lesson study are considered of the same level. This implies that MTEs need more engagement in professional learning activities such as lesson study.

Although teacher educators work in higher education, they have many roles in the educational context. They play "a mediating role in the two main areas of acquiring the profession-higher education institutions and schools. They have different roles in each of these contexts and are required to develop and enact different sensitivities" (Golan & Fransson, 2009, p. 49). First, they are schoolteachers, as they used to work in this role (Swennen, Jones, & Volman, 2010). They are not only teaching prospective teachers but also act "indirectly for the teaching of the pupils who will be taught by their student teachers." In the schools, they are supervisors to empower and support student teachers in classroom teaching practices as well as other aspects of professional work (Swennen et al., 2009, p. 92-94). They also support primary school teachers, so teacher educators need to have completed SMK and PCK of the primary education to anticipate unusual solution methods and evaluate school students' conjectures (Schellings & Beijaard, 2018). Therefore, teacher educators should understand the development of pupils, facilitate and supervise (prospective) teachers' development, be able to lead their own professional development and colleagues, and act as a role model for (prospective) teachers (Murray et al., 2009, p. 32).

Second, teacher educators play a role as instructors in TTCs or universities. To teach in higher education, they must possess knowledge and skills about the education of teachers. Additionally, they are required to have new professional knowledge beyond schoolteachers, as well as knowledge of higher education curriculum, appropriate and required content, and how to teach a specific subject to student teachers (Swennen et al., 2009, p. 92-93). Teacher educators are expected to teach or lecture student teachers, collaborate with mentors and colleagues, design curriculum for their institutions, supervise student teachers' research and thesis writing, and publish their own research work (Swennen et al., 2009, p. 94). Since teacher educators are the teachers in higher education— teacher of teachers, overall—they are role models for their student teachers (Golan & Fransson, 2009, p. 48-49; Swennen et al., 2010). Therefore, they "bear a heavy responsibility both as teachers and as individuals for the process of becoming a teacher" (Golan & Fransson, 2009, p. 48-49). In teacher education, the teacher educator has a significant role to not only encourage deep discussions regarding the intertwining among pedagogy, knowledge, purposes, aims, and value of teacher education, but also share "knowledge and the beliefs about professional dispositions, attitudes and values" (Redman & Rodrigues, 2014, p. 2). Furthermore, they must educate future teachers to build their own professional identity (Giardiello, Parr, Mcleod, & Redman, 2014, p. 14). Thus, they should have a teaching standard by being a model of effective teaching. Teacher educators should be able to demonstrate and promote critical thinking as well as problem solving among prospective teachers, in-service teachers, and their colleagues (ATE, 2019). Overall, most teacher educators' professional development efforts emphasize being a competent model teacher for instructors in higher education as well as being researchers, which is the signature or identity of teacher educators (Erbilgin, 2019).

Third, teacher educators play the role of researchers to build their own professional identity in their chosen area to improve knowledge and skills and contribute to academic knowledge within the educational community (Swennen et al., 2010; Erbilgin, 2019). The demand on conducting research is affected by institutional ratings or ranking systems and continuous learning to improve teaching and learning in six domains. These include the following: (1) dynamic view of knowledge ("because it is not static quantum but subject to continuous growth, change to fit temporal context in which it is to be used"); (2) societal change; (3) changing in educational landscape (i.e., universal education in school level and the growth from entering colleges and universities); (4) inter-personal working, (5) lifelong learning, and (6) collaborative model for the development of teaching and learning. Teacher educators want to conduct research to enhance their understanding of the complexity in teaching and learning in both higher education and school contexts. Moreover, they aim to add and improve knowledge, improve existing teacher education programs, demand improvement in the quality of the educational process within schools, and request career promotion and advancement from governments or other agencies (Livingston, McCall, & Morgado, 2009, pp. 192-194). This role corresponds to the Standard 3 of teacher educators, as defined by ATE (2019), that teacher educators should perform and apply research to their teaching practice, conduct action research, (including, perhaps, lesson study), and pursue new knowledge relating to teaching-learning.

Fourth, teacher educators can also act as policy makers, because the tasks of teacher educators include not only working on his/her own development (professionalism) and providing a teacher education program, but also taking part in policy and teacher education development (Koster, Brekelmans, Korthagen, & Wubbels, 2005). This also corresponds to the requirements of teacher educators in Standards 5, 6, 7, & 8, as defined by ATE (2019), that teacher educators should engage in program development by designing, developing, or modifying the teacher education program based on best practices, research, and theory. Teacher educators should collaborate in the decision-making and improvement of teacher education, engage in public advocacy by working with policy makers at the local level, and improve teacher education by writing or editing textbooks and reviewing or editing manuscripts for publication (ATE, 2019).

Ping et al. (2018) found that teacher educators' professional learning emerges through academic engagement, collaborative activity, attending professional development programs, and reflective activity. They need professional learning because of external requirements, personal ambitions, and professional role transitions. These authors also found teacher educators' professional learning that includes professional learning through teacher education pedagogy, research and reflection, professional identity, and knowledge base. Regarding (1) the content of learning about teacher education pedagogy, teacher educators must be "learning about teaching" to understand how student teachers learn to teach. They must also understand student teachers' needs, concerns, identities, beliefs, difficulties, and the expectations student teachers face. Teacher educators acquire professional learning on "teaching about teaching" through pedagogical reasoning that underlies teacher educators' own teaching. They explain clearly to student teachers about the purpose and reasoning behind their teaching behavior. Teacher educators learn through "mentoring and supervision" during student teachers' internships and their small-scale research. Regarding (2) research and reflection, teacher educators gain knowledge of and methods to conduct research. Reflection involves reflecting on their own teaching practices as well as encouraging their student teachers to practice reflection. Regarding (3) professional identity, teacher educators play the roles of educator and professional as a "teacher of teachers" and a researcher, respectively. Concerning (4) professional learning about knowledge base, teacher educators must have content knowledge of what to teach, know how to teach a specific subject to student teachers, and have curriculum knowledge (Ping et al., 2018). Teacher educators grow their professional learning through experience and pedagogical knowledge gained as a teacher educator in higher education, acquiring practical knowledge of the higher education institution, enhancing and generalizing the existing knowledge base of schooling, developing ways of working with mentors in school-based settings, and developing an identity as a researcher (Murray & Male, 2005).

Therefore, teacher educators should (1) understand the development of pupils, (2) facilitate and supervise student teachers' development, (3) be able to steer his/her own professional development and colleagues or participants, and (4) be a role model for (prospective) teachers (Murray et al., 2009, p. 32). For novice teacher educators, engaging in these activities may help succeed in their transition from beginner to experienced teacher educators:

> … First, ask novice and experienced colleagues to work collaboratively on the preparation of lessons, assessment, and curriculum development. Second, exchange visits with other novice and experienced teacher educators and discuss your teaching and learning in a safe and supportive learning environment, using feedback methods cooperatively. Third, create your own

support group of colleagues who want to expand their identity from classroom teachers to teacher educators. Fourth, get involved in research with colleagues in, across, or outside of your institution. Finally, one must acquire a sense of belonging to a work community and a feeling of being part of that community (Swennen et al., 2009, p. 101).

Based on previous studies from the above discussions, MTEs' professional learning is within these four roles of schoolteacher, teacher educator, researcher, and policy maker. The content of MTEs' professional learning is also associated with the content of schoolteachers; learning about pedagogy of teacher education, knowledge base, role model, and providing a teacher education program in higher education; building professional identity as researcher; and engagement in the development of teacher education and policy making. However, for this study, the research focuses on the two important roles: MTEs' professional learning in the roles of teachers and teacher educators.

2.3 Lesson study and its process of practice

Lesson study is a systematic process to improve instruction and decrease teacher isolation. It examines successful teaching strategies to increase student learning (Podhorsky & Fisher, 2007, pp. 446-449). Lesson study is well known globally as an effective professional development activity and is, therefore, adopted and adapted in many countries outside Japan. In this study, the author describes certain lesson study procedures of those adaptations in some countries in Section 2.6. This section, however, describes only the Japanese lesson study, which comprises different levels including national-based, district-based, and school-based (Lewis et al., 2012; Fujii, 2016). At the national level, lesson study emphasizes the topic that is difficult to teach or tasks and/or new, never-before-seen materials. At the school level, lesson study aims to complete a school mission using familiar tasks from the textbooks or by slightly modifying them (Fujii, 2014). Lesson study has five steps: goal setting, lesson planning, research lesson, post-lesson discussion, and reflection (Fujii, 2017, p. 93) (see Figure 2). First, goal-setting means to set goals for what students will be learning in the long-term setting, determine the gap between this goal and the present situation, and design a research theme. Second, the lesson planning is to plan and design a research lesson collaboratively to address the goals, as well as write and revise a detailed instruction plan including long-term goals, student-thinking anticipation, a model of learning trajectory, and the reason for choosing a particular approach, among others. Third, conducting the research lesson involves delivering the lesson by the group representative while the others observe the live lesson and collect teaching and student learning data. Fourth, conducting the post-lesson discussion involves offering feedback in a formal lesson colloquium in which observers share data from the lesson to illustrate student learning, content discrepancies, lesson and unit design, and broader issues in teaching-learning. Finally, reflection is achieved by documenting the cycle to consolidate and carry forward knowledge as well as new questions for the next lesson study cycle. Additionally, a report or bulletin must be written and include a lesson plan, student data from the research lesson, and reflection on what was learned.

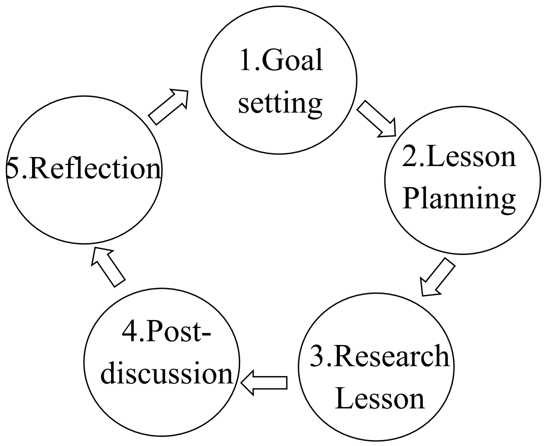


Figure 2. Lesson study procedure

Fernandez and Yoshida (2004, pp. 7-9) also briefly explained six steps of the lesson study process. Firstly, the teachers join to collaboratively plan a research lesson, sharing previous ideas or knowledge to construct the best lesson. The final product of this step is to have a well-detailed and designed lesson plan. Secondly, the group members see the study lesson in action. Thirdly, the group members and/or outside observers discuss the study lesson to share what they have witnessed. Fourthly, if the group desires, lesson plan revision is implemented. Fifthly, if the group desires, the revised lesson will be retaught with a different group of students; however, this is optional for both the fourth and fifth steps. Finally, the group members share the reflections about what has been observed in the new version of the lesson while the group member records the shared data for including in a later report.

2.4 Effective mathematics teaching approach

Teaching and learning mathematics in a classroom is influenced by four conceptual theories: Behaviorism, Cognitivism, Constructivism, and, newly, Connectivism. Behaviorism is relatively rote learning that "students respond to the stimulus given by the teacher." Students' obvious "incorrect behavior in the class must be warned and replaced by the correct behavior." Cognitivism "is mental processing, thinking, knowing and problem solving" that is stored and retrieved by mind, whereas Constructivism is the active learning process in which students construct their own knowledge and understanding. They explore several ways of solving problems to create new knowledge. Connectivism is a 21st teaching and learning theory involving a teacher shifting from being an expert or "spoon feeder" to a facilitator, listener, and/or observer for the collaborative and interactive learning

(Kashefi, Ismail, Mirzaei, Tak, Obeng, & Ching, 2017). Regarding these theories, Guey, Cheng, and Shibata (2010) imply that the trend of the teaching-learning activity of the 19^{th} century is generally teacher oriented. The teacher takes control of all classroom activities, and students are passive learners. Teaching-learning of the 20^{th} century is material oriented with major concern on teaching and presenting material organization. Currently, in the 21^{st} century, “instruction is increasingly student oriented, [as] the individual needs and uniqueness of students are treated as the highest priority.” One of the concrete instructional methods that emphasizes students’ learning needs, individual thinking, and knowledge construction is the problem-solving approach that Japanese teachers intertwine with lesson study practice. This is because, perhaps, it is believed that lesson study—a specific type of teacher professional development—is “based on constructivist tenets” that greatly influences teacher’s pedagogy, content knowledge, and student achievement (Wright, 2009).

Problem solving, a Japanese mathematics teaching approach, is a unique way of teaching that many novice and scholar-teachers outside Japan try to adapt into their classrooms. Stigler and Hiebert (1999) described this as “structured problem solving” in which, during the teaching, Japanese mathematics teachers facilitate and encourage students to produce their own ways of solving a mathematical problem that is clearly classified into five steps. Isoda (2010) and Fujii (2017) described similar concepts in four steps, naming their methods “problem solving” and “teaching mathematics through problem solving,” respectively. These patterns include (1) problem posing that comprises reviewing previous lessons and students’ understanding of the problem, (2) students solving a problem in groups or individually, (3) students comparing and discussing their different strategies and solutions (neriage) with the teacher, and (4) the teacher summarizing various solutions (matome) with the students (see Table 3 and Figure 3).

Table 3. Japanese mathematics teaching approach

<table>
<tr><th>“Structured problem solving” Stigler and Hiebert (1999)</th><th>“Problem solving approach” (Isoda, 2010)</th><th>“Teaching mathematics through problem solving” (Fujii, 2017)</th></tr>
<tr><td>1. Reviewing previous lesson</td><td rowspan="2">1. Posing a problem</td><td rowspan="2">1. Presenting the problem for the day (5-10 mins)</td></tr>
<tr><td>2. Presenting the problem of the day</td></tr>
<tr><td>3. Students working individually or in groups</td><td>2. Independent solving</td><td>2. Problem solving by students (10-20 mins)</td></tr>
<tr><td>4. Discussing solution method</td><td>3. Comparison and discussion</td><td>3. Comparing and discussing (neriage) (10-20 mins)</td></tr>
</table>

5. Highlighting and summarizing the major points	4. Summary and application	4. Summing up by the teacher (matome) (5 mins)

Source: (Shingphachanh, 2019)

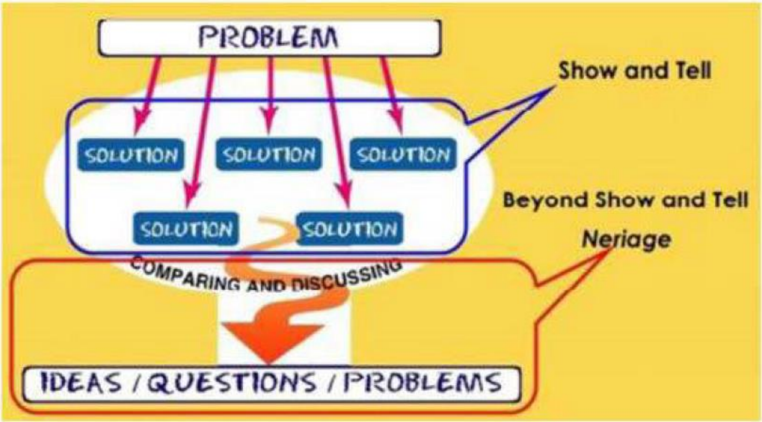


Figure 3. Teaching through problem solving (Takahashi, Lewis, & Perry, 2013)

Although different authors have defined several processes of the problem-solving approach, it maintains its original importance of valuing various solutions and processes for how students solve mathematical problems rather than focusing on one single correct answer (Fujii, 2017, p. 88). In the Japanese context, the problem-solving approach has been integrated into the curriculum and teaching strategy for decades. Accordingly, Japanese textbooks collected a well-tested series of lessons with a set of problems containing rich mathematical concepts. Moreover, the books contain experiential knowledge of student mathematical thinking in the books from with others can learn. Therefore, Japanese teachers can develop and articulate their instructional practices appropriately (Takahashi et al., 2013).

Similarly, to the aforementioned teaching concept, the Japanese mathematics teaching approach is also called an “open-approach method” (Nohda, 2000) and “open-ended approach” (Becker & Shimada, 1997). Nohda (2000) mentioned that this approach stimulates students to gain self-confidence to share their thoughts about the mathematical concept with classmates while the teachers increase their understanding of students’ mathematical thinking. Becker and Shimada (1997) highlighted that the open-ended approach aims to present an incomplete problem for students to discover various complete answers for, finding new ways of learning through students’ mathematical thinking, including how they link previous knowledge to solve current problems. Therefore, a well-designed mathematical task is most important. The task should provide students with a desire to solve it and acquire a feeling of achievement. Simultaneously, the tasks should be suitable for the students’ levels of mathematical thinking, and generalizability, offering various solutions for different levels (Kwon et al., 2006). The following section details how to employ the problem-solving approach.

2.5 Integration of mathematics teaching approach and lesson study

Problem solving is used in almost every research lesson with open-ended problems to deepen students' mathematical thinking. To solve open-ended problems, students must use prior relevant knowledge to solve it. It is believed that students can learn new information through this solving process (Groves, Doig, Vale, & Widjaja, 2016). Fujii (2018, p. 10) also emphasized that mathematics teaching in lesson study usually employs the problem-solving approach or structured problem-solving approach with a single mathematical task. Consequently, lesson planning—especially task design—becomes crucial for the entire research lesson. The integration of these approaches is challenging for lesson study practitioners. How to intertwine the problem-solving approach with lesson study requires sufficient professional knowledge and skills for productive results. Before demonstrating the details of how to teach using the problem-solving approach, what is a good lesson? Miyakawa (2015) used the theory of didactical situations, (Brousseau, 1997) concluding that a good lesson comprises two main characteristics depending upon the nature of the task "milieu" and the "nature of the social interactions" (or didactical contract) in the lesson:

> Teachers should not provide an answer or solution to the given task or directly validate pupils' answers. The teacher may ask the reason for a given answer, clarify pupils' statements, and bring them to a common solution by respecting their ideas. The answers found were the results of an effect of didactical contract, not the results of interaction in the student-milieu system. Although the pupil's milieu is not organized well enough to offer feedback, it is not a teacher who provides feedback, but social interactions with other pupils promoted by the teacher. The role of the teacher is to organize a lesson, and pupils are to find, formulate, and validate solutions or mathematical ideas (p. 345).

Concerning a suitable lesson, the teaching process should follow five steps (see Figure 4). Firstly, the teacher presents a problem; secondly, students understand the problem of the day and solve it in pairs or individually; thirdly, students present their solution to the whole class; fourthly, the teacher leads the discussion based on the students' solution(s), summarizing the lesson into the contents that students will take note to their book. Finally, if time allows, the teacher offers students similar or slightly different questions to use their gained knowledge on; if not, it can be assigned as homework (Daro, 2017, pp. 150-156; Fujii, 2017, pp. 87-91). The following figure details each teaching step based on these two researchers (Daro, 2017; Fujii, 2017).

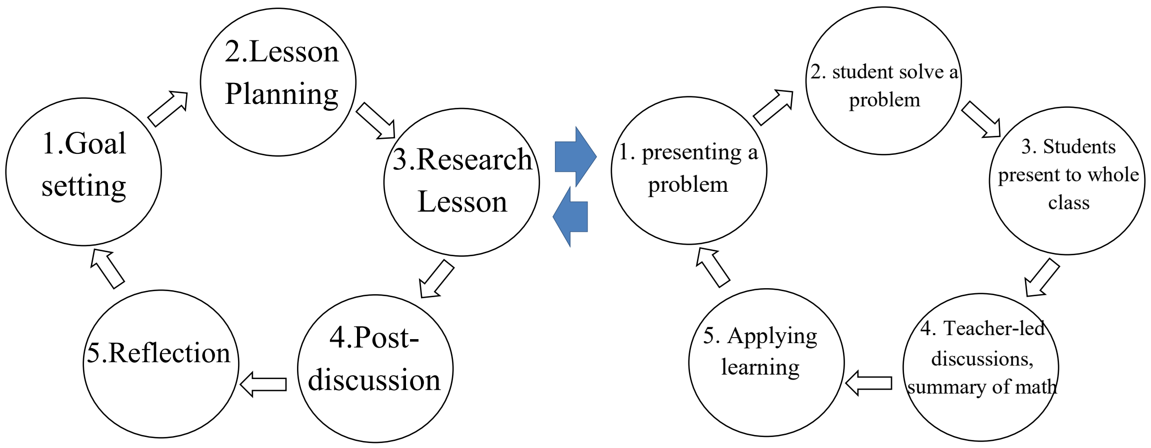


Figure 4. Problem solving teaching approach and lesson study intertwined

Presenting a problem (5 mins): After a regular greeting or short self-introduction, the teacher briefly talks about previous knowledge or background relating to the day's problem. The teacher then presents a problem or task of the day. The teacher should not directly explain how to solve it but spend a few minutes on reading comprehension and Q&A before instructing students to work on the problem. Do not devote "too much time giving a long list of warnings and assignment specifications, such as thing not to forget, things to watch out for, things to make sure of, things to remember, etc." If possible, only address students after they have worked to solve the problem, or offer help when students become stumped. "The goal is productive struggle with a divergence of approaches that reveal the diversity of prior mathematics."

Students solve a problem (13 mins): After understanding what students are supposed to do, the teacher allows students to solve the problem individually or in pairs. Solving a problem individually will "develop a [student's] individual point of view and activation of prior knowledge." Then, the teacher may ask students to work and share in pairs or explain their solutions to their partners before presenting to the class. The goal of pair work is to "prepare a presentation of their way of thinking about the problem and how their solution makes sense." While students are working on the problem, the teacher should walk around to check or identify and collect information about "which student is doing which type of solution (out of the various solution methods, correct and incorrect, that [the] teacher anticipated when planning the lesson)." The teacher should be able to identify methods of solving the problem that most students use in general (tendency). On one hand, if the teacher finds students have difficulty, they may offer them a hint. On the other hand, for students who solve the problem quickly, instruct them to try a different approach to reach the solution to enhance their understanding. In the meantime, while monitoring students' work, the teacher should consider what to do in the discussion phase, how to compare, which student will present first, which student will present after, and where the potential point of the lesson should be.

Student presentations (14 mins): After students work for 15 minutes, it is assumed they will have employed different solution methods, ranging from "naïve" to "sophisticated." The teacher would then appoint three to four different ideas determined while students were solving the problem. The purpose of the presentation is to explain their perspective, as well as how it relates to previous mathematical knowledge. Remember, the audience of this presentation is not the teacher but the students. Therefore, the explanation is to help other students understand their approach. At this stage, the question is how to decide which student will present first. Typically, the first presenter is a student who procures an easy way of solving the problem—tangible, visual, or "most concrete and explicitly connected to the earliest mathematics." The last presenter is a student who determines the solution with the ideas "closest to target mathematics, grade level mathematics or that is most abstract, generalizable, and closest to grade level expression." In the case that students discover the same strategies, the first presenter would be a student who makes more mistakes than others, and the last presenter would be a student who has less or no mistakes. When presenting an idea, they may become stuck; the teacher should then redirect by calling on students who have made progress and "who have a way of thinking that might get others out of the rut."

Teacher-led discussion and summary of mathematics (10 mins): After presenting three to four different ideas of mathematical thinking, a group discussion is held with the entire class about the mathematical idea that emerges from the class work on the given task. In the case when a teacher is trying to move the discussion forward, but students are not talking or cooperating well, the teacher may ask students to repeat the question. When students say something that advances the discussion toward target mathematics, the teacher should direct students to discuss that statement so that everyone is focused on the target mathematics. The teacher should quote students' ideas, showing their work and highlighting it to illustrate mathematical thinking. After all ideas are presented, how can we conclude the lesson? Fujii (2017) suggested, "If the teacher concludes a lesson with a procedure-oriented comment, the students may feel that procedure knowledge is most important in mathematics..." It is important for the teacher to "highlight how students construct their ideas by using their former or previous knowledge. This indicates that How We Think Is Highly Valued. In other words, the summing-up phase is an opportunity to elevate the process aspect of mathematics…" (p. 91). Therefore, to conclude the lesson, the teacher should incorporate and modify students' work or responses and integrate them into the point of learning.

Apply the learning (3 mins): Following the lesson summary, if time allows, the teacher may propose exercises related to the given problems for students to work on individually or in pairs. This purpose is to develop students' confidence about what they have learned. Depending on the remaining time, those exercises can be assigned as homework.

Schipper, Goei, de Vries, and van Veen (2017) reviewed the literature, claiming that for teachers to have professional growth through the lesson study approach, adaptive teaching competence is crucial. This competence includes four dimensions: (1) in-depth subject content knowledge and knowledge about differentiation; (2) knowledge of student conceptions to diagnose individual student learning, needs, and characteristics; (3) "teaching methods as part of the repertoire of teaching approaches; and (4) classroom management in order to create conditions which facilitate student learning" (Brühwiler & Blatchford, 2011, as cited in Schipper et al., 2017). The National Council of Teacher of Mathematics (NCTM) regarded eight areas to consider for an effective mathematics teaching practice. Firstly, teachers should establish clear goals for student learning to guide instructional decisions. Secondly, teachers should implement tasks that promote reasoning and problem solving for students to discuss the tasks with appreciation of varied solutions strategies. Thirdly, the mathematical tasks should engage students to use and connect mathematical representations to deepen their understanding in both mathematical procedure and concepts. Fourthly, teachers should facilitate students with meaningful mathematical discourse by analyzing and comparing students' ideas to share a common understanding of mathematical ideas. Fifthly, teachers should pose purposeful questions relating to the task implementation. The questions are very important to stimulate students' thinking, reasoning, and relating mathematical ideas. The sixth area involves building students' procedural fluency from conceptual understanding so that they will have a strong foundation to solve contextual mathematical problems. The seventh area supports productive struggle in learning mathematics. By providing them an opportunity to struggle with mathematical problems, they will be individually and collectively engaged and learn from the tasks. Finally, teachers elicit and use evidence of student thinking to adapt instruction for students' further learning (NTCM, 2014).

2.6 Lesson study in international perspectives

The publication of the book, entitled "Teaching Gap" by Stigler and Hiebert (1999), revealed Japanese lesson study to the world. Thus, several countries integrated or adopted lesson study to their existing professional development activities. However, for lesson study adaptation to fully gain effectiveness outside of Japan, it is first necessary to study and understand Japanese lesson study (Hart & Carriere, 2011, as cited in Groves et al., 2016). In the Australian context, Groves et al. (2016) adapted a structured problem-solving mathematics lesson and Japanese lesson study that teachers highly valued in the lesson plan details, specifically regarding mathematical goals, statement of the task, lesson in the unit and curriculum, prior knowledge of students, and their solution anticipation. However, teaching culture and cultural differences between Australia and Japan are long-term cultural practices to overcome. In the Netherlands, Schipper et al. (2017) combined lesson study with "adaptive teaching competence," or the ability to adjust teachers' planning and teaching to students' individual learning processes, determine teachers' professional growth, and become more conscious about students' different educational needs. Teachers learned a great deal about students' characteristics and how students learn, differentiating their subject matter to meet students' learning preferences. Additionally, Moss, Hawes, Naqvi, and Caswell (2015) modified the Japanese lesson study cycle with four adaptations to enhance teaching and learning geometry. These four adaptations include teachers engaging in mathematics, conducting co-designed task-based clinical interviews, collaborating with researchers to design and teach exploratory lessons, and creating resources for other teachers. The study found the approach successful as it helps members gain "deep content knowledge and broaden conceptualization of geometry and spatial reasoning." Da Ponte, Quaresma, Mata-Pereira, and Baptista (2018) also adapted lesson study in the Portuguese context through the project using 12 sessions. The study presented interesting findings; although teachers initially had difficulty choosing the teacher to conduct the research lesson, they realized the values of lesson study for their professional learning experiences. These values included various beneficial tasks, consideration for students' prior knowledge, students' strategies for solving problems, generalizations, and justifications as well as fostering students' learning through class discussions. The study also argued that employing lesson study was not ideal if teachers' major concerns involve covering a wide range of topics and curriculum aims. However, it would be best suited if teachers value in-depth work. Some of the aforementioned studies have shown that non-Japanese lesson study adaptations greatly affect teachers' professional learning to improve teaching and student learning. The following are some insights into how some countries adapted lesson study.

2.6.1 Lesson study in the United States of America

Lesson study was brought to the United States by four publications. These include Yoshida's (1999) dissertation, entitled "Lesson Study: A case study of a Japanese approach to improving instruction through school-based teacher development"; Lewis's (2002) lesson study handbook, entitled "Lesson Study: A handbook of teacher-led instructional change" (see Figure 5); the Mill College Lesson Study Group (2000); and Stigler and Hiebert's (1999) book, entitled "The Teaching Gap: Best ideas from the world's teachers for improving education in the classroom." After these publications, lesson study rapidly spread across the United States. Within four years, lesson study was adapted in 32 states and, approximately, over 225 schools (Lewis, Perry, & Murata, 2006).

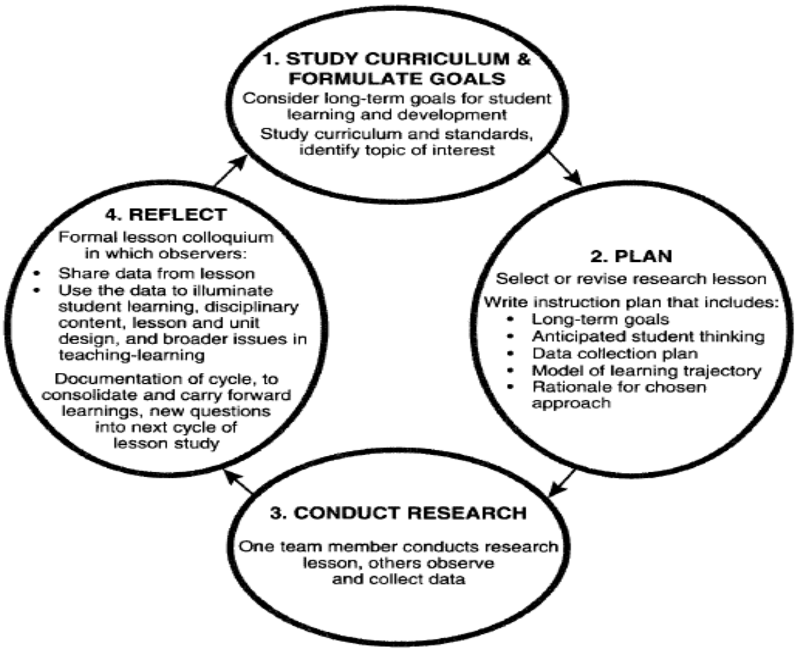


Figure 5. Lesson study model (Lewis, 2002)

Watanabe (2018) also summarized that lesson study in the US was initiated by the studies of Yoshida (1999), Stigler and Hiebert (1999), and Lewis and Tsuchida (1998). Yoshida's study was later published as Fernandez and Yoshida's (2004) book of the same name. The book conceptualized a six-step lesson study practice: (1) collaboratively plan a research the lesson, (2) observe the employed study lesson, (3) discuss the study lesson, (4) revise the lesson plan (optional), (5) reteach the lesson with a different group of students (optional), and (6) share reflections on the observation (Fernandez & Yoshida, 2004). Stigler and Hiebert (1999, pp.112-116) defined eight steps of lesson study practice: (1) defining the problem, (2) lesson planning, (3) teaching the lesson, (4) evaluating the lesson and reflecting on its effect, (5) revising the lesson, (6) teaching the revised lesson, (7) evaluating and reflecting, (8) and sharing the new results. The US's version of the lesson study involves classroom research to develop teacher knowledge. This is consistent with the Japanese educators' perspectives that teaching is recognized as research. Lesson study is embedded in Japanese daily teaching, therefore, "classroom teachers often talk about their own 'research agendas', and mathematics teacher educators will say that the main objective of student teaching is for teacher candidates to identify and sharpen their agenda of research" (Watanabe, 2018). Lewis, Perry, and Hurd (2005) conducted lesson study with 26 volunteer teachers of K-8 in 2000. They found changes in teachers' knowledge of subject matter, instruction, student thinking, and the capacity to capture it, as well as their motivation to improve the lesson, capacity to work with colleagues, and accountability to value practice community. For example, teachers increased their understanding that if the arrangement of the triangles is modified, the mathematical pattern would change. Teachers also alter their conceptions about student learning because how students count is a representation of their mathematical thinking. The change in pedagogy is that correctly completing the chart does not guarantee students' understanding of a mathematical pattern. Students' understanding of mathematical patterns will be deepened when they manipulate the triangles themselves (Lewis et al., 2009). Gonzalez and Deal (2017) revealed that teachers change their understanding of subject content knowledge about "perpendicular bisector in relation to other concepts in curriculum." They explain the definitions of perpendicular bisectors while discussing the lesson plan. Their knowledge of students' conceptions also changes because they anticipate students' mathematical thinking in tasks related to perpendicular bisectors. There is also a change regarding content knowledge of teaching because the teachers set a criterion to select the tasks "that would best enable student discovery of specific properties of perpendicular bisectors."

2.6.2 Lesson study in Singapore

During an international conference in Singapore in 2004, Catherine Lewis and her academic team from Japan introduced the concept of lesson study to Singaporean researchers and teacher educators (Lee & Lim-Ratnam, 2015, p. 42). It "has been adopted by some schools as a school-based professional development program or as cluster-initiated program" (Cheng & Yee, 2012). In 2006, after being acquainted with lesson study for two years, the teacher educators and researchers of the National Institute of Education (NIE) started implementing lesson study practice within primary schools. Catherine Lewis, Patsy Wang Iverson, and Akihiko Takahashi perhaps influenced the lesson study process in Singapore, as they guided several workshops from 2006 to 2009. Consequently, it started booming, and the numbers of Singapore schools practicing lesson study dramatically increased from eight schools in 2007 and 112 schools in 2010 to 170 schools in 2012 (Lee & Lim-Ratnam, 2015, p. 42). Apparently, to gain more from lesson study's effectiveness, Singaporean researchers did not limit their opportunity by adopting a singular lesson study model, even combining Lewis' model based on the handbook (2002). They also utilized the learning studies of Hong Kong's lesson study model by adopting "pre-and post-tests for diagnosis of students' prior knowledge and assessment of learning outcomes and variation theory to analyze the research lessons" (Fang & Lee, 2015).

2.6.3 Lesson study in the United Kingdom

Peter Dudley introduced lesson study to the United Kingdom (UK) in 2001. Generally, this model was taught with three research or study lessons (see Figure 6). Dudley's perspective on lesson study was "a specified form of classroom action research focusing on the development of teacher practice knowledge" (Dudley, 2014, p. 1). This practice knowledge is tacit knowledge, and it "tends to stay with the teacher who discovered it and who is usually unconscious of its existence." Dudley conceptualized lesson study into three cycles. First, lesson study group members jointly planned the first lesson. They then taught and observed the lesson, interviewed students, and held a post-lesson discussion.

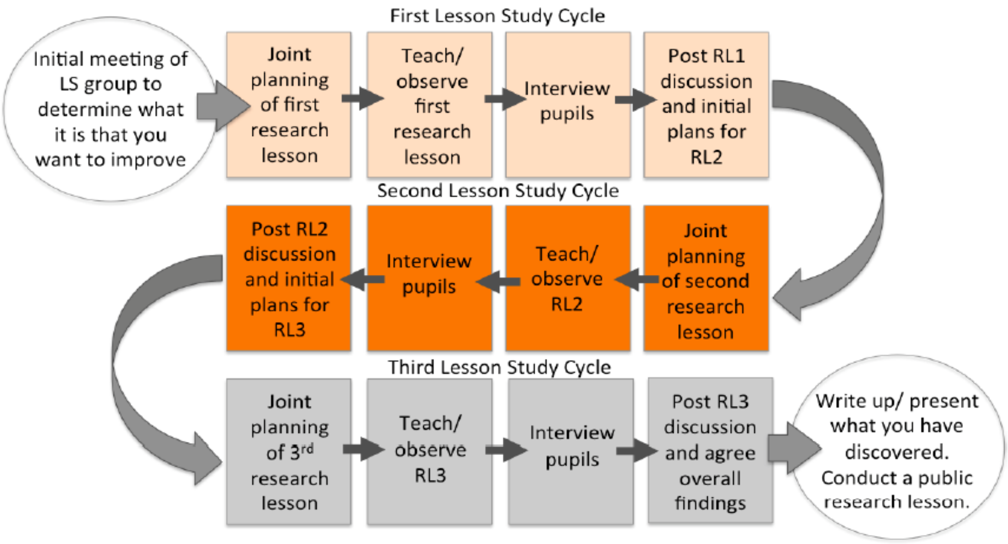


Figure 6. Lesson study in the UK (Dudley, 2014)

2.6.4 Lesson study in Thailand

Thailand has eight educational universities and 36 Teacher Colleges that are responsible for training primary and secondary school teachers (Inprasitha, 2006). Dr. Maitree Inprasitha of Khone Kaen University first introduced lesson study in Thai mathematics teacher education in 2002. He incorporated the lesson study concept with Open Approach using open-ended problems to run the mathematics class activities. Initially, he piloted with 15 pre-service teachers in seven secondary schools in Khon Kaen city. This project has positively influenced mathematics teacher education in Thailand, expanding to other schools and provinces. For example, in 2004 and 2005, over 800 teachers participated to "train using open-ended problems to create rich mathematical activities in their classrooms" (WALS, 2015). This innovative integrated approach continued gaining attention from schools and universities. Consequently, in 2010, 22 project schools that train pre-service teachers from Chiang Mai University were implementing this approach. There were "60 project schools implementing lesson study and Open Approach across Thailand" (WALS, 2015). This innovative approach of the 2010 model has three simple steps for mathematics teachers to perform collaboratively: (1) design a lesson ("PLAN"), observe the research lesson ("DO"), and reflect on the teaching practice ("SEE"). The second step, "DO," has four specific steps of teaching—posing open-ended problems, students' self-learning, whole class discussion and comparison, and summarizing through connecting students' mathematical ideas that emerge in the classroom (Inprasitha, 2010). Nonetheless, the "SEE" step the 2015 model has slightly changed from "collaboratively reflection on teaching practice" to "collaboratively discuss and reflect on the research lesson" (see Figure 7) (Inprasitha, 2015; WALS, 2015).

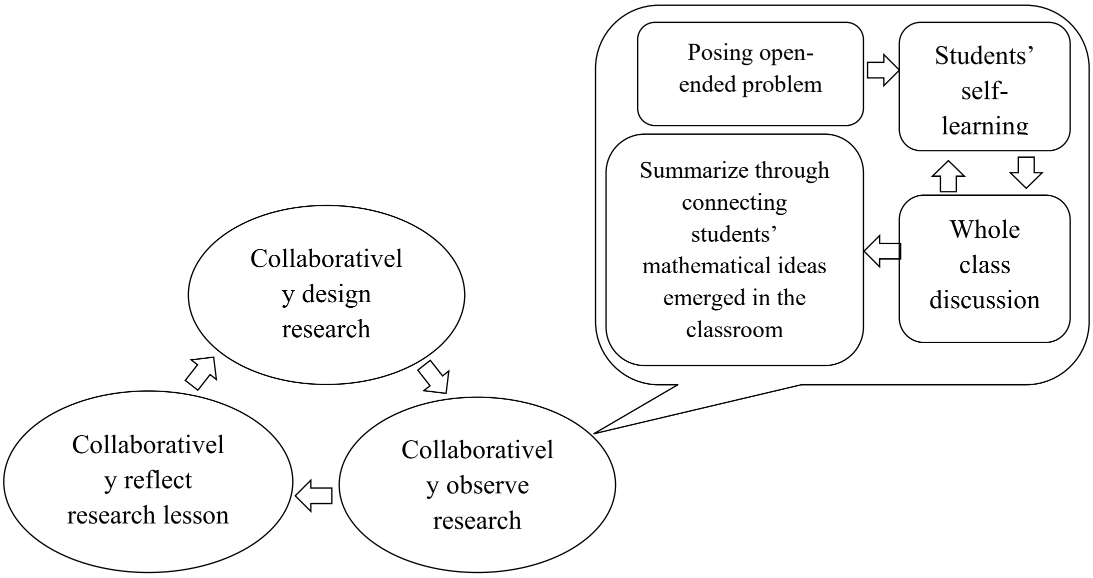


Figure 7. Lesson study with Open Approach (Inprasitha, 2015, p. 220)

Lesson study practice in Thailand is a weekly cycle. It perhaps is aiming to closely relate to everyday teaching practices by demanding to cover all content stipulated by the curriculum. Subsequently, a step is eliminated in the revised and re-taught version of the lesson plan. If the teachers want to utilize this version, they must wait a year to implement it. Utilizing the Thai lesson study method, previous research—entitled "Professional development of mathematics teachers with lesson study and Open Approach: The process for changing teachers values about teaching mathematics"—determined some changes to teachers' perspectives on how to teach mathematics. They have altered their view and classroom evaluation, changing from teacher-centered to "directing and stimulating students' ideas," valuing student-centered instruction, changing from one-way teacher speaking to listening to students, and have gained confidence (Kadroon & Inprasitha, 2013). The lesson study incorporated with structured problem solving has changed teachers' value of teaching mathematics for all steps, including modifying lesson planning, research lessons, observation focus, assessment, and post-lesson discussions (Inprasith, 2010, as cited in Kadroon & Inprasitha, 2013). It also influenced pre-service teachers to increase collaborative work, consider multiple solutions for problems, and increase their reasonability. Nevertheless, prospective teachers faced some issues associated with tension, anxiety, and confidence especially when their ideas are rejected by the group participants (Inprasitha, 2006). Therefore, there is a need for the teachers and teacher educators to be knowledgeable in lesson study and possess a strong mathematical background "to grasp student solution methods in real time and to recognize whether and how they relate to the key mathematical points that need to be learned" (Silver et al., 2005, as cited in Takahashi et al., 2013). Moreover, they must be skillful in the problem-solving method to utilize this integrated approach effectively.

2.7 Professional learning through lesson study

Lesson study is recognized as a flexible approach for professional learning among teachers, teacher educators, practitioners, and researcher globally (Lee & Ratnam, 2015, p. 41). Cheng and Yee (2012) found that teacher professional learning develops through the learned lesson from students and colleagues. Observing students' work and listening to their responses is a great opportunity to closely examine and analyze students' learning, as well as "identify factors that might give rise to student learning difficulties." Therefore, knowledge built from prior lesson study engagement is considered significant to carefully plan every mathematics lesson. When learning from colleagues, lesson study group members acquire more intense feedback, fruitful critiques, varied perspectives, and the opportunity to offer and share students' misconceptions and difficulties (Cheng & Yee, 2012). Seemingly, learning from colleagues closely relates to learning about student conceptions. Teachers and teacher educators also increase their professional knowledge in mathematics, learning about key measurement concepts. For example, "having [a] sufficient unit for end-to-end measurement helped students prove that the unit itself did not change lengths." Lesson study also sharpens teachers' observational skills, improves task design, and aids in predicting students' mathematics abilities. They considered that students would not have sufficient mathematics knowledge and skills initially but would be improved at the end of lesson study practice (Bruce, Flynn, & Bennett, 2016). Teacher professional learning typically emerges when teachers plan or analyze research lessons through discussions. Teachers simulate the lesson as if they were in a real classroom situation. Their in-depth discussion helps each individual modify the group's suggestions "by [assuming the] role themselves and offering an alternative suggested question, instruction or phrase" (Dudley, 2015, p. 17-18). Then, teacher professional learning shifts to create a satisfactory learning atmosphere, identify specific issues for effective teaching and learning alignment in the schools, and directly shift from teacher focus to student learning focus (Sithamparam, 2015, pp. 171-172). Because of the depth of reflection, teachers increase their own strategies of examination on students' learning, subject matter knowledge, and knowledge of how students learn—especially in the three areas of intensive professional development, such as “subject matter knowledge for teaching, understand [*sic*] students’ thinking, and instructional practices” (Sithamparam, 2015, pp. 171-172). Nonetheless, there is an argument that the knowledge teachers use in the classroom differs from what researchers produce. It is usually called “craft knowledge,” which is based on specific contextual and concrete phenomena (Sithamparam, 2015, pp. 175).

Teacher professional learning changes periodically. Furthermore, comparisons are drawn between traditional and contemporary professional learning, stating that the traditional professional learning begins with an answer while lesson study begins with a question. Traditionally, an outside expert drives the activity whereby group members drive the lesson study aspect. The flow of communication of the traditional way moves from trainers (outsiders) to teachers, but teachers discuss amongst themselves with the lesson study approach. Traditional professional development activity has “hierarchical relations between trainers and teachers, but it [comprises] reciprocal relations among learners (teachers) in lesson study.” More importantly, research informs practice in the traditional form, while practice informs research for contemporary professional learning (Fujii, 2016).

2.8 Issues in lesson study practice

Although lesson study can greatly enhance the teaching and learning practice that is widely adapted to several countries’ context, transposing the idea from different cultural norms is not always as smooth as its home origin because of misconceptions and lesson study challenges. Several studies found that teachers’ misunderstanding of lesson study and insufficiency of knowledge in content and pedagogy are the obstacles to overcome for effective lesson study practice (Yoshida, 2012). Teachers lack understanding of lesson study including perceptions towards lesson study, selecting a lesson, lesson planning, conducting a research lesson, and post discussion. First, lesson study aims for in-depth study about students’ mathematical thinking, so it should not be conducted as a workshop for trainees expected to improve or acquire particular skills at the end of the practice (Fujii, 2014; Ebaeguin & Stephens, 2014). Second, the lesson selected for the lesson study should be chosen with supported reasoning. For instance, the lesson might be overly challenging for students to understand or it is difficult for teachers to teach. It should not be selected solely because of “the simplicity of the content or teachers’ favorite topic to teach” (Fujii, 2014). Third, conducting a research lesson does not imply following the written scripts in the lesson plan exactly but also depends on the actual situation of the students in the classroom. Sometimes, the content and activities should be modified based on the students’ actual problems (Lewis, 2002; Fujii, 2014). During lesson planning, teachers may emphasize, “the needed materials, the role of students, and who would teach the lesson” but “very limited discussion on the content" (Meyer & Wilkerson, 2011, p. 21). Fourth, time and workload issues limit lesson study practice because it may "put great demands on teachers who are already constrained to follow a tightly defined schedule preparing students for specific examinations" (Verhoef, Tall, Coenders, & Van Smaalen, 2014). Generally, a "heavy workload and time constraints [are] the negative [aspects] of lesson study." As a result, involving lesson study practice may cause a few complaints regarding absence from school activities (Khalid et al., 2016). Bjuland and Mosvold (2015) criticized some issues of lesson study practitioners, claiming they focused on mathematical topics but lacked a research question, observed but lacked observational focus, and the planned lesson was not well designed for eliciting students' mathematical thinking. Teachers also had difficulties in posing mathematics topics that contained deep mathematical values. Therefore, clearly understanding the lesson study concept, holding sufficient professional knowledge, being skillful in instructional strategy, and sufficient time management may be the potential keys to effectively practicing lesson study in a non-Japanese context.

CHAPTER THREE: PRELIMINARY STUDY AND CONCEPTUAL FRAMEWORK

This chapter explains how initial conceptual framework was constructed, including the preliminary survey of lesson study experiences in seven TTCs throughout the country to validate initial conceptual framework and finalize it. To identify the depths of professional learning of MTEs, the levels of professional learning relating to the conceptual framework were also clearly explained in the last section of this chapter.

3.1 Grounded theory for the framework construction

Grounded theory is an inductive method to build a theory that emerges from the data. It is "iterative, interactive…and flexible methodological strategies" for theory building (Charmaz, 2015, p. 54). Grounded theory is a useful method to understand how a person handles problems. Then, it generates the theory based on the projected data from the phenomenon (Adolph, Hall, & Kruchten, 2011). Some studies demonstrate a guide for building a theory through this method (i.e., Strauss & Corbin, 1998; Charmaz, 2015; Hawker & Kerr, 2016). Nonetheless, the most popular grounded theory research method is the one guided by Strauss and Corbin because it has "a more structured and proceduralized approach to analysis" (Adolph et al., 2011). Published in 1998, this theory includes three main coding processes: open, axial, and selective coding.

First, open coding is a preliminary coding from a line-by-line analysis performed by naming each line or paragraph using a precise or meaningful label to prevent the researcher "from becoming so immersed in … respondents' world-view" that researcher usually accepts it without questioning (Charmaz, 2015, p. 69). The process involves labeling or highlighting the segments within the new words, phrases, or sentences that meet the accounts (Hawker & Kerr, 2016, p. 155). Furthermore, open coding is the process of naming and labeling the data to discover its dimensions and properties "suggested by the context in which an event is located." The "properties are characteristics of a category, the delineation of which defines and gives its meaning," and the dimensions "are the range along which general properties of a category vary, giving specification to a category and variation of the theory." Open coding is not only initializing the code but also involves category generation (Strauss & Corbin, 1998), which is sometimes called focused coding, to scrutinize the data and conceptualize initial categories (Charmaz, 2015).

Second, axial coding refers to a category refinement and its relation to each other as well as reassembling those categories and/or sub-categories into major categories (Hawker &

Kerr, 2016, p. 155) or reassembling the initial categories into the new categories and relating them with sub-categories (Charmaz, 2015). Therefore, axial coding is the connecting of both sub- and main categories acquired from open coding under its' characteristics and range. However, those main categories can still be further developed seeking the major theme (Strauss & Corbin, 1998). Subsequently, selective coding is the formation of a major category by integrating the main categories from the axial coding as a "larger theoretical scheme that the research findings take into the form of theory" (Strauss & Corbin, 1998, p. 143). This process is also called theoretical coding, which is the final process of drawing categories and codes together.

> [This process works to] formulate important categories in a conceptual way and move toward an overarching theory or explanation that can be applied to all accounts while also explaining conflicting data. When researchers reach the stage where a category with high frequency is mentioned and is well connected to other categories, it is safe to adopt this as a core category (Hawker & Kerr, 2016, p. 156).

This final coding might be included in writing memos, as defined by Charmaz (2015, p. 75), in which it is a process of defining the new categories before writing a full analysis description. The grounded theory is a flexible method and can be extended (Charmaz, 2015, p. 54; Thistoll, Hooper, & Pauleen, 2016). Therefore, this research method is applied to enhance theoretical sensitivity by conducting systematic literature review using grounded theory as a method for data analysis. Thistoll et al. (2016) applied grounded theory to conceptualize "grounded preliminary literature review," or GPLR, before progressing to the stage of theory development. They followed seven steps developed by Beekhuyzen (2007) using NVivo software for literature data analysis. These steps include (1) installing the software, (2) reading and summarizing literature, (3) importing literature, (4) coding the first round, (5) structuring nodes, (6) coding the second round, and (7) conducting an analysis.

Using the study of Thistoll et al. (2016) as a lens to construct the current research's conceptual framework, the author utilized flexible grounded theory to conceptualize the research framework. Maxwell (2005) summarized that we can construct conceptual framework through four main sources: (1) "experiential knowledge," (2) "existing theory and research," (3) "your pilot and exploratory research," and (4) "thought of experiments." In this research, the author constructed the conceptual framework in three stages: initializing conceptual framework, preliminary study, and finalizing conceptual framework before implementing the main research. The following sections reveal how the conceptual framework was developed.

3.2 Development of the initial conceptual framework

The significant concept of developing this framework was guided by grounded theory (Strauss & Corbin, 1998) using secondary data as the main source for this conceptual framework construction. The data included here was acquired from the interview, "observational field notes, videos, journals, memos, manuals, catalogues, and other forms of written and pictorial materials" (Silverman, 1993, as cited in Strauss & Corbin, 1998, p. 58). The initial framework construction began with preparing the data by searching articles assuming they contained some of the major components related to lesson study. The search was conducted using the keywords "lesson study," "professional learning," and professional development (see Figure 8).

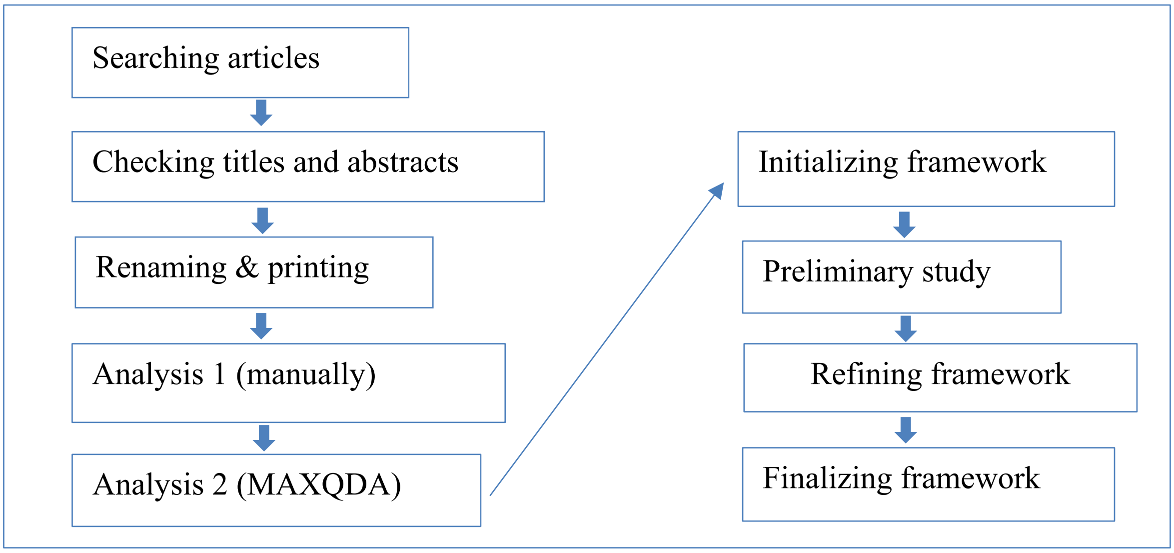


Figure 8. Conceptual framework development

The data were searched using five famous online research libraries or publishing companies, such as the Education Resources Information Center (ERIC), Elsevier, SAGE, JSTOR, and Springer. During the process of collecting article data, the researcher faced difficulty accessing the articles from the International Journal for Lesson and Learning Studies (IJLLS) associated with the WALS (World Association of Learning Studies). This journal contains the keyword "learning studies." Due to this limited access, the IJLLS was excluded from the initial framework construction.

When the searched titles were found, the researcher carefully read the articles' titles and abstracts before downloading to the local drive. Once the article was downloaded, the author renamed the file. For example, articles from ERIC were renamed to ER_001, ER_002, ER_003, and so forth. Then, those files were printed and coded for every article corresponding to the filename. Throughout the searching process, the study found 120 articles relating to lesson study, including 62 articles from ERIC, 25 from Elsevier, 8 from SAGE, 13 from JSTOR, and 12 articles from Springer. Manually, however, after scrutinizing its relevance during Analysis 1 through re-checking titles, abstracts, methods, and findings, some were excluded while 63 articles were chosen in the first selection (see Table 4). Selection 1 included 26 articles from ERIC, 16 articles from Elsevier, 5 articles from SAGE, 4 articles from JSTOR, and 12 from Springer. Furthermore, through the coding process in Analysis 2 using software package, MAXQDA, the researcher found some remaining irrelevant articles. Subsequently, 42 articles were selected in the second selection. Selection 2 included 19 articles from ERIC, 11 articles from Elsevier, 11 articles from Springer, and 1 article from SAGE, while 21 articles were excluded.

Table 4. Summary of collected data

No	**Articles**	**Reviewed**	**1st selection**	**2nd selection**
1	ERIC (er001, er002, …)	62	26	19
2	Elsevier (es001, es002, …)	25	16	11
3	SAGE (sa001, sa002, …)	8	5	1
4	JSTOR (js001, js002, …)	13	4	-
5	Springer (ZDM001, ZDM002, …)	12	12	11
Total		***120***	***63***	***42***

After those data were accurately checked, the researcher proceeded with the literature analysis by following the grounded theory steps (see Sec.3.1) using MAXQDA to manipulate the data. The researcher then began a line-by-line analysis in the open coding process to determine key findings of the articles. Those key findings were mostly acquired from the research finding section and, occasionally, from the abstracts. Once the key findings were found, they were coded immediately (see Figure 9 & Figure 10). First, after all findings were coded, the author carefully and consecutively checked each to determine similarities, then reorganized them into the categories. In this process, the author grouped similar patterns and selected a category name to represent that group of data. Therefore, categories and sub-categories emerged during this process. After that researcher attempted to relate categories and subcategories that emerged earlier, axial coding was employed to find the connection among them and determine if it could form a new category. After discovering that relationship, those categories were reorganized and synthesized into a major category, selective coding, to conceptualize the entire data set. The major category from the coding integration became the main components or primary domain of the conceptual framework. Practically, these processes of coding were simultaneously manipulated during the analysis using MAXQDA software.

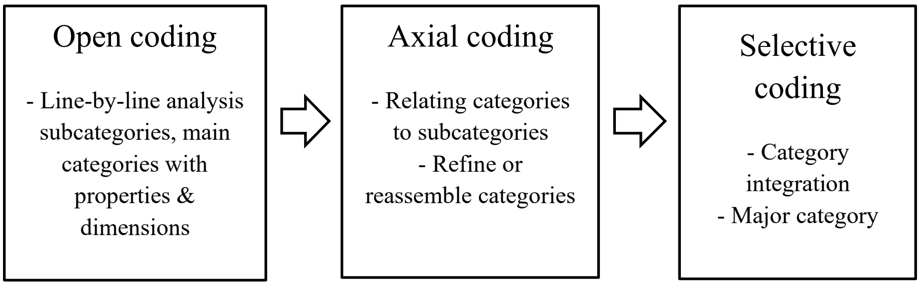


Figure 9. Model for creating the framework (Strauss & Corbin, 1998)

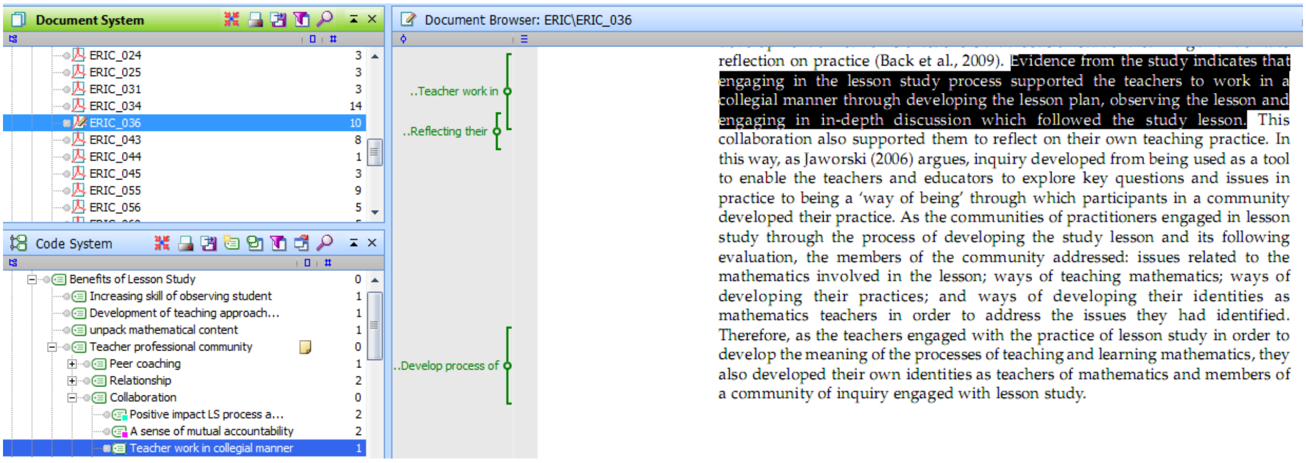


Figure 10. Literature analysis 2 using MAXQDA 10

The first domain was called, "teacher learning about specific knowledge." Initially, teaching profession requires some areas of knowledge to deliver teaching-learning activities for effectively passing intended information or content knowledge and experiences to the learners—specifically knowledge of subject content, pedagogy, and curricula (Shulman, 1986). By expanding Shulman's theory, knowledge of subject content includes common content knowledge, knowledge at the mathematical horizon, and special content knowledge. Knowledge of pedagogy includes knowledge of content and students, content and teaching, and curriculum (Hill et al., 2008). In the task of teaching, teachers are supposed to possess common content knowledge, such as knowing the mathematics being taught, correctly using mathematics terms and notations, identifying student errors, knowing inaccurate textbook definitions, and understanding mathematics within the curriculum. Furthermore, specialized content knowledge is needed for presenting mathematical ideas, selecting representations for particular purposes, and giving mathematical explanations. Basic knowledge about students—and, ideally, of content—is also important to anticipate students' potential deliberations, what they find interesting, or how they will handle a task, as well as common misconceptions. Furthermore, knowledge of content and teaching is something teachers should possess to know how to design, sequence, and choose a task in the instruction (Van den Kieboom, 2013). From this knowledge, lesson study provides an opportunity for teachers to extend their professional learning. This can be obtained by growing their mathematical subject knowledge (Lewis et al., 2012; Bae et al., 2016; Utami & Nafi' ah, 2016; Leong et al., 2016), increasing knowledge on the subject matter (Yarema, 2010; Hoong et al., 2012; Lewis & Perry, 2013), or finding reasons for meaningfulness within the content (Lewis et al., 2006). Conducting lesson study creates a "framework for learning mathematics, knowledge of content and student, and knowledge of content and teaching" (Post & Varoz, 2008; Leavy & Hourigan, 2016), eliciting improvement of a subject's teaching and learning (Nashruddin & Nurrachman, 2016), and mathematical collaboration for teaching including curriculum and student thinking (Gonzalez & Deal, 2017).

The second domain is "instructional learning and change." This category of professional learning differs from previously mentioned pedagogical content knowledge because it happens after specific knowledge utilization. Lesson study deepens instructional knowledge and investigates how to teach, pedagogical shifts, reasoning, and action (Hoong et al., 2012; Pella, 2015). It enhances and increases teaching skills, awareness of various teaching strategies, improving teaching, and deepening the understanding of teaching (Utami & Nafi' ah, 2016; Iksan et al., 2014; Yarema, 2010; Chassels & Melville, 2009; Stigler & Hiebert, 2016; Huang et al., 2014). It is strongly believed that lesson study is a sharp tool for improving instructional and teaching approaches (Lewis et al., 2012; Norwich & Ylonen, 2013; Leong et al., 2016), specifically enhancing teachers' pedagogical practices and transforming instructional practice and mathematical teaching (Yarema, 2010; Cheng & Yee, 2012; Gee & Whaley, 2016). Therefore, lesson study is an operative instrument for professional learning (Zhou & Xu, 2017), which is also regarded as "an alternative and innovative model for teacher professional development" (Lee, 2008; Mon et al., 2016). However far or deep the practice of lesson study is, it is successful in the area of improving teaching practices (Rock & Wilson, 2005), enhancing and increasing teaching skills (Iksan et al., 2014; Utami & Nafi' ah, 2016), maintaining material development (Murata, 2010), and refining understanding toward students' behind rational thinking (Bao & Stephens, 2013). The enthusiasm for lesson study in the classroom changes the teaching-learning practice in positive ways, preparing and conducting a better learning process (Khotimah & Masduki, 2016; Yakar & Turgut, 2017). In lesson planning, teachers will be aware of the different teaching strategies to determine an appropriate method; their collaborative work will improve their mindsets in reflective ways and provide purpose to one another (Choksi & Fernandez, 2004; McMahon & Hines, 2008; Chassels & Melville, 2009; Cheng & Yee, 2012). Moreover, it is an experiment to test students' knowledge and learn how they think and react to such artificial activities. Simultaneously, teachers become motivated and develop habits of critical observation, analysis, and reflection by enhancing efficacy and confidence (Taylor et al., 2005; Lewis et al., 2006; Chassels & Melville, 2009; Kusanagi, 2013; Mostofo, 2014; Bocala, 2015).

The third domain is "learning about students' conceptions." The aforementioned knowledge of students is a common knowledge that most learners and teachers may possess. Teachers use this knowledge to anticipate or predict students' viewpoints or reactions toward a task in general, but it is not yet verified. However, at this point, teacher professional learning about students' conceptions is the learning from student participation or interaction toward particular teaching-learning tasks and materials when conducting lesson study. Through the lesson study practice, tasks and teaching materials will encourage interactive learning and elicit students' perceptions, thinking, reasoning, learning needs, misconceptions, and so on, that teachers may not see in a regular setting. Additionally, they might behave differently than teachers originally anticipated. Students' conceptions of learning vary and depend on their learning motivation. Typically, they have conceptions of learning mathematics in three ways: for (1) "preparing for tests," (2) "calculating and practicing," and (3) "achieving understanding," which deepens students' thinking (Wang, Liang, Lin, & Tsai, 2017). Therefore, in association with lesson study, teachers are shifting their attention to emphasizing students' learning and progression (Taylor et al., 2005; Lewis et al., 2012; Bae et al., 2016), understanding how children learn in order to support their learning in mathematics (Hunter & Back, 2011), and gaining insights into students' needs (Chassels & Melville, 2009). If teachers are knowledgeable or have gained new understanding about their pupils, they will adjust their teaching practice to suit the manners in which pupils learn, and children will benefit from more participation in learning activities (Dudley, 2013; Matanluk et al., 2013). Knowing how children learn closely relates to what children already know and how they utilize that knowledge to tackle the problems they face in a learning task. This process is a precious opportunity to understand students' minds and thinking methods, discover students' misconceptions, incite rational thinking, and listen to students' mathematical thinking (Towaf, 2016; Yarema, 2010; Bao & Stephens, 2013; Bruce et al., 2016). Moreover, teachers can gain awareness of students' various educational needs, characteristics, and how they learn, as well as ways to differentiate the subject matter (Schipper et al., 2017). Subsequently, teachers or team members will also act as researchers (Lewis et al., 2006), in and outside classrooms;

students are expected to present their opinions and logical thinking, in which teachers scrutinize students' responses to determine and correct their misconceptions (Yarema, 2010; Bao & Stephens, 2013). Through such opportunities, lesson study strives to elicit silent and unobservable phenomena from children to comprehend their mentality and further teaching development.

The fourth domain is "learning about teaching-learning resources." It is the most significant tool for research lessons, especially lesson planning and teaching materials, to support task design. Lesson study ambitiously aims to design the best lesson plan, new learning tasks, and materials. Through the process of lesson plan refinement, learning task design, and materials management back and forth, teachers will learn significant lesson planning in more detailed ways (Pang, 2016), including teaching methodology such as the objectives of instruction, process, and mathematical tasks' sequences (Huang et al., 2014; Lim et al., 2016). A sufficient lesson plan is one that effectively incorporates the high quality of learning tasks and materials (Lewis, 2016), planning questions and investigations to encourage students to form an explanation and create questions (Groves et al., 2016; Lim et al., 2016). Students, on the other hand, can learn mathematical ideas while they enjoy solving the task (Bruce et al., 2016).

The fifth domain is "systemic learning." This type of professional learning is the learning gained during the lesson study procedure but focuses more on individual context. Teachers will attempt to learn through observation, discussion, and self-critical thinking that reflects their own settings (McMahon & Hines, 2008; Cheng & Yee, 2012). This learning might be unconscious behavior as it is intrinsic learning through extrinsic activities. Through investigating and planning, research observation, and debriefing, teachers will gain knowledge individually, including learning about the uniqueness of observing instruction (Bocala, 2015), skills for observing students (Bruce et al., 2016), experience-gaining (Ebaeguin, 2015), and individual self-criticism (Yakar & Turgut, 2017). Because lesson study involves live teaching, an individual student may respond or react differently to the task and teachers may adjust themselves to the situation. Therefore, teachers participating in lesson study will be learning in a systemic way rather than through systematic learning (Fujii, 2013).

The sixth domain is "collaborative community learning and sharing." One of the characteristics of lesson study itself is collegiality in which the teachers create a network among study members. Thus, teacher professional learning can occur throughout the process of lesson study because a group of teachers is collaboratively establishing a goal to archive student learning, collegially planning a research lesson, and collaboratively reflecting on the teaching-learning outcome. A group of teachers collaborates even if they have multidimensional ideas, eventually seeking out a consensus and sharing the same goal and direction. Their clarification, collegial manner, solidarity, sharing ideas, critical comments, and so on will significantly contribute learning experiences from which their colleagues will benefit. Lesson study forms a community of teacher educators for collective learning and supporting one another in their profession (Murata, 2010; Hadfield & Jopling, 2016; Towaf, 2016; Gonzalez & Deal, 2017; Zhou & Xu, 2017). Within the community, teachers develop a professional network through collaboration and create their own learning culture, such as peer learning, transforming leadership within work, and a community of inquiry (Taylor et al., 2005; Lee, 2008; Hunter & Back, 2011). However, solely founding community would not be sufficient for enhancing teaching and learning; teachers should also recognize the importance and benefits of collaboration (Puchner & Taylor, 2006; Chassels & Melville, 2009; Norwich & Ylonen, 2013; Gee & Whaley, 2016), especially in planning and reflection (McMahon & Hines, 2008; Mathews et al., 2009), which is regarded as an important part of lesson study. Additionally, regarding the characteristic of lesson study itself, it is apparent—and not surprising to state—that the lesson study procedure requires gathering teachers in a group for developing teacher teaching and children learning. This is important because it might be difficult for the individual teacher to observe and understand all students' nonverbal thinking in a classroom while s/he is teaching. Even if teachers presume that they know their students well and have a "basic knowledge about [each] student," it is believed that different teachers may have different foci and views toward the same problem presented in the classroom. Therefore, a community of learning and networking is crucial to improve the analysis of individual children's actions, interactions, and judgement. Therefore, this kind of intervention is the cycle of mutual learning that helps a community utilize individual experiences to formulate what they consider an appropriate lesson and conduct a test for verification. At the same time, teachers will utilize this opportunity to learn from each other through exchanging their notions or sharing experiences to develop their own individual teaching when they proceed with their regular classroom teaching practice, and this is the trajectory of mutual teacher learning. Essentially, teachers have a few initial experiences in lesson study and will perceive based on what they have gone through during its process. Thus, lesson study provides an opportunity for collaboration (Post & Varoz, 2008) with other member teachers to exchange basic ideas (Choksi & Fernandez, 2004) with the lesson study procedure through opportunities to practice individually (Zhou & Xu, 2017) and treat one another's work equally while sharing their knowledge of practice (Parks, 2008; Fernandez, 2010; Gonzalez & Deal, 2017). They also utilize this occasion for freely arguing with other participants (Lee, 2008). However, they are more likely focusing on what they consider correct teaching skills (Yakar & Turgut, 2017) and, sometimes, there appears to be good or bad judgment (Iksan et al., 2014) that is commonly happening in the preliminary stage of lesson study practice. Implicitly, what is presented during a class observation must have some reasons behind it. Therefore, a single phenomenal analysis would not be sufficient in this case (Cheng & Yee, 2012; Mostofo, 2014) but rather should involve investigating the reason in a pedagogical context and taking action (Pella, 2015) for a positive change in teachers' minds and practices—namely, the "opportunity to deepen professional knowledge" (Widjaja, 2013).

From these long explanations, the diagram of initial conceptual framework is demonstrated in the Figure 11.

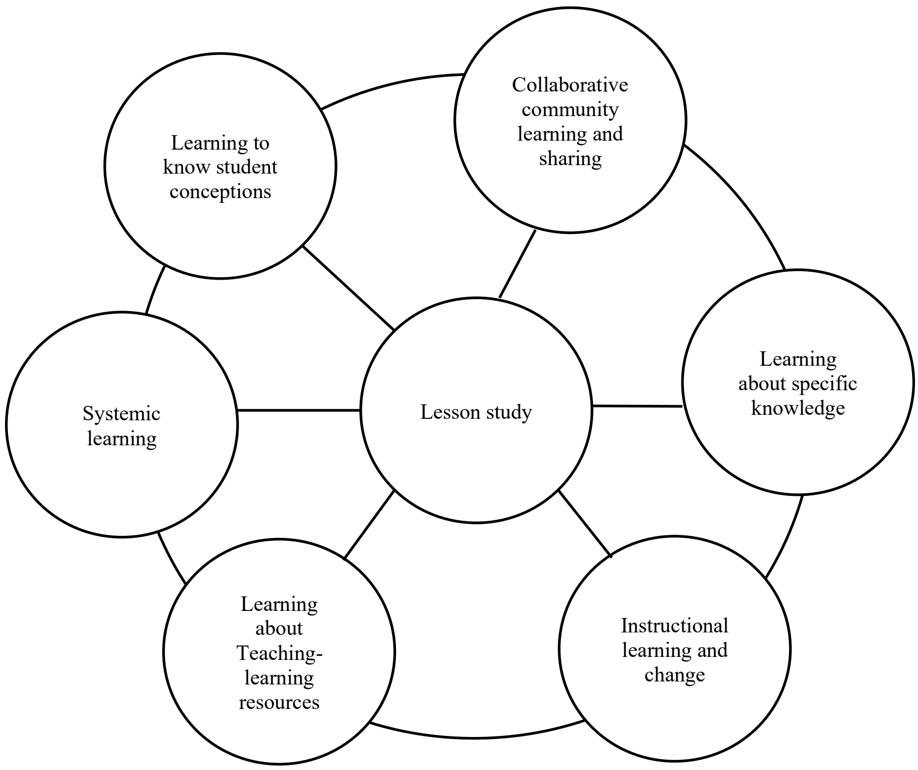


Figure 11. Initial conceptual framework

3.3 Preliminary study for framework construction

To achieve the multifaceted researcher objectives, this study is divided into two parts: preliminary and main studies. The preliminary study, first, aimed to have some background of lesson study experiences from the views of MTEs in various TTCs for determining the target TTCs for the main study. Secondly, it aimed to develop a conceptual framework of MTEs' professional learning through lesson study experiences to confirm the validity of the created framework and determine its effectiveness. This preliminary study used a qualitative approach to understand the meaning of people' lives, represent people's beliefs and perspectives, and contribute "insights into existing or emerging concepts that may help to explain human social behavior" (Yin, 2011, pp. 7-8). The data were collected more openly through semi-structured interviews. The interviews were used because "we cannot observe behavior, feelings, or how people interpret the world around them. It is also necessary to [utilize interviewing] when we are interested in past events that are impossible to duplicate" (Merriam, 2009, p. 88). The second type of data collection used in this preliminary study was an observation of the available lesson study practices during the fieldwork. Observation is often needed to "see the things first hand and use his or her own knowledge and expertise in interpreting what is observed rather than relying on once-removed accounts from interviews" (Merriam, 2009, p. 119). The third type data was documents to support the interview data and observations because it contained compelling information about the lesson study steps, observation sheets, and pre- and post-test questions for each lesson study practice group. Those data were manipulated and analyzed using licensed qualitative data analysis software (QDA), MAXQDA 10.

3.3.1 Background of Teacher Training Colleges

Teacher education in Laos depends on four university faculties of education and eight TTCs nationwide. A university's faculty of education is responsible for training student teachers to be upper secondary school teachers, whereas TTCs are inclusively responsible for training kindergarten through upper secondary school teachers. Seven TTCs were selected for this preliminary survey, including LPB-TTC, KK-TTC, DKX-TTC, BK-TTC, SVNK-TTC, SLV-TTC, and PS-TTC. Annually, these seven TTCs receive newly enrolled student teachers who graduated from upper secondary schools, especially from within and for from nearby provinces, as well as from lower secondary schools. On average, each TTC has 155 working staff members, 1,637 student teachers, and approximately 206 newly enrolled student teachers.

The education subjects provided by each TTC may differ each year depending on the decisions made by the MoES. However, the number of accepted new student teachers is predictable (see Table 5). In the 2018-2019 academic year, LPB-TTC accepted 189 new student teachers from two different systems: 12+2, and 12+4 (12 years in general education and 2 or 4 years in TTC, respectively). The 12+2 system consisted of student teachers of kindergarten and primary school while the 12+4 system consisted of five different subjects including physics, ICT, English, French, and biology. Student teachers who will graduate from the system 12+2 receive diplomas, and those who graduate from the 12+4 system will receive a bachelor's degree. KK-TTC accepted 206 new student teachers from both the 12+2 system (focusing on primary school, sports, and kindergarten) and the 12+4 system (focusing on physics, geography, history, and Lao language-literature). DKX-TTC accepted 253 new student teachers from the primary school and kindergarten courses of the 12+2 system. This TTC also accepted four courses for the 12+4 system that included biology, history, and the kindergarten and primary school courses. BK-TTC accepted 168 new student teachers that year, including the primary and kindergarten courses for the 12+2 system and mathematics, English, biology, and Lao language-literature for 12+4. SVNK-TTC accepted 196 new student teachers that included primary and kindergarten for the 12+2 system and mathematics, ICT, English, chemistry, and Lao language-literature of 12+4. SLV-TTC accepted 216 new student teachers studying primary and kindergarten in the 12+2 system and chemistry, Lao language-literature, primary, and kindergarten courses for 12+4. PS-TTC accepted 212 new student teachers. The 12+2 system included the kindergarten and primary courses as well as sports, while the 12+4 system subjects were mathematics, physics, English, French, and geography.

Table 5. Numbers of staff members and students from each TTC (collected during the field).

No	**Teacher Training College**	**Total number of staffs (2017-18)**	**Total number of students (2017-18)**	**Newly enrollment (2018-19)**
1	LPB-TTC	176	1,387	189
2	KK-TTC	183	1,180	206
3	DKX-TTC	114	1,877	253
4	BK-TTC	144	1,643	168
5	SVNK-TTC	169	2,642	196
6	SLV-TTC	124	1,431	216
7	PS-TTC	175	1,301	212
Total		**1,085**	**11,461**	**1,440**
Average		**155.00**	**1637.28**	**205.71**

3.3.2 Participants of preliminary study

Intentionally, this preliminary survey aimed to cover all 133 MTEs who were experienced with lesson study practice. Based on their availability during the field survey, however, 87 MTEs participated in this study, including 75 MTEs, 9 directors, and 3 Japan

Overseas Cooperation Volunteers (JOCVs) (see Table 6). Yet, the latter two groups—directors and JOCVs—only provided basic information about lesson study in those TTCs. More in-depth research regarding lesson study practice was suggested for each MTE. Among these 75 MTEs, 12 participants did not know about lesson study. Therefore, 63 (72.41%) out of 87 MTEs were the focus of this research. This number of MTE respondents consisted of 36 (57.14%) males and 27 (42.86%) females (see Table 7). The number of respondents with one to five years of work experience was 19 (30.16%); 22 (34.92%) had 6 to 10 years of experience, and another 22 (34.92%) had more than 10 years of experience as MTEs, respectively. The ages of the participants included 18 (28.57%) between 20 and 29-years-old, 34 (53.97%) between 30 and 39-years-old, and 11 (17.46%) who were older than 39.

Table 6. Number of respondents

No	**TTCs**	**MTEs**		**Directors**		**JOCVs**		**Total**
		F	**Total**	**F**	**Total**	**F**	**Total**	
1	KK-TTC	6	16	0	1	0	0	17
2	DKX-TTC	4	10	1	1	0	0	11
3	BK-TTC	3	8	0	1	0	0	9
4	SVNK-TTC	7	17	0	2	1	1	20
5	SLV-TTC	4	10	0	2	0	0	12
6	PS-TTC	4	8	0	0	0	2	10
7	LPB-TTC	3	6	0	2	0	0	8
Total		***31***	***75***	***1***	***9***	***1***	***3***	***87***

Table 7. Age, gender, and working experience

Age (years)		**Gender**		**Working experience (years)**	
20-29:	18 (28.57%)	Female:	27 (42.86%)	1-5:	19 (30.16%)
30-39:	34 (53.97%)	Male:	36 (57.14%)	6-10:	22 (34.92%)
More than 39:	11 (17.46%)			More than 10:	22 (34.92%)
Total:	***63 (100%)***	***Total:***	***63 (100%)***	***Total:***	***63 (100%)***

3.3.3 Instruments and data collection of the preliminary survey

This preliminary survey aims to explore the extensive data on lesson study practices among MTEs in each TTC. Therefore, triangulation data including interviews, observation (optional), and some lesson study reports were collected (see
Table *8*). This survey was conducted for nearly two months from January to March 2018, during which was the middle of the second term of the Lao school calendar. Therefore, the author was not able to interview some MTEs because they traveled to practicum fields to supervise their student teachers. Two months before the field survey, an official document asking for the permission of data collection was sent to the Teacher Training Department under MoES; then, the relevant office sent a notification letter to each TTC asking for their cooperation. During the field survey, 75 MTEs were asked semi-structured questions. The following are some investigating questions adapted from a previous study (Schipper et al., 2017). Q1. How did you learn about lesson study? Q2. How did you conduct lesson study? Q4. How did you design a lesson plan? Q5. What did you observe in class during the lesson study? Q6. What sorts of comments did you receive from teachers or offer to other teachers? Q7. What did you learn from the lesson study? Q8. What challenges did you face when conducting the lesson study? Q9. What do you need to know more about lesson study? Furthermore, additional investigations were added if the researcher determined that the respondents did not sufficiently describe their experiences. The interviews were conducted during a working day at each TTC and lasted for 30 to 60 minutes. In some TTCs, the interviews were carried out in group discussions because of participants' availability; however, the author tried to approach each participant individually. The researcher was also aware of the ethical issues; therefore, permission was acquired before recording the data and taking photos.

Table 8. Data collection checklist

No	Teacher Training Colleges	Interviews	Observations	Documents
1	LPB-TTC	✓		
2	KK-TTC	✓		✓
3	DKX-TTC	✓		✓
4	BK-TTC	✓		✓
5	SVNK-TTC	✓	✓	✓
6	SLV-TTC	✓		
7	PS-TTC	✓	✓	✓

3.3.4 Data analysis of the preliminary survey

The collected data were transcribed into MAXQDA10 and stored in seven groups according to the number of the TTC. First, the interviewed data were successively transcribed into mother tongue (Lao language), while the name of each respondent from each TTC was noted in short form and suffixed by the number of recorded interviews (see an example in Figure 12). Then, the data were analyzed through "thematic analysis" using the following six steps: data familiarization, coding generation, theming, thematic reviewing, defining and naming the themes, and writing the report (Clarke & Braun, 2016; Clarke et al., 2015). In this preliminary study, the term categories or themes that emerged during the analysis were used interchangeably (Morse, 2008; Merriam, 2009, p. 178). After transcribing all of the data, the author followed the steps of analysis by rereading the data to find the keywords and important expressions corresponding to the interview questions and assigned a code of that key sentence. In some cases where the expression was not clear, the author analyzed and interpreted its meaning and wrote an additional note in parentheses for his own comprehension before generating the code. At this point, the codes and additional sentences were written in English before generating and reviewing the themes. Once the themes were set, they were retrieved several times to ensure they fit and would be representative of the entire data of those particular groups. Each theme contained a sub-theme or sub-category that the study categorized and counted to determine the number of occurrences of similar respondents' perceptions in the frequency. Thus, this data analysis was mixed with the content analysis technique (Mayring, 2015; Wilkinson, 2015). Finally, those themes or categories were interpreted, discussed, and became the findings of this preliminary study. Some MTEs reported not clearly remembering their lesson study experiences. Thus, during data analysis, the author tried to capture their descriptions, comparing them to the given descriptions from other MTEs, such as if they were discussing the same lesson study practice. The author also referred to the collected lesson study reports from each TTC to determine consistency.

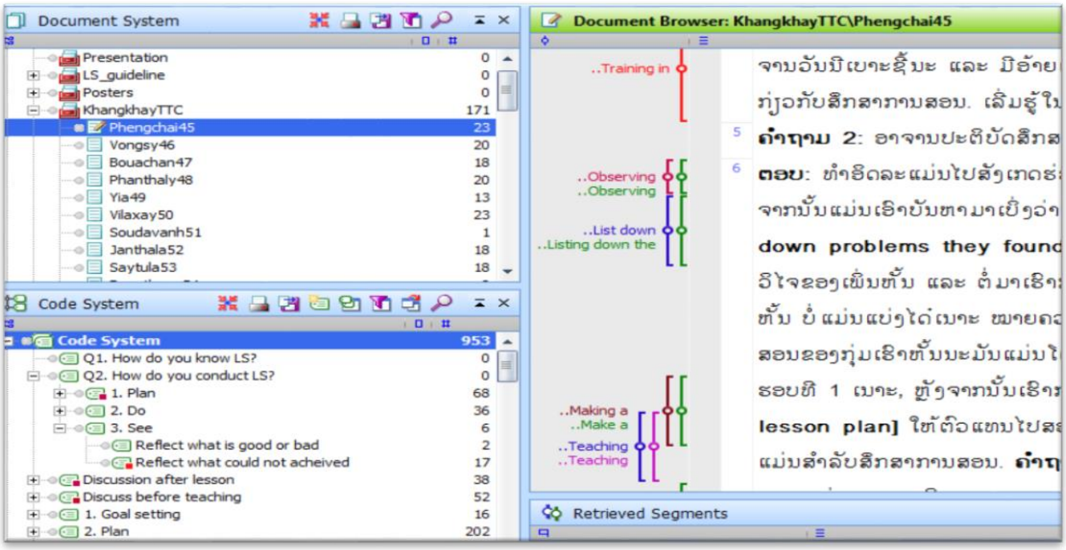


Figure 12. An example of data coding excerpted from MAXQDA 10

3.3.5 Sources of receiving lesson study

MTEs in TTCs experienced lesson study in several ways. Most acquired an idea of lesson study through the training within their TTCs (see Table 9). This corresponds to the aims of the educational policy to increase teachers' opportunity to receive school-based training. While some MTEs did not directly receive training about how to conduct lesson study from their workplace, they learned through actual practice in collaborating with their colleagues. In addition, some MTEs had an opportunity to experience lesson study from the trainers of SEMEO RECSAM, JICA, MoES, and other TTCs in their home country. Alternatively, some had a chance to learn lesson study abroad, for example, in Thailand, Indonesia, and Japan.

Currently, MTEs are engaged in lesson study through the program, BEQUAL (Basic Education Quality and Access in Lao PDR). Lesson study in the BEQUAL program is also referred to as lesson study guidelines designed by MoES, but it differs slightly in the first step, requiring several class observations to identify problems and conduct lesson study to address them. The remaining steps are the same as MoES. In the final six months, some MTEs who engaged in this program were trained and expected to observe several primary classes to identify the problems. The meeting to report the observation results, which included lesson study training, was held from February 6 to 15, 2018.

JICA also organized a workshop (on January 29 and 30, 2018) related to lesson study that focused more specifically on teaching-learning analysis. JICA introduced five elements to analyze the tendency of teachers' teaching behavior and students' action in learning. These included teacher explanations concerning the learning subject as well as the teacher's questions, writing and removal of information on the blackboard, and assessment of students' knowledge, among others. For students, five elements of data analysis were included: students' (a) answering of questions; (b) presenting in the classroom, (c) including explaining their solution on the blackboard, (d) working individually, working in a group, and (e) others. However, this preliminary study still lacks information on how the BEQUAL program and JICA will continue to support lesson study in those TTCs.

Table 9. Sources of receiving lesson study

No	Sources of receiving lesson study	Frequency
1	Training within workplaces	44
2	Learning from colleges	12
3	SEMEO RECSAM	8
4	Training in other countries	7
5	Training in other TTCs	6
6	BEQUAL	5
7	JICA	3

3.3.6 Lesson study experiences in each TTC

In July 2016, the MoES' lesson study training became a practical guide for all MTEs. Commonly, based on the data analysis, this preliminary survey found MTEs practiced lesson study in two models. The first model follows the Japanese lesson study that included the "PLAN-DO-SEE" steps stipulated in the lesson study guidelines. MoES designed the contents of the guidelines with unknown references. Generally, this model was practiced in six TTCs (SVNK-TTC, DKX-TTC, BK-TTC, KK-TTC, SLV-TTC, and LBP-TTC). However, the guidelines did not provide enough details for each step, especially in lesson planning, teaching, observation, and reflection. Practically, as a result, each TTC practiced differently based on their mentors' understanding of lesson study. In this regard, the researcher attempted to conceptualize and demonstrate clearer pictures of how MTEs in each TTC practiced each step of the lesson study based on their own understanding. The second model is influenced by Thai mathematics education, which combined Japanese lesson study and its "PLAN-DO-SEE" cycle with the Japanese mathematics teaching approach. This concept of the combination has followed the model of Inprasitha (2011) that combined Japanese lesson study with Open Approach. The following section details how each TTC practiced lesson study.

3.3.7 Lesson study experience in KK-TTC

Based on the descriptions from the respondents and analysis of lesson study reports, lesson study in KK-TTC began by forming a group of MTEs and setting the whole schedule for lesson study participation (see Figure 13). Usually, each group contained 3 to 10 members. When the group was set and the schedule was fixed, MTEs began observing each member's class within their group to identify any issues that occurred during the teaching and learning activity. Once all members were observed, the group met again to gather all the problems they noted from the observation, and these problems were used as the points for observation as well as a reason to conduct lesson study. Additionally, the group selected the subject and a teacher educator to present the first lesson to solve the problems on the observation sheet. Usually, a new and younger person was chosen to demonstrate the lesson, and the subject was automatically chosen according to that teacher educator. Once the teaching representative was selected, they were in charge of creating a lesson plan, which was later shared with other members before conducting the research lesson. The remaining members were usually asked to help prepare teaching materials. The lesson unit for creating a lesson plan usually followed the regular daily class session. For example, if Lesson 20 were the last lesson taught, the lesson study practice would be Lesson 21. On the day of the research lesson, observers were given the previously made observation sheets to evaluate if the problems had been solved. Photos and videos were often taken during the observation. After the class observation, the lesson study group held a small meeting to discuss the results just observed, especially noting what the new problem was that differed from the observation sheet and what problem the lesson implementer already effectively completed. The pre-distributed observation sheets were also collected, and one member was assigned to determine the mean and standard deviation to confirm the improvement and new problems found. The results of the mean and standard deviation would determine whether a second cycle of lesson study was necessary. However, a strategy appears to be that the first lesson will not score highly for every item on the observation sheet, while the second cycle tends to see improvement in all of the choices. After identifying the significant points, the second cycle of lesson study is conducted as the first round. However, at this point, the observation sheet might be altered, and additional points may be included depending on what was found from the first lesson's observation. Some lesson study groups removed the checklists. Furthermore, the one receiving the mean score from 3.5 to 5.00 and remains the choices below 3.5 and newfound problems for this second cycle of the lesson study.

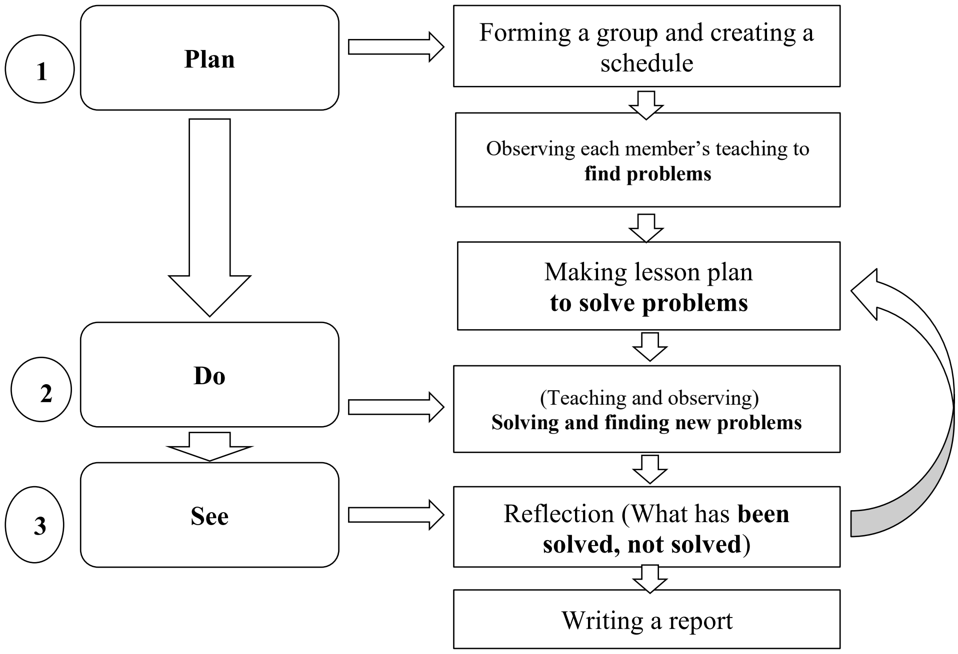


Figure 13. Model of lesson study adaptation in KK-TTC, created by author

Once the second cycle of lesson study was completed, if they desired, the group members organized another meeting to designate a section or chapter to each member, which would be used to write a lesson study report. Later, all contributions are combined into a completed lesson study report.

3.3.8 Lesson study experience in DKX-TTC

Lesson study practice in this TTC was conducted differently from KK-TTC, especially considering the PLAN step. First, a group was formed and the whole schedule set, with discussions among group members about problems in teaching and learning mathematics. Usually, they discussed with homeroom teachers, especially primary teachers. Secondly, they observed the lesson of that targeted homeroom teacher to determine some issues from the teaching and learning and organized another meeting to discuss the complications found during observations (see Figure 14). With the first lesson, the lesson plan was created using the homeroom teacher's idea without any input from group members. Data from the interview revealed that the majority of the problems mentioned were the students' ability in the calculations. For example, students had difficulty in calculating subtraction. Finally, they decided to conduct lesson study to enhance students' calculation skills. At this point, the other members interfered and provided comments on the second lesson plan, including suggestions on how to teach as well as designing learning tasks to increase the ability of students to apply the calculation skills accurately. This second lesson plan was modified from the first, which included the group members' ideas, especially those from the lesson study mentors' ideas. MTEs also made pre- and post-test mathematics questions to measure students' improvement and utilized observation sheets from the lesson study guidelines to evaluate teacher's teaching. At the start of the second modified teaching lesson, the homeroom teacher tested students' knowledge using prepared mathematics questions before proceeding with the full teaching activity and did posttest at the end of the lesson. If the results of the posttest achieve high scores, the lesson study is successfully achieved and is ready for a generated report. However, before creating a report, some lesson study groups had to teach up to three times or more with the same class and lesson until receiving satisfactory results from the students' calculation skills, as this MTE said:

> We let the homeroom teacher teach the lesson three times before we tested students' ability. We also tested students prior to the lesson. Then, we let the teacher teach using their previous method. After that, we observed the problems and added more activities and tasks. Then, we asked the teacher to teach it again, aiming for improvement. Revise, teach, improve; revise, reteach, then test the students again. Because we obtained positive results, the procedure was considered successful. [...] We concluded the lesson study by following three chapters in the guidelines made by the Department of Teacher Training (T-VL65).

Following each research lesson, MTEs also held a reflection session. Most comments in this session concerned teacher's teaching behavior, interaction with students, and method of teaching, as this MTE said:

> We reflected on that teacher's class attendance and those who observed, considering in what aspects the teacher did not succeed and their method of transferring knowledge to students, determining what is the exact problem is. We also rechecked students' ability from the results of the pre-test questions. Thus, we discuss these to evaluate how much mathematical knowledge students have (T-DY60).

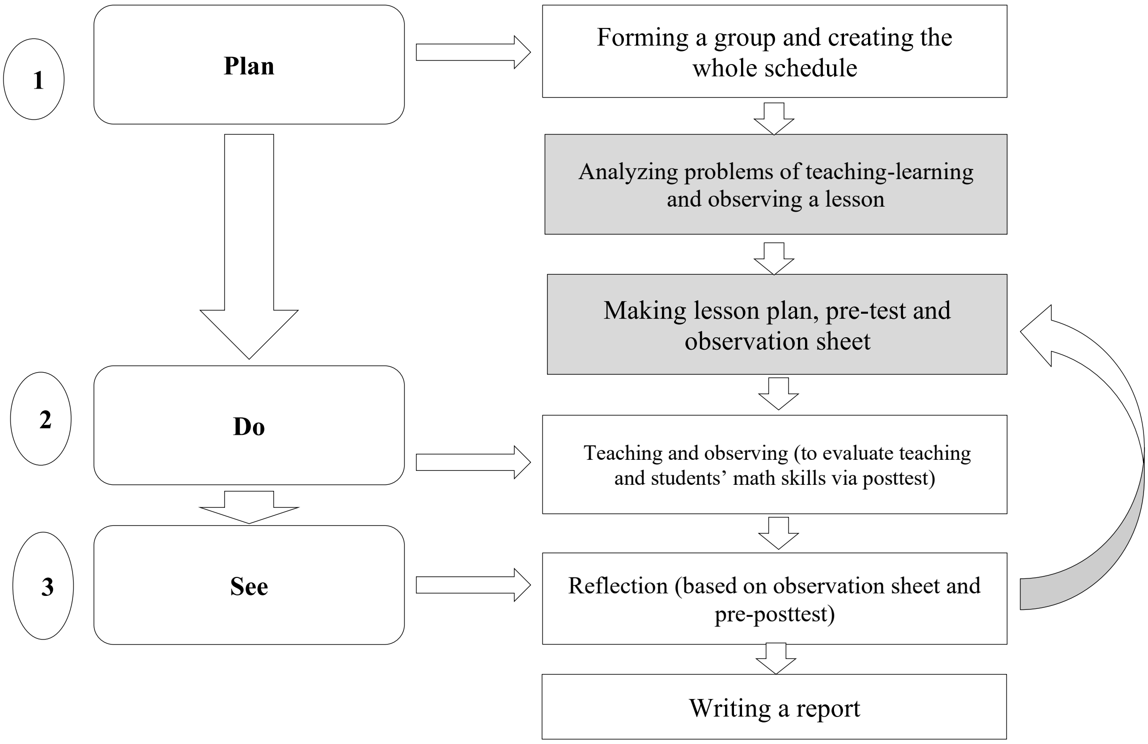


Figure 14. Model of lesson study adaptation in DKX-TTC (created by author)

3.3.9 Lesson study experience in BK-TTC

Lesson study among MTEs in this TTC was not clear or well-practiced. They recently reported practice, but an incomplete step remained. Based on the interview from the head of the mathematics department, he briefly explained that they formed a group of MTEs and predetermined some topics in which to conduct lesson study, dividing the topics between groups. Then, each group conducted lesson study according to the given topic. They constructed a lesson plan, improved it, taught the lesson, and collected recorded video and photos of the observation for later discussion. However, because of a lack of time, there has not been a reflection thus far. More interestingly, they organized the lesson plan by having the lesson study group ask a selected teacher educator to create a lesson plan themselves, which they later shared with other members with no or superficial changes. Usually, this TTC taught the same lesson twice to the same student teachers. The tools they used for data collection in the observation were a teaching evaluation form based on the guidelines, pre-test, and posttest mathematics questions, similar to DKX- TTC. Furthermore, the research lesson was selected based on the regular daily lesson. Most MTEs emphasized that the completion of writing the lesson study report is the success of the lesson study practice. The report is the evidence of their lesson study achievement. Simultaneously, the report is highly demanding for them, as this MTE claimed:

> First, I teach the lesson as a regular class, and I teach alone. I recognized some problems ... for example, this year, this lesson with these batch of student teachers, they could not do, in the following year, we plan. Then, we discuss with the head of the unit before making a timetable that I will use for lesson study the same day and moving forward. I will teach the lesson, and I want other teachers to observe my classes. Nonetheless, no report was completed after the lesson study (T-PS76).

As a mathematics department head also mentioned:

> In this first semester, we divided our MTEs into two groups: Group A and Group B. We then conducted lesson study. Finally, I must say to you, frankly, that it was not successful because there was not a lesson study report (T-BL77).

Based on the data from the interviews, the author was not able to design the model of lesson study adaptation in this TTC because all respondents did not clearly define how they conducted the lesson study. It is assumed that MTEs in this TTC did not understand or rarely practiced lesson study to enhance their teaching and students' learning.

3.3.10 Lesson study experience in SVNK-TTC

Lesson study practice in this TTC followed three steps, as described in the guidelines designed by MoES. However, it seemed that MTEs were still finding improvements for conducting it because their description included the former and current styles of lesson study practice. In the former style, after establishing lesson study group members and setting the overall schedule, MTEs discussed the problems that they endured or encountered based on the members' experiences in teaching. Then, all group members listed their ideas and selected a problem to conduct the lesson. Accordingly, that problem became the topic of the lesson study. In this style, the group members divided into three subgroups. The first subgroup was responsible for constructing a lesson plan. The second subgroup checked the lesson plan, while the third was responsible for making teaching materials. These subgroups were meant to collaborate. In contrast, the interviews revealed that the teacher educator selected to demonstrate the lesson performed all three tasks themselves, believing they knew their subject more than the others did. Once the lesson plan and teaching materials were ready, they proceeded to the real teaching process and reflection, as stipulated in the guidelines. In this format, this TTC also used the observation checklist from the guidelines but no pre-test or post-test questions. MTEs had more experiences likely because of the BEQUAL project, which had a special strategy for conducting lesson study. For the first six months, MTEs were supposed to observe as many classes as they could to identify the problems. Then, they were meant to solve those problems and report the results to the evaluation meeting of the BEQUAL project. This practice influenced MTEs by changing the practice method of the "PLAN" step, observing other classes several times to identify the problems happening during the teaching (see Figure 15). This method was similar to that of KK-TTC; after identifying the problems, group members determined the main concerns and discussed to solve those problems. However, KK-TTC tried to address all identified problems simultaneously, while SVNK-TTC tried to solve only some of the problems they believed were the main cause. Based on the interviews, they recently observed seven classes and decided to solve three problems: (a) the primary teacher's questions were not diverse, (b) no multi-activities in teaching, and (c) no genuine teaching materials (T-PL92). As with other TTCs, it was clear that the problems they tried to solve, were not mathematical problems but rather general problems they believed were significant and could be solved through lesson study. During the data collection period, this TTC conducted the first lesson to solve those three problems. They also planned three more lessons for lesson study. In this new style, there was no evaluation checklist provided for observation aside from direction to freely observe phenomena in the class.

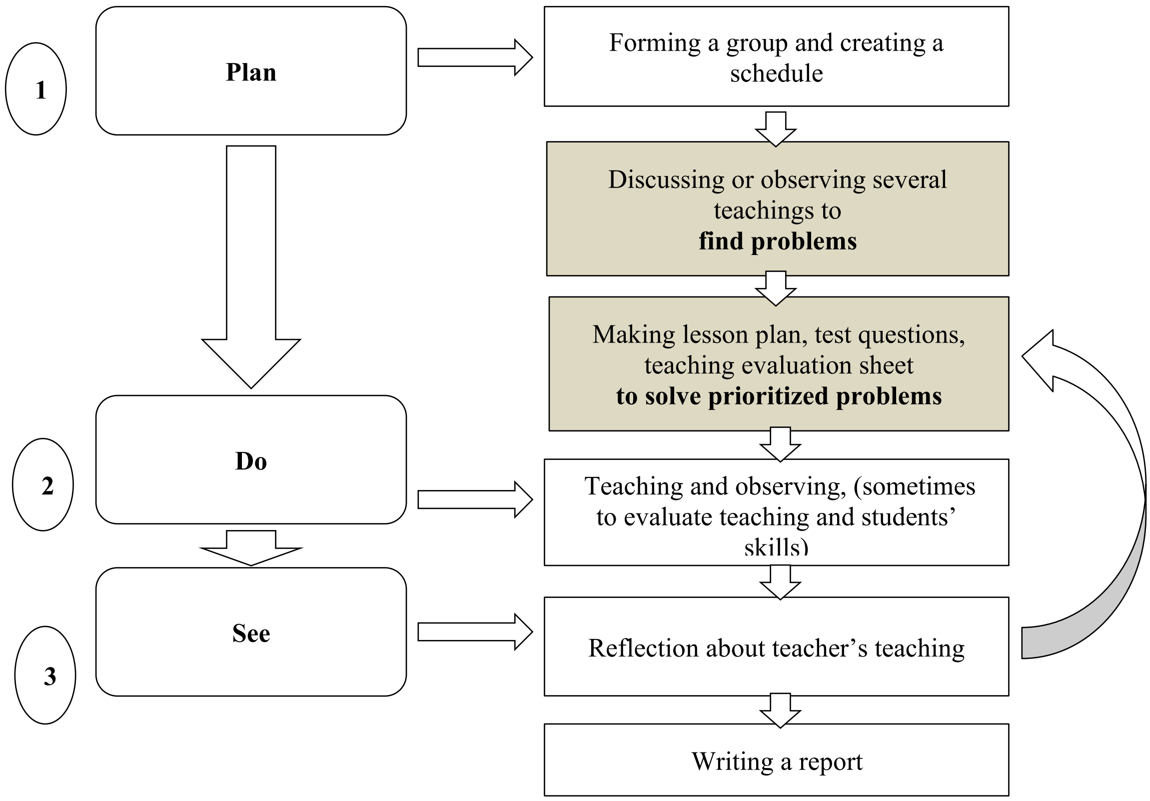


Figure 15. Model of lesson study adaptation in SVNK-TTC (created by author)

As with other TTCs, the research lesson was selected following the regular daily lesson. When planning a lesson, they usually discussed the objective of that particular lesson, their objective of conducting lesson study, learning task design, and teaching materials. Then, they assigned one teacher to write all the details of the lesson plan. Typically, a teacher who was selected to teach was responsible for creating the lesson plan to cover all the contents the group planned together. This lesson plan would later be discussed with the group members before actual teaching practice.

3.3.11 Lesson study experience in SLV-TTC

MTEs in SLV-TTC learned about lesson study during training from February 9 to 13, 2015. These key trainers were trained in Japan and cooperated with staff members from the Teacher Training Department from the MoES and standing JICA expert in Laos. This TTC also practiced lesson study in two styles. The first style involved MTEs having discussions with the schoolteacher about the challenges they experienced with a difficult unit or chapter, without any class observation. Then, the group decided to conduct lesson study to overcome that difficult unit. Together, they planned the lesson and created teaching materials to help students understand that issue by teaching the same lesson several times until students sufficiently understood the lesson or mastered that particular unit. As this MTE said:

> First, we study its theory. After studying the theory of lesson study, we visited with and asked secondary school teachers what problems they have in what chapter or topic that they were unable to resolve. Because a secondary school teacher also accepted that he could not teach this topic, the students did not understand. Then, we found a solution. We constructed a lesson plan and taught it, but we were unable to create the first lesson. Therefore, we revised the lesson and retaught it. The students were able to understand this topic following the repeated lesson (T-ITV97).

This lesson study style implied the aim for increasing students' mathematical skills by repeatedly teaching the same lesson, so students become skillful in that particular content. This was similar to the case of DKX-TTC in which they taught the lesson three times before proceeding with the post-test to confirm the improvement of students' mathematical skills. However, this TTC did not mention a pre- or post-test or how the lesson was taught or reflected on. The respondents in this study did not provide sufficient descriptions but rather stated, in general, that they taught the lesson after creating the plan, posted pupils' answer sheets on the blackboard, and conducted a reflection session after the lesson.

In contrast, the second type of lesson study practice was conducted just a week before this data collection. Initially, they voluntarily grouped MTEs who were motivated to participate in this collaborative teaching. They later sent a permission letter to the targeted school and discussed with the head of the primary school regarding the reasons and objective of conducting lesson study in the particular school. In this lesson study type, they reported having carefully focused on textbook content analysis before setting the goal of the lesson. Then, they proceeded with the real teaching, discussed what activity to employ, questions that should be asked to reach that goal, and the teaching materials needed. However, thus far, this style did not clearly state which model they were following. Based on the respondent's description and background, this method of conducting lesson study might be the influence of the mathematics education course from Khon Kaen University in Thailand. The leader of this group had just recently received their master's degree from that university, and student teachers graduating from this university tend to utilize Inprasitha's concept of lesson study and Open Approach model. Nonetheless, MTEs nearly forgot their lesson study experiences and did not provide sufficient details. Therefore, this study was not able to design the model created by this TTC.

3.3.12 Lesson study experience in PS-TTC

Lesson study adaptation in this TTC was clearly practiced by following a certain step of Japanese lesson study and mathematics teaching approach from the concept of Inprasitha (2011) (Inprasitha, 2011, as cited in Khammeungkhoun, 2017, p. 29) (see Figure 16). This approach also followed the "PLAN-DO-SEE" step but was well structured in the step of "DO," especially in teaching. Firstly, MTEs formed a group by cooperating with primary teachers in the attached school and making a schedule. For example, this semester, they had two groups that had a schedule of conducting lesson study every Tuesday and Thursday afternoon. After forming a group, MTEs met to design a lesson plan. They started asking a homeroom teacher to describe what was taught in the previous lesson and students' status to transition smoothly to the next lesson. As with other TTCs, the selected lesson for conducting lesson study followed the regular daily lesson. After obtaining basic information on the previous lesson, they proceeded with analyzing the textbook and unit objective related to the upcoming lesson. Lesson study in this TTC emphasized the content, especially designing learning materials and tasks that link the real world to mathematical concept. Ideally, the lesson was designed with only one learning task within 45 minutes, while most of the other TTCs created several learning activities and used the full teaching period of up to 90 minutes. Surprisingly, as noted during the author's observation on March 1, 2018, this TTC spent only one afternoon session preparing everything, including analyzing the textbook, designing a learning task, and creating teaching materials. The lesson was immediately taught the next morning. By following the utilized teaching approach, a selected teacher began teaching by explaining the real-world situation to students and then linking it to the mathematics question. Once students understood what to do, they were dispersed for group work. The teacher walked around to determine who did what and which group would present first. Usually, as noted in the interview, a group that made many mistakes or used the simplest way of solving the mathematics problem was prioritized as a first presenter, and the group that found the correct answer or used a more abstract strategy presented last. During the instruction, group members freely observed the teaching without using a checklist, considering students' learning, difficulty, participation in the activity, and mathematical thinking. They even set the rule not to criticize the teacher who taught the lesson while reflecting on the teaching during the debriefing session. Once the class ended, the discussion session was immediately underway in that classroom. Interestingly, each member was allowed only a few minutes to express his or her comments, usually between three and five minutes for each, and the entire discussion was not more than 30 minutes. Lesson study practice within this TTC was subject-based. They intended to practice as they would their everyday teaching practice with short preparation. On one hand, this might be promising to improve the quality of teaching mathematics in Laos. On the other hand, short-term preparation and immediate results were probably not the goal of lesson study. That is why lesson study in the Japanese context was conducted once or twice a year with long-term planning and preparation.

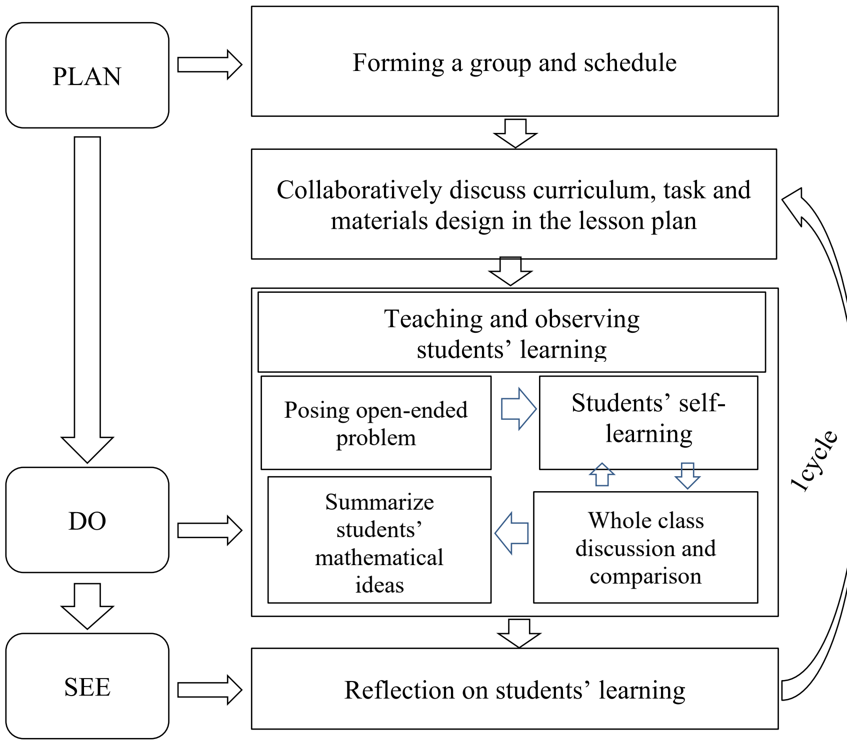


Figure 16. Lesson study model in PS-TTC (created by author based on Inprasitha, 2011)

3.3.13 Lesson study experience in LBP-TTC

Data from the interview revealed that MTEs in this TTC obtained some training on lesson study from many different programs, such as the key trainer within their TTC, using Seiyama's video provided by JICA, lesson study by SEAMEO RECSAM, and by BEQUAL project. Therefore, because of mixed experiences, it was difficult to highlight which model they were following. This TTC has also included lesson study reports made by MTEs. Unfortunately, it was highly confidential, and the author was not allowed to collect those documents. Nevertheless, based on the interview data, the author tried to elicit how MTEs in this TTC conducted lesson study. They started by investigating homeroom teachers. During student teachers' short internship course, they observed which chapter the primary students had difficulties. For example, one MTE reported a problem regarding the addition of fractions with unlike denominators. Then, the group of MTEs helped one another create teaching materials and lesson plans before teaching the same lesson with these two different primary schools, conducting reflection after the teaching. It is reported that the first lesson in the attached primary school completed three activities during the allocated time while another school only completed two activities. As this MTE pointed out:

> … They had a problem in a fraction. They could not perform the addition and subtraction of unlike denominators. They mostly added a similar fraction with the same denominators. Then, we constructed a lesson plan together, directing one teacher to create teaching materials. The lesson plan was then taught in Satith and Khonekham primary schools. While teaching in the Satith primary school, the lesson was completed within the allocated time. However, while teaching at Khonekham primary school, the lesson only completed two activities … Following the instruction, we held a reflection session to improve the lesson plan. In the reflection, we focused on two sides: teacher and students. For the teacher, we discussed class management, as the explanation for the lesson plan activity was unclear. Some students were attentive while others were depending upon other students. This was our observation (T-SGN112).

These results implied that the achievement of this lesson study type was probably measured by the completion of all lesson content prepared during the designated time and to increase students' mathematical skills, as with DKX-TTC and SLV-TTC. Another type of lesson study was following BQUAL project's strategy, as with SVNK-TTC. They practiced by observing several primary classes to identify the problems. However, this method was not introduced to all MTEs worldwide, but only to those selected groups of MTEs from the project who were practicing. During this survey, the selected group of MTEs observed four times, during which they found teachers' problems included only following the textbook, a lack of confidence regarding mathematics subject knowledge, and students' lack of attention toward the teachers. Moreover, teachers did not appear to care about students, especially those who were sitting at the back of the class. Other problems included uninteresting learning activities and small teaching materials. Nonetheless, the problems were not solved during the field survey. Therefore, this study has yet to learn how they will handle these issues using lesson study. All seven TTCs' lesson study adaptations are summarized in Table 10 below.

Table 10. Summary of lesson study practice from 7 TTCs

TTC	Before conducting lesson study	Number of teaching	Observation tools / evaluation tools
KK-TTC	- Observing all members' class to identify problems	-At least twice to solve identified problems	- Checklists using identified problems as the items
DKX-TTC	- Discussing and sometimes observing primary teachers to find problems	- At least twice to increase students' calculation ability and evaluate teachers' behavior	- Checklists from guidelines for teacher - Pre-test and post-test for students
BK-TTC	-	-	-
SVNK-TTC	(1) Gathering problems from members' teaching experiences (2) Observing several primary teachers' classes to identify problems	(1) At least one time to solve prioritized problems; (2) At least 4 times to solve prioritized problems;	- Before, use checklists from guidelines, - Currently, no tools
SLV-TTC	(1) Discussing with primary teachers about difficult lesson (2) Just started, not yet clear	(1) At least twice to help students understand lesson (2) Not clear yet	- Did not mentioned
PS-TTC	-Discussing with homeroom teacher about students' background then analyzing textbook to achieve lesson goal	- One time as regular daily lesson	- Freely but focus on students' learning
LPB-TTC	(1) Discussing with primary teachers about difficult lesson (2) Observing several primary teachers' classes to find problems	(1) Teach the same lesson with 2 schools and compare (2) Not clear yet	- Not clear yet

3.3.14 MTEs' views on professional learning through lesson study experiences

Figure 17 presents the overall categories of MTEs' professional learning based on their views through their previous experiences. From this coding map, we could not determine which categories or sub-categories most MTEs have emphasized. The researcher has separated them into tables for clarity.

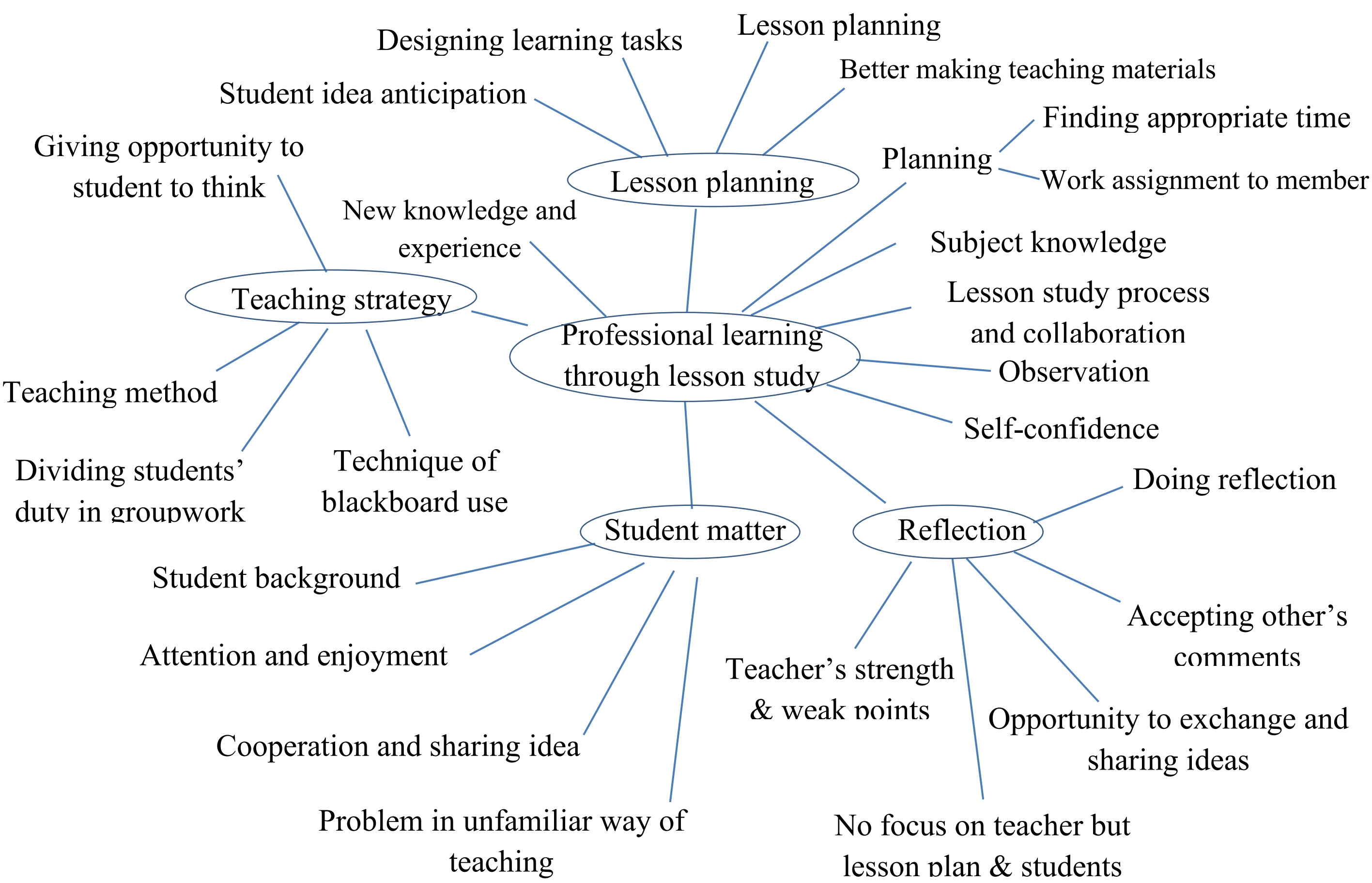


Figure 17. Main and sub-categories of professional learning

Table 11 demonstrated overall categories corresponding to the Figure *17* that most of MTEs perceived they have learned in relation to lesson planning (37) following by teaching strategies (37), lesson study process itself and collaboration (28), learning about reflection (17), student matter (7), observation (5), planning (3), subject matter knowledge (2), new knowledge and experience (2) and self-confidence (1) respectively.

Table 11. MTEs' learning through lesson study practice

No	Category	Number of coded segments
1	Lesson planning	37
2	Teaching strategy	37
3	Lesson study process and collaboration	28
4	Reflection	17
5	Student matter	7
6	Observation	5
7	Planning	3
8	Subject matter knowledge	2
9	New knowledge and experience	2
10	Self confidence	1

3.3.14.1 Lesson planning

Lesson planning is in the first step of the lesson study process after the group members have determined the complete schedule of lesson study practice for one academic year. In the process of lesson planning, there are several components that lesson study group members must prepare in a single lesson. In the lesson study process, as defined by several researchers (i.e., Lewis, 2002, 2011; Fujii, 2014; Fernandez & Yoshida, 2004), prior to designing the actual lesson plan, teachers set a long-term goal that they want to achieve in the next couple of years. They, then, select a lesson unit and lesson topic before practicing curriculum analysis. Why that specific lesson unit and topic is selected must also have reasoning behind it. Then, the group members design lesson content, mathematical tasks or conditions, including planning how to teach, how students will respond (students' response anticipation), and construct teaching-learning materials. These processes are supposed to be well prepared before the actual research lesson has been implemented. In the Lao context, however, these processes are difficult for them because they have an immense familiarity with traditional lesson planning. Subsequently, when it comes to lesson study practice, they only see things that are explicitly in front of them. Actually, their views are easily associated with creating teaching-learning materials and task design, as this MTE clearly stated that lesson study helps him to "… get a good lesson plan. Sometimes we teach without a lesson plan, but when conducting lesson study, we need to pay attention to making a lesson plan" (T-PT82). "… Lesson study helps us [create] better teaching materials. Mainly, to me, emphasis [is placed] on making materials" (T-VLX50). This showed us that what MTEs' views differed from the intention of lesson study stipulated in the literature. Perhaps, they may not be able to decipher between what they knew beforehand and what they gain from the lesson study. They might fail to consider the uniqueness of lesson study, which is why we must spend time carefully preparing a lesson plan and teaching materials. The reason behind that process and the final goal that lesson study intends to achieve, and so forth, might not be clear yet among these MTEs.

Table 12. Lesson planning

No	**1. Lesson planning**	**Number of coded segments (37)**
1.1	Lesson planning	17
1.2	Better making teaching materials	10
1.3	Designing learning task	8
1.4	Anticipating student ideas	2

However, in the sub-category of designing learning tasks, MTEs could at least learn how to reduce the number of learning tasks when engaging in lesson study. Although the primary textbook contains 43 units in Grade 1 (Somsanith et al., 2007), lesson study group members worked to consider the core activity of that lesson and reduce the number of tasks to grasp students' attention effectively. As this MTE stated, "… [teaching] one topic is [effective] for the children. There is no effect if we teach many topics because students' attention is limited [to] only 30 minutes. [Therefore], only one topic is enough" (T-PVL105). Thus, an appropriate number of tasks for one period of the lesson was considered important.

3.3.14.2 Teaching strategy

This category of professional learning through lesson study experience defined by MTEs is also based on what MTEs accomplished during lesson planning and observation. In every lesson, especially in the lesson study context, teaching method is often the biggest concern for the teacher who will demonstrate the lesson. As a result, more than half of the discussion during the lesson planning involves how to teach and divide students into the groups, how long students will need individually or in group work, and blackboard use. Of course, the lesson study group members must prepare these indispensable steps. Therefore, many MTEs considered that what they obtained from lesson study experiences involve the category of teaching method, allowing students to contemplate solutions, group work design, and how to use the blackboard (see Table 13). Moreover, why must we select a particular teaching method, offer students the opportunity to think, and carefully design lesson plans using the blackboard? Perhaps, MTEs might discover some reasons behind these arrangements.

Table 13. Teaching strategies

No	2. Teaching strategy	Number of coded segments (37)
2.1	Teaching method	27
2.2	Giving opportunity to student to think	6
2.3	Dividing duty to each student in each group	3
2.4	Technique of using board	1

3.3.14.3 Lesson study process and collaboration

This category of professional learning is straightforward to the process of lesson study itself. In the lesson study process, there are so many steps that practitioners might become confused. In fact, lesson study may be their first experience with professional learning. In most cases, they are deeply influenced or become trapped by the lesson study process. This implies how much MTEs understood the concept of lesson study. If MTEs describe that what they could learn from lesson study is simply the process, then MTEs might superficially understand lesson study, because the process is quite broad in reality.

Furthermore, lesson study practice needs teachers' collaboration. They plan a lesson together, help each other during teaching, and reflect on the research lesson to refine the teaching and improve the next lesson. Considering this characteristic, it could not be denied that many MTEs had views on collaboration (see Table 14). However, for a well-understood lesson study practitioner, through collaboration, what we are able to benefit and learn from other people is valuable in lesson study. That is why collaborative work is the heart of the lesson study practice.

Table 14. Lesson study and collaboration

No	3. Lesson study process and collaboration	Number of coded segments (28)
3.1	Lesson study process	14
3.2	Lesson study collaboration	11
3.3	Teachers have convergent thinking	1
3.4	Writing conclusion of lesson study	1
3.5	Group problem not a single teacher's	1

3.3.14.4 Reflection

Similar to Section 3.3.13.3—in which MTEs could only see the surface or outside appearance of the lesson study concept—lesson study offered them a chance to exchange or share ideas with others in two sessions. These included planning and post-lesson discussion so that MTEs would have a consensus or alternative idea for improving their lessons. This sub-category is perhaps related or belonging to the category of collaboration. Apart from that, when Lao teachers observe or offer comments to someone, they commonly prefer to discuss only good points and weaknesses (see Table 15). There are also other sub-categories, including how to reflect or conduct reflection with others doing lesson study, others' comment acceptance, and avoiding criticizing the teacher but rather offer suggestions regarding lesson plan and students. However, there are too little who are perceived like this concept.

Table 15. Reflection

No	4. Reflection	Number of coded segments (17)
4.1	Opportunity to exchange and sharing ideas	6
4.2	Doing reflection	4
4.3	Teachers' strength and weak points	3
4.4	Accepting other's comments	2
4.5	No focus on teacher but lesson plan and students	2

3.3.14.5 Student matter

Regarding the initial framework, this category could be considered student conceptions. There were at least some comments regarding students' conceptions. The first sub-category was the background of student knowledge. These MTEs have seen that the knowledge background differed between city and rural students. This was a lesson one female MTE learned to adjust how she teaches her pre-service teachers. The second and third sub-categories (see Table 16) were common impressions of MTEs when the teacher occasionally allowed students to focus on an activity using concrete teaching materials. However, this MTE had an outlook regarding student concentration during the lesson. Their short concentration span of 5 to 10 minutes made it difficult for her to control the class and complete the lesson as planned. She noted that "teaching primary students is difficult, because we think that we will completely [follow] what we have planned. Perhaps, when we teach, it doesn't go smoothly because students' concentration span is approximately 5 to 10 minutes long before it changes…" (PVL-105).

Table 16. Student matter

No	5. Student matter	Number of coded segments (7)
5.1	Seeing different students' knowledge background	3
5.2	Attention and enjoyment	2
5.3	Cooperation and sharing idea	1
5.4	Student concentration	1

The preliminary survey demonstrated that MTEs' professional learning through lesson study experience varied and was concerned in pedagogy throughout the process as well as the process of lesson study itself. Obviously, the powerful process of lesson study that differs from their daily traditional teaching practice persuaded them to address the surface of this dynamic approach. For example, the views of MTEs highlighted teaching method, teaching strategy, task design, lesson planning, etc. This corresponds to our initial conceptual framework, to some extent, particularly instructional learning and change (teaching strategy (37), teaching method (27)), learning about teaching-learning resources (lesson planning (37), teaching materials (10), designing learning tasks (8)), systemic learning (lesson study process (14), reflection (4)), and collaborative community of learning and sharing (collaboration (11), opportunity to exchange and share ideas (6)). Their professional learning toward student conceptions and subject matter knowledge were rarely found within this preliminary study. Furthermore, the effects or results of the lesson study implementation were not yet explicit in their consideration. This might be because the MTEs' lesson study experience did not offer them many options or opportunities to deepen their awareness of the essential concept of lesson study. Intentionally, using initial conceptual framework as a lens, it was noticeable that the main categories and sub-categories found in this preliminary survey were scattered and jumbled in each table. This was because the data was categorized based on its own characteristic rather than the natural framework so that it would leave some space for the author to manipulate differently to refine and reassemble for further searching of the new major categories. Thus, this conceptual framework still needs further development.

3.4 Finalizing conceptual framework of MTEs' professional learning

In the process of further development of this framework, the researcher also provided the entire coding data to some Ph.D. colleagues and professors who specialize in mathematics education to acquire their insights and critical comments. Their input revealed no issue related to the open coding, but rather a correlation with axial and theoretical coding categorization (Strauss & Corbin, 1998). This is because some of the framework components—such as learning about specific knowledge, teaching-learning resources, and student conceptions—seem to be professional knowledge that closely relates to the Knowledge of Content and Student (KCS) and Knowledge of Content and Teaching (KCT) of the Mathematical Knowledge for Teaching (MKT) model (Hill et al., 2008). Collaborative community of learning and sharing and systemic learning relate to "HOW" we learn. It is a method of how people learn, while the content of the learning for the other models comprises "WHAT" people learn. They also offered a critique regarding the instructional learning and change component, stating that it might be focusing more on changing, which may be another aspect. Therefore, learning about "WHAT" and "HOW" MTEs learn and "WHY" they must learn are the main insights from the colleagues and professors to avoid subjectivity and uncover validity and objectivity of the framework development.

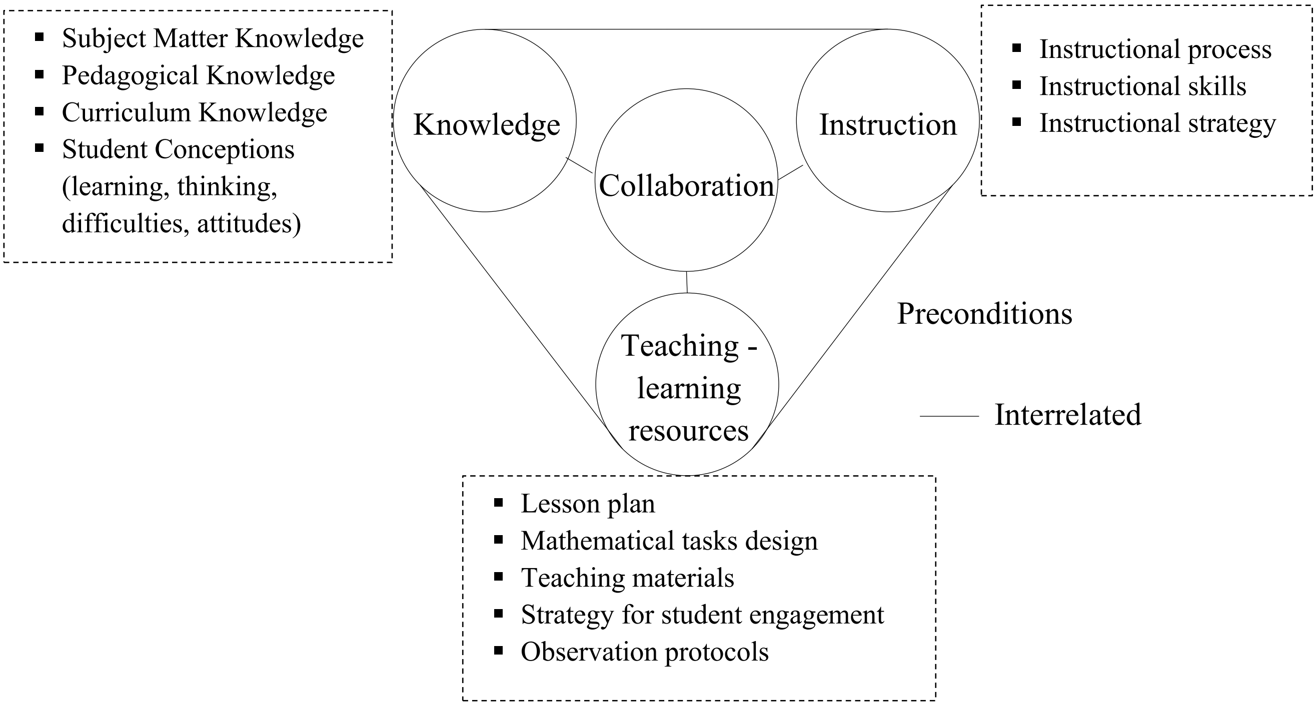


Figure 18. Conceptual framework of MTEs' professional learning through lesson study

Through their comments, the researcher realized some weak points of this framework that he needed to reflect on using the existing theories related to the discipline to reduce bias, subjectivity, and its uniqueness while maintaining its originality. He needed to be aware of some existing frameworks; perhaps, some important terminologies may be adopted from these studies. These include the interconnected model of professional growth (Clarke & Hollingsworth, 2002); intervening changes and improvement of instruction (Lewis et al., 2006); intervening changes and instructional improvement (Lewis et al., 2009); "theoretical model of teacher learning and change … with the four phases of lesson study" (Bae et al., 2016); MKT model (Hill et al., 2008); and Pedagogical Content Knowledge (PCK) (Shulman, 1986) among other previous studies. Through the researcher's endeavor, the following is the latest conceptual framework of MTEs' professional learning through lesson study (see Figure 18).

Based on the preliminary survey results, initial conceptual framework consideration, awareness of previous studies, and consideration of beneficial comments from knowledgeable others (Ph.D. colleagues and professors), the researcher reassembled student conceptions and learning about specific knowledge into the term, "Knowledge," which it has already been defined by many researchers. Systemic learning of the initial conceptual framework is modified as the "Preconditions" of professional learning. Collaborative community of learning and sharing is replaced by "Collaboration"; instructional learning and change is considered "Instruction"; and learning about teaching-learning resources remains "Teaching-Learning Resources" (see Figure 18). These four conceptual domains are interrelated and influenced by one another. Because lesson study is a collaborative professional learning model, through collective work starting from the collaboration, teachers and teacher educators would enhance teaching-learning resources, their prior knowledge (subject matter knowledge, curriculum knowledge, and student conceptions), and instruction for an effective lesson and teaching practice in a classroom. The knowledge domain is also influencing the quality of teaching-learning resources (i.e., quality of designing lesson plan, mathematical task, and teaching materials) as well as the quality of instruction, while instruction is also influencing teaching-learning resources and knowledge because a well-designed lesson plan and materials with qualified knowledge cannot guarantee effective teaching. Therefore, professional learning through lesson study must be functioning well and collaboratively among these domains.

"Knowledge" refers to teacher professional knowledge or specific knowledge theorized by (Shulman, 1986; Hill et al., 2008; Fennema & Franke, 1992). This knowledge includes knowledge of mathematics (Fennema & Franke, 1992, p. 162; Zhang & Stephens, 2016), specific content (Ball et al., 2008), and subject matter that emphasizes learning about common content knowledge. Pedagogical knowledge regards content and teaching as well as when to pause, use students' ideas, and ask new questions (Ball et al., 2008). It also covers teaching procedure, strategies, behavior management techniques, classroom organizational procedure, and motivational techniques (Fennema & Franke, 1992, p. 162; Shulman, 1986). Curriculum knowledge includes knowledge about the interpretation of intentions of the official mathematics curriculum (Zhang & Stephens, 2016) or knowledge about curriculum of particular subjects and topics at a given level, including a "variety of instructional materials.… understanding about materials for instruction" (Shulman, 1986, p. 10; Ball et al., 2008). Student conception is associated with Knowledge of Content and Student (KCS) (Ball et al., 2008), which is the knowledge of anticipating the tendency of students' thinking, confusion, motivation and interest, and incomplete thinking that are "common student conceptions and misconceptions." It is teachers' capacity to interpret the difference between "what students actually do (or did) and what they are likely to do. [It also involves the ability] to recognize the typical errors that students make and what mathematical thinking led to these errors" (Zhang & Stephens, 2016).

"Teaching-learning resources" refers to the lesson plan for promoting student learning, mathematical tasks to reveal student thinking, observation protocols to capture key elements of student learning, and strategies to facilitate student engagement in deeper reasoning (Lewis et al., 2006; Lewis et al., 2009; Bae et al., 2016). The lesson study process requires curriculum analysis, instructional material testing, lesson sequencing, activities, classroom management strategies, and planning for when the certain unit or topics will be taught in a year (Bae et al., 2016). It also involves designing instructional aids or manipulatives—and determining if they fit on the blackboard—materials to capture or evaluate student thinking, and observation protocol for exchanging or sharing data in post-lesson discussions (Lewis et al., 2005).

"Instruction" is the learning of instructional skills, processes, and strategies. It is learning about concept and technical instruction to connect with student learning (Huang, Su, & Xu, 2014). This may relate to the Knowledge of Content and Teaching (KCT) (Ball et al., 2008), as well as the actual teaching practice in the classroom, because what is planned may not be covered as expected because of the classroom environment and student conditions. The effect of lesson study extends teachers' knowledge of instruction, teaching method investigation, and pedagogical reasoning (Hoong et al., 2012; Pella, 2015). Pedagogical discussion would enhance teachers' teaching skills, teaching strategy awareness, and understanding of teaching enhancement (Utami & Nafi' ah, 2016; Iksan et al., 2014; Yarema, 2010). When teachers create a lesson plan, their collaborative contribution of knowledge will adjust to the best-suited teaching method for the lesson; in a way, teachers will create a reflective mindset to enhance each other's weaknesses (Choksi & Fernandez, 2004; McMahon & Hines, 2008).

"Collaboration" is a learning mode that correlates to those three components. It is collective learning through teacher collaborative work. Teachers and teacher educators share their specific knowledge, teaching-learning resources, motivation, long-term goals, processes, and lesson analysis framework (Lewis et al., 2006; Lewis et al., 2009; Bae et al., 2016). They share language, perspectives in planning and instruction, and framework to improve lesson plans and instruction (González & Deal, 2017; Gee & Whaley, 2016). They share an equal aspect of considering the work and sharing their knowledge of practice (Parks, 2008; Fernandez, 2010; Gonzalez & Deal, 2017).

3.5 Levels of depths of MTEs' professional learning in lesson study approach

From this conceptual framework and its reflection to the preliminary survey, the researcher realized the necessity to define the levels of MTEs' professional learning to analyze the data. The researcher defined four levels of professional learning through the lesson study engagement by adapting from previous studies (Walkoe, 2015; Gonzalez & Skultety, 2018).

Level 0 is the lowest or superficial professional learning, while level 3 is the highest or deepest professional learning. In addition, in this research, Japanese lesson study is regarded as the highest level.

Level 0: MTEs are regarded as playing two roles in lesson study practice: a teacher and an teacher educator. At this level, both roles share the same characteristics. MTEs focus on superficial instruction that describes how a teacher or teacher educator establishes and runs a classroom and speaks to pupils, the classroom dynamics, how a teacher establishes the routines, and the procedures for distributing materials. MTEs describe or criticize demonstrated teacher behavior, physical appearance, what should or should not be done, teaching fluency, judging the correspondence/appropriateness of the task, and the appropriateness of materials and lesson content. This level also includes a general statement of preconditions and collaboration of sharing ideas with others without a clear description, including complaining about their group collaboration, punctuation, workload, and time issues.

Level 1: When MTEs play the teacher role, they describe the process of teaching-learning resources. MTEs are concerned about students correctly solving problems and describe disappointment by the source of student confusion (Bocala, 2015). This also relates to the knowledge but in the form of describing or restating students' ideas by quoting their expressions (Sherin & Van Es, 2009). MTEs describe mathematical content knowledge (i.e., properties, principles, formula, etc.) and their rationale or justification for selecting a specific mathematical content or topic. However, they offer no discussion or evidence interpreting the concept behind the mathematics knowledge, no connection to broader principle of mathematical ideas, and often lack connection to the situation. MTEs do not see or describe what prior mathematical knowledge is needed or connected to the particular topic, its connection to higher mathematical knowledge in other grade levels, or how it connects to the ultimate goals (Walkoe, 2015). MTEs describe pedagogical strategy, teacher's actions, and enactment of the lesson (Gonzalez & Skultety, 2018). MTEs are concerned with how the designed pedagogy directly affects students and how it should be used in the lesson; awareness of different pedagogical strategy or a change in their pedagogical approach; and proposing new instructional strategies to address students' misconceptions or flaws. However, they lack connection to the larger principles in mathematical pedagogy (Bocala, 2015; Vrikki, et al., 2017). When the MTEs are in the teacher educator role, they make teachers or colleagues aware of the aforementioned points by asking some questions to stimulate them, such as how to design a mathematical task for this lesson topic and "If students use this method, what would you do?" MTEs encourage teachers or group members to think about appropriate teaching materials and strategies to engage student learning. They facilitate teachers and colleagues to consider alternative ways of task designing, pedagogy to engage student learning, and teaching materials to promote students' thinking. Simultaneously, MTEs may propose alternative pedagogical choices based on the teachers' ideas. However, they consider only short or immediate goals of the day's lesson without a connection to mathematical concept for long-term goals or mathematical concepts behind the lesson.

Level 2: At this level, when the MTEs play the teacher role, they are more concerned about the knowledge, analysis, and interpretation of the practice that relates to mathematics and students in a broader way. MTEs interpret and connect students' thinking to other students' thinking, gather details of student thinking, and discuss in a way that is more connected to the situation and supported by concrete evidence (Walkoe, 2015). They "examine the meaning of students' ideas, synthesize across the ideas of different students" (Sherin & Van Es, 2009). They analyze and interpret students' mathematical ideas, including discussing the details in a way that is not only connected to the situation but also to a larger context of mathematical instruction or pedagogical landscape (Walkoe, 2015). MTEs explain or interpret the mathematical concept of the selected lesson, students' errors, misconceptions, confusion, or problems observed in the lessons. They try to interpret the students' responses or thinking and determine how students approach the problems. They diagnose where students have flaws or inefficient strategies to solve problems, explaining why students operate in such a way and their thinking method, supported by concrete examples (Bocala, 2015; Vrikki, et al., 2017). When MTEs play the teacher educator role, they stimulate teachers and colleagues to consider the aforementioned, ensuring teachers are aware of the interpretation of students' mathematical thinking and reasoning. They also make sure that teachers consider further connection of the mathematical knowledge and concept behind the scenes to prepare for building their own local teaching theory. MTEs may offer alternative interpretation or analysis built by using the teachers' initial idea or interpretation.

Level 3: This level is a generalization of student mathematical thinking and teaching. It is theoretical conceptualization. "In the case of Japan, theories of teaching approaches and theories of subject matter or curriculum have been the product of lesson study" (Isoda, 2010). Playing the role of teachers, they produce their own theory of teaching (local theory) through the practice of lesson study. This level is the ultimate goal of lesson study in which it "is not limited only teachers' professional knowledge but contributes to the theories of mathematics education. It is [a]scientific activity for teachers who try to develop their own theories, which are used for developing and sharing better practices" (Isoda, 2015, p. 82). Therefore, the true meaning of professional learning in this study is not just learning about teachers' professional knowledge from the class and post-lesson discussion, but also theory building of mathematics education as the outcome. When MTEs play the role of teacher educators, they simulate teachers to theorize based on the evidence through their interpretation or deep analysis of students' thinking, SMK, and PCK. MTEs require teachers to contemplate creating their own local theory. MTEs stimulate "each participant [who] tries to reproduce what s/he has observed in class with his/her own developed local theories," and each local theory is regarded as "a description of one's PCK" (Isoda, 2015, p. 82). Through integration of MTEs' professional learning framework and the levels of professional learning, the researcher summarized the concepts into the following table (see Table 17).

Table 17. Levels of MTEs' professional learning

		Levels of MTEs' professional learning			
		Level 0 Instruction, collaboration	**Level 1** Teaching-learning resources (includes level 0)	**Level 2** Knowledge (includes level 1)	**Level 3** Theory building (includes level 2)
MTEs' role	**Teacher's role**	Commenting teacher's appearance, fluency in teaching, etc.	Describing students, lesson plan, task design, materials, etc. but no analysis	Analyzing and interpreting students' thinking, connecting mathematical ideas, etc.	Creating a local theory of teaching through evidence-based
	Teacher educator's role	Commenting teacher's appearance, fluency in teaching, suggesting a way to improve fluency in teaching, etc.	Asking, stimulating teachers ware of mathematical task, student reaction; providing alternative ideas based on teacher's ideas; but related today's lesson only	Asking, stimulating teachers to analyze and interpret students' thinking, connecting mathematical ideas from previous, present and higher-grade levels for long-term connection	Stimulating teachers to create their local theory of teaching through evidence-based

CHAPTER FOUR: RESEARCH METHODOLOGY

This chapter consists of four main parts. The first part describes how the data collection was conducted in the three selected TTCs. The second part describes the theories of the quantitative and qualitative methods used in this study, including data collection tools. The third part explains how the data were analyzed, and the fourth part concerns research ethics.

4.1 Data collection

4.1.1 Research sites

This research was conducted in three TTCs in Laos from February to April 2019. These included the Savannakhet, Pakse, and Khangkhay TTCs. The selection of these three TTCs was decided based on the results of the preliminary survey conducted from February to March 2018 regarding their lesson study practices ("regularly practice," "seldom practice," and "rarely practice"). In these three cases, Pakse TTC was regarded as regularly conducting lesson study; Savannakhet was regarded as seldom having lesson study practice, and Khangkhay TTC rarely practiced. The following offers background on each TTC.

4.1.1.1 Savannakhet TTC

Savannakhet TTC is in the Savannakhet province in the middle part of Laos. This province is located approximately 470 kilometers from the Vientiane capital city to the southern part of the country ("Tourism marketing department," 2012). Savannakhet TTC was established in 1966 and became fully functioning in 1969 as "Ecole normale Savannakhet." The development of this TTC has experienced four phases. From 1969 to 1975, this TTC ran two systems of teacher education as the 6 + 2 system (acceleration system) and 6 + 4 system (complete primary teachers) for two provinces: Savannakhet and Khammouane. From 1975 to 1989, this TTC was upgraded and named Middle School Teacher Training School No. 5. During this period, the school began a new teacher education system, called the 8 + 3 system, to support those primary school teachers who had already received basic teacher education (with the 6+2 and 6+4 systems) in proceeding with middle school teacher qualifications. From 1984 to 1989, other than the 8+3 system, Savannakhet TTC also established a branch of Savannakhet University of Education and included a new system, called the 11+4 system (bachelor's degree). This new teacher education system accepted both public school students (who graduated from upper secondary school) and middle school teachers (certificate from the 8+3 system). These pre-service teachers would become future high school teachers. Eventually, during the 1990s, Teacher Training School No. 5 and the branch of University of Education merged, becoming Savannakhet TTC, and created new systems, 11+1 and 11+3 (diploma) ("Savannakhet TTC," n.d.). Today, Savannakhet TTC provides several education systems to support the development of education in Laos. In academic year 2018-2019, there were 1,099 pre-service teachers registered in over 15 available courses. These included Kindergarten 12+4, Primary teacher 9+3, Primary teacher 12+2, Kindergarten 12+2, Mathematics 12+2+2, Primary teacher 12+2+2, English 12+2+2, Chemistry 12+2+2, Primary 12+4, ICT 12+4, Mathematics 12+4, Lao language and literature 12+4, English 12+4, Physics 12+4, and Chemistry 12+4. Besides regular courses, there are also additional courses available in the evening (General English course) and summer courses for upgrading Kindergarten and primary teachers in the 11+1+3 system. Savannakhet TTC had 165 staff members in 2017, 170 in 2018, and 171 in 2019 distributed among 10 offices (see appendix H). Typically, four offices work with teaching and learning, including Foreign Language Office, Natural Science Office, Social Science Office, and Pre-and Primary Office. Practically, teacher educators who teach mathematics or other subjects are not only the members of these four offices but are also dispersed in other offices. Regarding the academic qualifications, in 2019, Savannakhet TTC possessed teacher educators with the following accreditations: 1 Ph.D., 2 post-master's degrees (1 is female), 43 master's degrees (14 are female), 2 post-bachelor's degrees (2 are female), 83 bachelor's degrees (43 are female), 31 diplomas (25 are female), 4 middle certificates (3 are female), 2 basic certificates (2 females), one upper secondary education, and one lower secondary school education.

4.1.1.2 Pakse TTC

Pakse TTC is in Champasak province, which lies in the southern part of Laos approximately 696 kilometers away from the Vientiane capital city ("Cost to travel," 2015). This province is accessible by bus and airplane. The travel time from Vientiane capital city to Champasak province is about 1 hour and 15 minutes by airplane, 13 hours by local bus, 10 hours by express bus, and 8 hours by VIP bus ("Tourism marketing department," 2012). Pakse TTC was initially established in 1962 as a local education center responsible for training intensive pedagogy to Grade 1 through Grade 3 teachers who were not yet trained at teacher training school. Later, in 1965, this local training center changed its name to Pakse TTC and accepted two education systems: 6+2 and 6+4 (student graduated from Grade 6 and continued studying at this TTC for 2 or 4 years, respectively).

Currently, similar to Savannakhet TTC, Pakse TTC offers numerous teacher education systems to the Laos society. In 2017, the number of teacher educators of all courses in a regular period, Monday to Friday, was 1,284. It has since decreased to 1,074 in 2018 and 859 in 2019 (see appendix H). Since 2012, Pakse TTC also offers summer courses for kindergarten and primary school teachers who want to further their degrees ("Pakse TTC," 2019). In academic year 2016-17, there were 229 kindergarten and primary teachers registered in the 11+1+3 system, which decreased to 71 the following year. According to the statistical report, this TTC has no evening courses. The organization of Pakse TTC, similar to other TTCs throughout the country, comprises 10 offices with each holding a different purpose. The number of working staff members in this TTC is consistently about 165 (see appendix H). According to the statistics in academic year 2017-2018, this TTC had 16 teacher educators holding master's degrees (6 teacher educators are female), one post-bachelor's degree, 107 bachelor's degrees (55 are female), 31 diplomas (23 are female), and 8 middle certificates (7 are female).

4.1.1.3 Khangkhay TTC

Khangkhay TTC is situated in Xieng khouang province in the northern part of Laos. This province is accessible via bus or airplane. Travelling from the Vientiane capital to this province takes approximately 10 to 12 hours by bus or 30 minutes by airplane. Khangkhay TTC is located in an urban area about 5 Kilometers from the city. This TTC is responsible for producing kindergarten, primary, and secondary school teachers for two provinces: Xieng Khaouang and Houaphanh. Inherited from Primary Teacher Training School in the Xamneua district of Houaphanh province, Khangkhay TTC was established in 1963. However, the history of how the Teacher Training School transferred to Khangkhay TTC is currently unavailable.

Khangkhay TTC, similar to Savannakhet TTC and Pakse TTC, provides many teacher education systems for both students from general education and current primary teachers who desire to further their educational qualifications. These include the 9+3 primary education system, 12+2 kindergarten and primary education system, and 12+4 teacher education system in which pre-service teachers can teach both in primary and secondary school levels. Because of the societal requirement, the Ministry of Education and Sports limits some teacher education systems. Therefore, some teacher education systems have been abolished, such as the 9+3 and 12+2+2 systems, among others. This influences the number of pre-service teachers, decreasing from 1,183 student teachers in 2017 to 951 in 2018. It continued decreasing to 855 student teachers in 2019 (see appendix H). Currently, for new student teachers for academic year 2019-2020, Khangkay TTC offers entrance exams for six courses including Kindergarten 12+2 system, primary teacher education 12+2 system, and four courses in the 12+4 system (Physics, Lao language and literature, and geography and history). Mathematics courses for this academic year are only available in Savannakhet TTC. A summer course is also available at Khangkhay TTC each academic year. In 2017, there were two courses—11+1+2 kindergarten with 29 teachers and 11+1+2 primary with 265 teachers (118 female teachers). In 2018, there was only the 11+1+2 primary system with 70 primary teachers (31 female teachers). In 2019, two courses were available: kindergarten 11+1+2 system with 35 teachers and primary 11+1+2 system with 60 teachers (22 female). Teachers who participated in these intensive courses received a quota from the provincial board of education for both the Xieng khouang and Houaphanh provinces. Khangkhay TTC has 10 main offices (see appendix H). Additionally, since 2015, MoES has a new policy requiring every TTC to be associated with a primary and secondary school. Therefore, an attached primary school is added but depends on the Pre- and Primary Office. However, this TTC has not yet been associated with a secondary school. The number of staff members distributed in each office is in between 10 and 25 people, and the total number is quite constant, with 181 people in 2017 and 2018 and 183 people in 2019. Additionally, in 2019, there were 37 people holding a master's degree (9 female), 97 people with a bachelor's degree (44 female), one post-bachelor's degree, 39 (32 female) with a high certificate, 7 (6 female) middle certificates, and 2 (1 female) holding a basic certificate.

4.1.2 Respondents of this main study

As mentioned in 4.1.1, this main study specifically focused on MTEs who were currently working at three TTCs. The number of MTEs in each TTC was relatively higher than in other subjects. For instance, Savannakhet TTC had 26 MTEs (10 are female), Pakse TTC had 20 MTEs (7 are female), and Khangkhay TTC has 28 MTEs (8 are female). Initially, this study was expected to collect data from 15 MTEs in total, or a minimum of 5 MTEs from each TTC. This number of participants, 15 to 20, is appropriate for a Ph.D. project (Clarke et al., 2015, p. 229). Fortunately, each TTC was cooperative regarding the number of participations. Therefore, 34 participated: 14 from Savannakhet TTC (11 MTEs, 2 primary school teachers, 1 lower secondary school), 7 from Pakse TTC (6 MTEs and 1 primary school teacher), and 13 MTEs from Khangkhay TTC (see Table 18).

Table 18. Respondents of each group from each TTC

No	Teacher Training Colleges	Female		Male		Total
		MTE	Pri-T	MTE	Sec-T	
1	Savannakhet TTC (TTC1-G1)	4	2	2	-	8
2	Savannakhet TTC (TTC1-G2)	3	-	2	1	6
3	Pakse TTC (TTC2-G3)	3	1	3	-	7
4	Khangkhay TTC (TTC3-G4)	1	-	2	-	3
5	Khangkhay TTC (TTC3-G5)	5	-	5	-	10
Total		***16***	***3***	***14***	***1***	***34***

Most of the 34 participants belong to the study's median age range, with 22 respondents (64.8%) being 26 to 35-years-old, whereas 12 participants (25.2%) are more than 35-years-old. In addition, few participants (8.8 %) have working experience of less than 5 years. If we separate participant data into 10 years of work experience intervals, they are almost equal between less than 10 years and more than 10 years; 16 participants (47%) have less than or equal to 10 years of work experience, and 18 participants (53%) have more than 10 years of work experience (see Table 19).

Table 19. Ages and working experiences

Age interval	Age (n)	(%)		Work_Exp (year)	Exp (n)	(%)
Less than 26	0	0.0		Less than 5	3	8.8
26-30	11	32.4		5-10	13	38.2
31-35	11	32.4		11-15	7	20.6
36-40	6	17.6		16-20	7	20.6
41-45	3	8.8		More than 20	4	11.8
More than 45	3	8.8		***Total***	***34***	***100.0***
Total	***34***	***100.0***				

4.1.3 Data collection handling

Prior to visiting each TTC, a tentative data collection schedule was sent to them a month before the fieldwork. Each TTC was requested to conduct two cycles of lesson study practices within the stipulated two weeks. As expected, Savannakhet TTC conducted two lesson study practices from March 4 to 15, 2019; Pakse TTC conducted its practice from March 18 to 29, 2019; and Khangkhay TTC conducted from April 1 to 12, 2019. Both Savannakhet TTC and Khangkay TTC conducted lesson study in two groups, while Pakse TTC conducted only one group (see Figure 19). The next chapter offers more details regarding how each group in each TTC conducted lesson study.

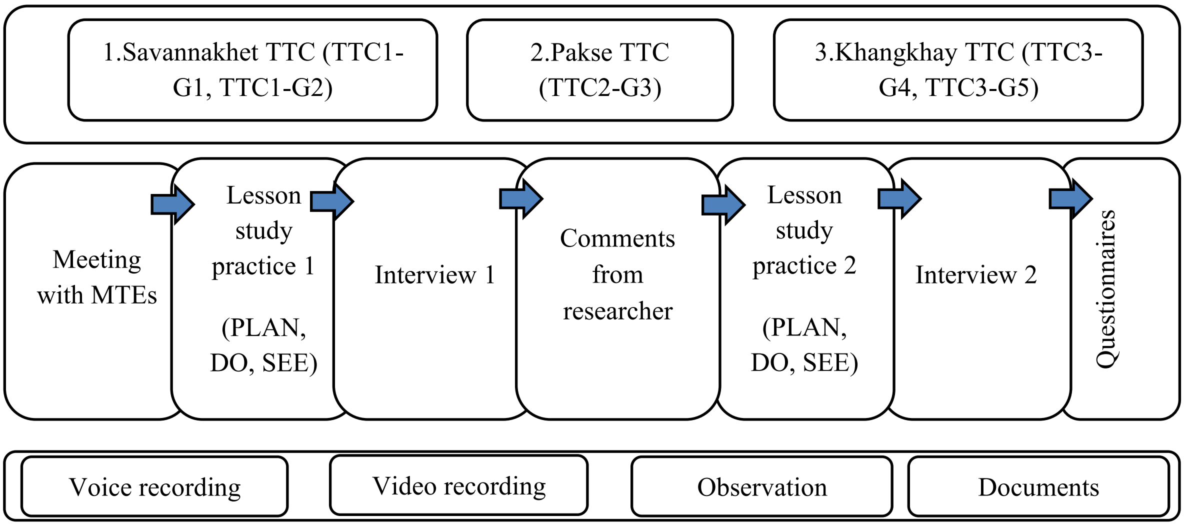


Figure 19. Data collection process

To capture as much relevant information as possible, this study used several methods of data collection including observation, interview, voice recording, video recording, questionnaire, and documents. During each step of the lesson study practice, the researcher was not only recording the videos but also observing their interactions and participation. This research did not provide any observation checklist, but the researcher freely observed based on his interest. During the planning, the researcher primarily observed how each MTE interacted with each other, their participation in commenting or sharing ideas with other members, and whether or not they took notes, checked their smartphone, or simply attended the session mindlessly. While observing research lessons, the researcher also observed whether MTEs were remaining silent at the back of the class, playing their smartphone, chatting with others, and/or spending time outside of the classroom to understand how serious the MTEs regarded the lesson study practices as well as their collaborative contribution to the groups.

The second method was the interview. This study intended to interview all members of each group individually following each step of lesson study practice, for example, proceeding with the interview after lesson planning, observing the teaching, and reflection. However, based on the MTEs' availability and time management, most respondents participated in the interview at the end of each lesson study cycle; occasionally, there was also a group interview. The interview took place at a provided room in each TTC during working hours, lasting approximately 30 minutes to an hour depending on how detailed each respondent's answers were. At Savannakhet TTC, in the first cycle of TTC1-G1, nearly every respondent was interviewed, except for one primary school teacher who did not participate in any interview. In the second cycle of the TTC1-G1, respondents cooperated with the interviews through the lesson planning. However, during the interview after reflection, only one MTE and one primary school teacher, who taught the lesson, participated in the individual interview; two MTEs were interviewed through social media. The remaining were not observed during the teaching because they had other duties that could not be denied in participating. Nearly all members of the TTC1-G2 group participated in the individual interview (see appendix C), except for one MTE who did not partake in any interview despite attending every cycle of the lesson study practice. The researcher also frequently reminded participants to participate in the interview at the end of each discussion. However, it did not appear to be effective. This method of data collection was also applied to the two TTCs. Pakse TTC had no issues with any process of data collection. All participants were cooperative with the researcher. Therefore, all data were impressively collected. In contrast to Khangkhay TTC, especially in the second cycle of TTC3-G4, the interview data was collected online because the lesson study cycle was completed after the researcher returned to Japan. Subsequently, few data were collected from this group. Luckily, however, this group was kind enough to share their recorded videos of lesson planning, teaching, and discussion during the second cycle.

The third method of data collection was video recording. This research recorded each step of the lesson study practices, including intervention from the researcher through a SONY video recording device as well as the researcher's smartphone (iPhone 7 plus). As soon as the recording was completed, the researcher immediately transferred the data to the external hard drive to free memory space for the next recording. This research comprised 82 electronic files of recorded videos that contained 134.1 Gigabytes of memory.

The fourth method was the questionnaire. Immediately after the interview, the researcher distributed the questionnaires to all members of each group following the second lesson study practice. The researcher also created online questionnaires using Google Forms for those who were unable to complete the questionnaires the day of the research. Combining in-person and online submissions, the study collected 25 questionnaires (4 online responses and 21 papers). Moreover, the study collected some documents such as lesson plans and student worksheets from each group to support the interpretation while analyzing the data. Unfortunately, the researcher was unable to collect the lesson plans from the TTC3-G4 because of a cooperation issue. Although the data were collected from the five groups, three groups' data were mainly used in this dissertation. The other two groups were added to the appendix (see appendix C).

4.1.4 Data collection tools

This research used both questionnaires and semi-structured interviews. The questions of the semi-structured interview guide were developed referring to the research questions and conceptual framework by adapting some interview questions based on previous studies (Rock & Wilson, 2005; Cheng & Lee, 2011; Pang, 2016; Schipper et al., 2017). The interview guide consisted of three parts: general information about the respondents, main questions of professional learning, and issues and additional comments. The first part was used to collect basic information regarding age, work experience, qualifications, and background of their lesson study experience. The second was used to collect the data about their professional learning and issues from the actual lesson study practices. This part included five main questions: (1) What did you learn while planning the lesson with your colleagues? (give specific examples), (2) What did you learn when you observed / implemented the research lessons? (give specific examples), (3) What did you learn through post-lesson discussion? (give some examples), (4) What do you think about the issues of this lesson study practice? (please explain), and (5) What do you want more understand of regarding lesson study? There were also sub-questions provided to the respondents to deepen understanding and clarify some ambiguous points. It was noticeable that every question required explanation and some concrete examples so that the researcher would clearly understand respondents' thoughts or issues. Finally, an open question session was offered to the respondents to ask their additional questions and make any requests or suggestions to ensure that they mentioned all they wanted to include.

The second tool for quantitative data was questionnaire. Similar to the interview guide, the questionnaire was developed referring to conceptual framework by adapting from several previous studies (Lewis et al., 2009; Bae et al., 2016; Gonzalez, 2016; Ni Shuilleabhain, 2015; Zhang & Stephens, 2016). Using the Likert scale, the questionnaire consisted of three sections with 37 questions in total. The first section asked basic information about the respondents, consisting of four questions regarding their age, gender, work experience, and classes they were currently teaching. The second section concerned MTEs' professional learning from the actual lesson study practices. The questions in this main section were developed in association with four main components of the conceptual framework (knowledge, collaboration, instruction, and teaching-learning resources). This portion contained 32 questions. Each question provided five choices for respondents to select the one they found most suitable. These five choices included "strongly disagree," "disagree," "neutral," "agree," and "strongly agree." The following are some questions excerpted from the questionnaire: I learn how to solve mathematical task correctly; I learn how to select or design appropriate task to best represent the core objective of the lesson; I learn about noticing student mathematical thinking through mathematical strategies and students' conversations. The final section comprises the additional comments for respondents who still had further information to share.

4.2 Qualitative and quantitative study

Typically, research in education uses qualitative method, quantitative one, or a combination called "mixed method." Each method has its own strengths and weaknesses. Qualitative study addresses verbal communication, explanation, and interpretation of the "color of dynamic of everyday experience" (Middleton, 2012, p. 302). Alternatively, "quantitative research usually means the statistical analysis of collected standardized data, for instance, with the help of questionnaires or by other highly structured techniques" (Kelle & Butchholtz, 2015, p. 329). People's interactions and discussions are perceived as qualitative phenomena. Apart from daily dialogue, qualitative data is also engaged with documents, whether they are "printed or handwritten, electronic or on paper, published or unpublished, public or private, contemporary or historical" (Middleton, 2012, p. 302). Data of qualitative research is "non-standardized" data that can be "obtained through open interviews or by writing field note which are analyzed with the help of non-numerical (interpretive hermeneutic) methods" (Kelle & Butchholtz, 2015, p. 329). In the school context, the interaction between teacher and students or students with other students, lesson plans, student worksheets, and writing on the blackboard are all main sources of data of qualitative study. Qualitative method helps researchers explore "previously unknown social life worlds." Investigation in the field may discover knowledge, "social rules and structures about which they had no idea before" that would help "to construct new theoretical concepts, categories, and sometimes even whole theories about the domain under study" (Kelle & Butchholtz, 2015, p. 336).

Research in education does not use a single method but rather a combination of qualitative and quantitative methods to accurately and adequately understand phenomena for an improved and fruitful option. It is believed that the mixed method will triangulate evidence to enhance "the strength and validity of research findings" (Biesta, 2012, p. 159). Each method will overcome the limitations of the other method. For example, the qualitative aspect can clarify "variable and mis-specified models," "help to understand previously incomprehensible statistical findings," and "identify unobserved heterogeneity in quantitative data" (Kelle & Butchholtz, 2015, p. 353). Nonetheless, within this combined method, it is up to the researcher to treat both methods equally, as "QUAL + QUAN"; with qualitative as the more dominant side, as "QUAL + quan"; or with more emphasis on the quantitative side, as "QUAN + qual." This is because "there [are] no typical methods for data collection in mixed research" and "no typical methods for data analysis" (Biesta, 2012, p. 162). Generally, research using mixed method is divided into several sub-studies and analyzed separately with either one quantitative or qualitative method. The results of these sub-studies, however, are related because each sub-study aims to answer specific research questions and, ultimately, combine to answer a main research question (Kelle & Butchholtz, 2015, p. 330).

For this research, the author used mixed method to deepen understanding of MTEs' professional learning and some issues projected during the lesson study process. However, the researcher put more emphasis on the qualitative aspect because the characteristics of the lesson study, research objectives, and questions that required strong descriptions. This study used quantitative data from the questionnaires to confirm their professional learning after intervention or receiving comments from the researcher during the fieldwork. Therefore, although collected, the questionnaires were not used in this dissertation because the researcher realized that MTEs' views of the questions were too different from their reality compared to their discussion during lesson study practices.

4.2.1 Semi-structured interviews

This research used a semi-structured interview guide to collect meaningful data because the interview allows us to acquire deeper insights into the situation or phenomenon that surveys may not be able to achieve. Interviews will reveal what the researcher does not know or discover the reasons behind the incident; then, "we record what we hear in order to systematically process the data and better understanding and analyze the insights shared through the dialogue" (Forsey, 2012, p. 364). To elicit deeper thoughts from MTEs, this study also used an in-depth interview by asking several questions related to the points and probing interviewees to provide examples for clarification. The in-depth interview method helps the interviewer "to learn what another person knows about the topic, to discover and record what that person has experienced, what he or she thinks and feels about it, and what significance or meaning it might have" (Mears, 2012, p. 183). Based on the characteristics of the lesson study, research objective, and research questions, the researcher employed a series of interviews with respondents in which the level of depth of in-depth interview is implied. Mears (2012, p. 184) clearly explained that the level of in-depth research requires multiple interviews. The shared data from the first respondent offers the following:

> [We] frequently shared story of events, or happenings without much depth, detail, or reflection. Therefore, to go beyond these simple facts.… offering you an enriched understanding or fresh insight, a series of two or three 90-minute interviews spaced about a week or two apart.… will provide a greater opportunity to build a rapport and achieve deeper reflection.

4.2.2 Group discussions

Several methods of data collection including group discussion, focus group, or group interviews have been used in this study to obtain multi-faceted data. Considering the nature of lesson study, group discussion among respondents is practical while group interviews are also often practiced when participants have a time limitation. Interviewing in groups is "used to complement other methods of data generation in the same study.… to help [the] researcher gain a 'feel' for participants' experiences or understand how [conversation] works to co-construct a shared reality" (Currie & Kelly, 2012, p. 407). This method will generate the essential data through people's interactions in which it is valuable to understand "local communities of shared meaning" (Currie & Kelly, 2012, p. 410). In some studies, group interviews and focus groups are frequently used interchangeably. The overall meaning of this method is to select individuals to gather and discuss in one place to "gain collective views about a research topic. Group interviews are a way to gather many opinions from individuals within a group setting but are largely didactic between an interviewer and each individual in the group." (Gibbs, 2012, p. 190). Through group interviews, people may feel confident discussing the related topics because they receive supportive ideas from other members, especially when they share similar concerns. If participants have conflicting ideas, they "may also enjoy group debate on a topic …[and] feel empowered by the group dynamic. Participants in focus groups may feel able to talk about sensitive topics in a way in which they would not do in an individual interview …" (Gibbs, 2012, p. 191). In the lesson study process, there is always a group discussion—whether in pre-planning, lesson planning, or reflection after the research lesson. Therefore, a collective idea greatly influences individual professional learning.

4.2.3 Observations

Observation in this research is also used to reveal how MTEs interacted with each other, their participation, and their collaboration when practicing lesson study as well as their willingness. Observation may not only reveal respondents' emotional status and what they are doing, but also "how this is influenced by and in turn influences the social setting within which their actions take place" (Dallos, 2006, p. 126). There are three types of observation: "participant as observer," "observer as participant" (less active than participant as observer), and "complete observer." In this study, the researcher acted as a "complete observer" because he did not interfere, suggest, or ask a question while observing the practice. The role of complete observer "is characterized by detachment from the group under study, with no direct contact with group members during the observational work. This is approximated in some clinical work, as well as when activity is viewed from behind a one-way screen" (Dallos, 2006, p. 131). Actually, the researcher observed the entire process from beginning to end. For example, during lesson planning, he observed what MTEs brought with them—whether they brought a pad for note taking or were simply present but not paying attention. He also observed what participants were doing while others were expressing or sharing ideas regarding lesson content and whether they supported such ideas, disagreed, nodded, or had no reaction. In addition, while observing the research lesson, the researcher was not only observing how the lesson was being taught but also where other observers were sitting, what they were doing, and so forth. Those data were essential to support research findings and discussion. It was also significant in that it might be influencing the depth in which MTEs express their comments in reflection and answer interview questions.

4.3 Data analysis of the main study

Majorly, this study focused on the qualitative method. Thus, these theories, including thematic analysis (Braun & Clarke, 2006; Clarke & Braun, 2016), grounded theory (Strauss & Corbin, 1998), and category construction (Merriam, 2009), were aware while analyzing the protocol discussions and the interviewed data. The protocol discussions consisted of lesson planning 1, post-lesson discussion 1, lesson planning 2, and post-lesson discussion 2. This study employed licensed software MAXQDA 10 to manipulate the thick data descriptions of those protocols. When analyzing these data, the author paid specific attention to the emergence of the MTEs' professional learning, and the depths of the emerged MTEs' professional learning.

This term of "emergence" that is frequently used in this research means the state of MTEs' professional learning and issues becomes visible through the critical data analysis because the author hypothesized that lesson study practice in Lao context was a sort of difficult to find obvious learning without deeply looking at it.

The data analysis separated the emergences, the depths, and the issues of the MTEs' professional learning based on both the MTEs as the teacher roles and as the teacher educator roles. These two roles were judged by some characteristics of the data. For example, to identify the emergences of the MTEs' professional learning as the teacher role, using the framework as the important lens (see Table 17), first, the author carefully read and reread the protocol discussions in the transcriptions several times to familiarize and understand what the lesson study team members have discussed. Second, the author interpreted the data and assigned a key term, or key pattern represented the meaning of the particular paragraph in the MTEs' protocol discussions. Of this step, throughout analyzing the entire protocol discussions, several key patterns were identified. And finally, regarding the framework as the main themes or main categories, the researcher categorized those key patterns in the sub-categories and correlated those sub-categories to the main themes. At this final process, if the characteristic of those key patterns or sub-categories indicated only commenting the teacher on his or her teaching behavior or physical appearance, then those patterns would be classified as the emergence of the MTEs' professional learning in the instruction and collaboration domain. At the same time, it would be regarded as in level 0 in terms of depth. However, if the key patterns or sub-categories emphasized describing the teaching materials, mathematical task designs, and students' participation, then those were judged in the domain of the teaching-learning resources and the depths would be in level 1. This level 1 also included the emergence of the knowledge domain if the key patterns or sub-categories emphasized only describing the knowledge in general. For example, simply copying the mathematics from the textbook to the lesson plan, being aware only today curriculum knowledge, and being aware or pointed out only students' difficulties, mathematical background, etc. without analysis.

Furthermore, if the patterns emphasized analyzing or interpreting the mathematical concept, analyzing students' mathematical thinking, analyzing the meaning of mathematical idea behind the designed mathematical problems, and relating the mathematical ideas for a long-term development, then they were also regarded in the knowledge domain but indicated as in the level 2 in term of the depths of the MTEs' professional learning. Moreover, if such key patterns associated with creating their local teaching theory or their analysis is associated with the existing theory of mathematics education, then they were classified in the theory-building domain and automatically regarded in level 3. This local theory is as equal to the design of hypothetical learning trajectories (Simon & Tzur, 2004) that includes "a theory about a possible learning process and the means of supporting that process" (Gravemeijer, 2007). For example, a lesson is about teaching subtraction, then the conjectures of the students' learning process would be a counting-subtraction method, subtraction-addition method, and subtraction-subtraction method (Fernandez & Yoshida, 2011, pp. 136-137).

Similarly, as the role of teacher educator, if the characteristic of the key patterns related to commenting the group members as well as suggesting the way to improve teacher behavior or fluency in teaching, then those were regarded in the instruction and collaboration domain in the level 0. If the characteristic of the key patterns associated with the stimulating team members to be aware of mathematical task, students' misconception as well as providing alternative idea to improve it or the awareness of the mathematical connection for today's lesson only, then they were classified in the domain of the teaching-learning resources with the depth in the level 1. Furthermore, if the characteristic of the key patterns related to the stimulating lesson study team members to analyze students' thinking, suggesting alternative ideas of analyzing mathematical concept or student mathematical understanding, stimulating the group members to make the connection of the mathematical concept in the long-term span, then they were put in the knowledge domain with the depth in level 2. And finally, if the characteristic of the key patterns or sub-categories associated with stimulating the team members to create a theory of teaching or alternating the theory of teaching mathematics, then those would be in the theory-building domain in term of the role of teacher educators with the depth in the level 3.

4.4 Validity, reliability, and ethics

Validity is to assure that what the researcher intends to measure is measured (Baker & Van Eerde, 2015, p. 443). It is the accuracy of the data interpretation and generalization of the research findings. There are two types of validity: internal and external. Internal validity is concerned with whether the results are drawn based on evidence in the collected data as well as "the soundness (credibility) of the reasoning that has led to the conclusions." External validity is concerned with research results' generalizability. "Internal validity is the extent to which results can be interpreted accurately, and external validity is the extent to which results can be generalized to populations, situations, and conditions" (Wiersma & Jurs, 2005, p. 5). Hedges (2012) also claimed the following:

> ...all empirical research designs involve the collection of empirical materials, which are organized by the analysis in order to draw conclusions. If the design doesn't assure that the empirical materials used in the analysis are adequate to draw conclusions, or if the analysis is not organized to permit drawing valid conclusions even if the materials collected are sufficient to do so, then the conclusions drawn from the research design will be invalid (p. 30).

The two types of reliability are also internal and external. Internal reliability is the consistency of the research method until the findings are within the same conditions. It manages how the data was collected, analyzed, and interpreted and if those are consistent (Wiersma & Jurs, 2005, p. 9). It also "refers to the degree of how independently of the researcher the data are collected and analyzed" (Baker & Van Eerde, 2015, p. 445). Similarly, external reliability is the ability of the replicability of that research method and if the same or similar findings will be obtained when other researchers follow the same or similar research settings. Therefore, if it is reliable, an independent researcher "using the same methods, conditions, and so forth should obtain the results as those found in a prior study" (Wiersma & Jurs, 2005, p. 9). Reliability should certify that the results are subjects- and conditions-based, not drawing from a researcher's impression, and the descriptions of "how the research has been carried out and how conclusions have been drawn from the data" should be made explicit (Baker & Van Eerde, 2015, p. 445).

Research ethics represents all epistemic and practical values of the researcher's work. By committing to truth, knowledge, and "honesty in presenting evidence and in providing information about how the research was carried out" (Hammersley, 2012, p. 58), the researcher is already engaged with research ethics. The researcher should be aware to avoid committing any harm to participants, showing respect to their autonomy, protecting their privacy, and not destroying reputations. Informed consent is usually used when dealing with interviews (Hammersley, 2012, p. 59-60). In this study, the researcher was overtly aware of respondents' privacy and autonomy. He also asked permission before conducting video or voice recordings and asked them to sign an informed consent waiver to ensure they were willing to participate in this research. Because of the research ethics concerns, although some MTEs neglected to participate in interview sessions, failed to return questionnaires, and ignored the online interviews, the researcher still respects their privacy and autonomy.

CHAPTER FIVE: LESSON STUDY PRACTICES AND MTES' PROFESSIONAL LEARNING IN THE CASE OF 3 TTCS

This chapter is organized into two parts. The first part consists of three main sections based on the number of the TTCs. Each TTC is also organized based on the group of lesson study practices. In each group of the lesson study practice, the study describes the content based on the step of the lesson study practice, including MTEs' discussions in lesson planning, teaching, and reflection. The second part describes MTEs' perceptions toward the actual lesson study practice. This second part is not yet analyzed but rather is a general description of what was happening during the interview. Although the data were collected from five groups of lesson study practices, three groups were analyzed as a representation from each TTC for this research report.

5.1 Description of lesson study practices at Savannakhet TTC

Briefly, the preliminary survey from February to March 2018 revealed that lesson study practice at Savannakhet TTC conformed to the guidelines designed by MoES. They followed the three steps of PLAN-DO-SEE. In the PLAN step, MTEs formed groups, listed all of their ideas, and, later, selected one or more problems to conduct in the lesson to solve the particular problems. In the DO step, the teacher taught the lesson and members observed using the checklist from the guidelines. As soon as the research lesson was complete, they proceeded with reflection using the checklist as a guide to evaluate the teacher during the SEE step. Influenced by the BEQUAL project, the MTEs conducted multiple observations (approximately 8) to uncover some problems and conducted lesson study to solve it.

In this main study, the data collection was implemented during the first two weeks of March 2019. On the first day of data collection period, March 4, 2019, the researcher cooperated with the head unit of mathematics, organizing a short meeting with some MTEs to inform them of the researcher's purposes. The discussion within the TTC lasted approximately 40 minutes. The brief content of the discussion was that MTEs were requested to conduct at least two lesson study cycles within the stipulated two weeks. They would be observed and their discussion recorded during each step of the lesson study practice. Furthermore, based on their availability, they would be requested to participate in a series of interviews during or at the end of each lesson study cycle. After the first cycle was completed, there would be an intervention (or a deeper explanation about lesson study) from the researcher. However, the researcher would not interfere or offer guidance during the practice of the two cycles, and the participants maintained their autonomy to conduct lesson study as they wished. Once they accepted the researcher's requests and understood the purposes, the MTEs decided to separate into two groups—one cooperated with primary teachers (refers to TTC1-G1) and the other cooperated with a secondary school teacher (refers to TTC1-G2). The members of the TTC1-G1 included six MTEs and two primary school teachers. The leaders of this group underwent three weeks of training experience in Hiroshima, Japan as JICA participants under the title "Improvement of Quality of Education through Lesson Study" (one was in 2010 and one was in 2018). The other members received minimal experience through actual practices within the TTC. Regarding the two primary school teachers, one was the head of this attached primary school and one was the homeroom Grade 1 teacher. This homeroom teacher had working experience as a secretary of the TTC for more than 10 years. However, due to the TTC system alterations, in mid-2018, she was appointed as a primary school teacher at the attached primary school. Therefore, her teaching experience was less than two years. The TTC1-G2 had five MTEs and one secondary school teacher, who was previously an MTE at the same TTC from 2007 to 2017. Because of the change in the system, however, he moved to the attached secondary school in 2018. The leader of the second group had also undergone three weeks of training experience in Hiroshima, Japan, in 2017, under the same title as the leaders of the TTC1-G1. The second group's other members only had two days of training experience in theory in 2016 but had not yet experienced an actual lesson study practice.

5.1.1 Lesson planning 1 of TTC1-G1

Fortunately, TTC1-G1 had already established a tentative plan to conduct lesson study in the attached primary school during the third week of March 2019. After receiving a request from the researcher, they finally agreed to conduct it during the first two weeks, as requested (see Table 20). Then, the leader of the TTC1-G1 contacted the members and held a meeting on March 5, 2019. This short 30-minute meeting had two participants (DSM & VNK) from the TTC and two primary teachers (SPC & MNV) from the attached primary school. DSM clarified to the members that the meeting's purpose was to plan a schedule together based on the researcher's request. They agreed to plan the first lesson on Thursday, March 7, 2019. Previously, however, primary teacher, SPC, was assigned to make a lesson plan for later improvement on March 7, 2019. Through the discussion, the group agreed to conduct lesson study under the title of "design [a] learning activity that students will collaboratively solve [a] problem together." The lesson for lesson study practice 1 followed the regular curriculum schedule, which was Lesson 13, quantity comparison. The group's decision to conduct lesson study on this topic was influenced by its participation in the February 2019 conference at Luang Namtha TTC, organized by JICA. After this conference, each TTC was given an assignment to conduct lesson study to accompany the new Grade 1 textbook. Thus, the discussion on March 5, 2019 was simply establishing the schedule of the entire two weeks.

Table 20. Schedule of lesson study practice at TTC1-G1

No	Activities	Number of participants	Date
1	Purposes of data collection	3 MTEs, leaders	March 4th, 2019
2	Pre-planning 1	4 (2 MTEs, 2 pri-Ts)	March 5th, 2019
3	Planning 1	7 (4 MTEs, 2 pri-Ts, 1 JOCV)	March 7th, 2019
4	Preparing materials	3 MTEs	March 11th, 2019
5	Teaching1 and reflection1	7 (5 MTEs, 2 pri-Ts, 1 JOCV)	March 12th, 2019
6	Comments from researcher	Individually right after the interviews	
7	Planning 2/1	6 (4 MTEs, 2 pri-Ts)	March 13th, 2019
8	Planning 2/2	7 (5 MTEs, 2 pri-Ts)	March 14th, 2019
9	Teaching 2 and reflection 2	4 (3 MTEs, 1 pri-T)	March 15th, 2019

On March 7, 2019, the group members of TTC1-G1 gathered at the teacher office of the attached primary school to make the first lesson plan. On this date, four MTEs (DSM, VNK, SSL, & JNL) and two primary teachers (SPC & SDV) attended. The first discussion of the lesson planning lasted 1 hour and 45 minutes, and most of the ideas arose from the two group leaders (see Table 21). VNK was not only sharing ideas more often than others share (111 times) but also typing the new lesson plan version on his personal computer. DSM also often expressed her ideas during the lesson plan (88 times). These two MTEs, as mentioned above, had more lesson study experience than the others did. At that moment, they were the lesson study trainers of this TTC. Subsequently, the entirety of this lesson's discussion was greatly influenced by their input. Their discussions in the lesson planning meeting could be categorized in each step as follows: lesson objective, teaching materials and students' group work, reviewing the previous lesson, activity for the whole class, group activity, conclusion, and evaluation.

Table 21. Frequency of sharing ideas in the lesson planning 1 & reflection 1

No	Name code	Frequency of sharing ideas in lesson plan (time)	Frequency of sharing ideas in reflection (time)	Notes
1	VNK	111	11	MTE
2	DSM	88	6	MTE
3	SPC	38	2	Primary teacher
4	SSL	22	-	MTE
5	JNL	15	1	MTE
6	SDV	6	4	Head of attached school
7	KON	-	6	MTE
8	PHT	-	3	MTE

Lesson objective: The group members of TTC1-G1 started by discussing the lesson objective based on what SPC previously planned (see the original lesson plan in Appendix A and the modified version in Appendix B). The objective of this lesson was to interest students toward the size of the object and help them understand the principle of quantity measurement. This objective was exactly as written in the teacher guidebook. VNK criticized that the objective of this lesson remained controversial even in the Research Institute for Educational Sciences that is responsible for designing and issuing national curriculum and textbooks. He interpreted the word "principle" as the principle of an object about quantity measurement, whereas the "size" of an object might be the size of a container. DSM agreed with VNK's ideas, further adding that the principle could be the unchanged volume of the water even when placing it in the different containers. DSM also highlighted that "principle" in the lesson objective was likely unsuitable for Grade 1 mathematics. She offered the expression, "understanding volume measurement," instead of the word "principle." Their discussion was as follows:

VNK: This is what sister SPC planned ... this is the first lesson, right, SPC?

SPC: Yes.

VNK: The objective is to get students interested in the size of an object and understand the principle of quantity measurement. This objective from the book is still controversial in RIES. Despite wanting to make it easily comprehendible, our word is hard to understand. The "principle" of this is the principle of the object, quantity measurement.

The size of an object would be the size of a container when we place water in it; because it is thin and long, it looks like it contains a lot of water. It would be this one; this is an understanding of quantity measurement.

DSM: As you said, the principle is the unchanged volume, but we will see in the case of the same amount of water that whatever containers we put the water in, the volume of the water remains the same even if the size of the object changes. However, using the word "principle" is a bit difficult. Perhaps we can use the word "understanding" …understanding measurement of volume.

VNK: This one is not about measuring, yet; it is as if we want to form our consensus understanding. Because, at the end of the activity, students will see different sized objects and the teacher will conclude the lesson on quantity.

SPC: Sir, if so, let us remove the word understanding "principle" and use the phrase "understanding about quantity comparison" instead.

VNK: No, we have not compared this one yet. We only want students to know this when we place the water in this container and then measure it. When we put in that container, how is it then? Although we are placing the water from a plastic bag into a different shaped object, it shares the same volume. So, please share the same understanding together.

The group continued discussing the concept of this lesson. JNL simply noted that the amount of water was changing when the container was changed. However, DSM did not agree with JNL's expression, and she explained that because it came from the same source, the volume of water is unchanged even if it was placed in a different shaped object. Therefore, DSM wanted students to be able to guess that point. At this moment, VNK identified the weakness of this lesson plan, stating that it did not correspond to the lesson objective because their intention was not to compare or measure the amount or volume of the water. However, DSM viewed this lesson differently, considering that it would be the foundation of students' understanding about the unchanged amount of water. JNL also supported DSM's idea that this lesson was only discussing a change or lack of change in the amount of water. See their discussion below:

JNL: [If we] Change [the] container, then the water is also changed.

DSM: Water, its volume, is unchanged, but it can be said that the amount of water is increased or decreased or [remained] unchanged; actually, it is unchanged. The amount of water is the same even if we put it in any shape of container. If students can guess that the water comes from only one plastic bag, it is the same. We want students to reach that goal, but our teacher should also have some deeper questions to investigate. In the case that students do not proceed as we expected, how can we proceed without telling them?

VNK: So, our lesson title is "quantity comparison"; thus, the content we place here is not corresponding to the objective.

DSM: That is okay, [because] this lesson is to provide background before moving to the next lesson about direct quantity comparison. Therefore, we want students to have a basic background initially when we teach [them] about the direct comparison. Then, whatever containers students put water in, it is up to them; it is their foundation.

JNL: Right, right—supposing that the pipe is longer, the water is increased, so it contains a great deal of water. This also refers to change.

DSM: This is only [providing] the basics for students. We have not yet reached [direct comparison]; it is a starting point. We will not start from direct comparison.

Teaching materials and students' group work: The group members then shifted the discussion to the teaching materials and students' group setting. They discussed what kind of materials to use for putting water into different shapes. The group agreed to use a plastic bag, plastic bottle, and a big cup for each group. Because the plastic bag and bottle were transparent, the group agreed to use color water so that students could clearly notice the level or amount of water in the containers. They also divided students into seven groups with five members each. Below are the excerpts of their dialogue:

VNK: Teaching material is [the] colored water.

SPC: We can use blue pea flower.

VNK: Because we [would] have to soak it to get it color, we [could] also [use] 2 to 3 small bags of color powder. Miss SPC, let me handle this.

VNK: I will check the color powder; I will inform everyone if I do not have it. So, now we have a glass of water, different sized bottles, a plastic bag, a glass of water … or we should follow teacher guidebook; it has "cup, big bowl, and plastic bag."

DSM: "Bowl" is a bowl made of glass.

SSL: If we do not have a bowl, we can use a bucket.

VNK: However, if we divide into many groups, our materials will be [many] or [not enough].

SPC: We have 35 students.

VNK: Six groups; each group has 7 students. That is too many; there should be 7 sets of the teaching material.

SSL: Five groups; each group has 7 students.

DSM: If [it is] 5 groups, then it is too [many students].

JNL & VNK: Seven groups mean each group has 5 members.

VNK: Can we change from a glass to plastic bottles?

SPC: We cut it.

VNK: No, no; we do not need to cut it... because we can pour water in --

SSL: -- two funnels.

SPC: [If there are] 7 groups, [there] should be 7 funnels.

VNK: It is a cup made of glass, so we will change [the material] for students' safety.

SPC: Use large plastic cups, instead.

VNK: Use plastic cups or bottles.

Reviewing previous lesson: Straightforwardly, the MTEs designed how to the review previous lesson. This part lasted a bit longer than the previous discussion. The previous lessons were about "addition," Lesson 12, and "length comparison," Lesson 11, respectively. However, VNK proposed an idea not to use previous lessons but, instead, utilize students' experiences related to daily life or directly ask them about the different object shapes to link to the new lesson. In contrast, DSM raised the point to review the length (comparison) of Lesson 11 despite it not directly relating to this lesson. SPC pursued VNK's idea of relating it to daily life and obtaining the concept of volume of water. Thus, SPC posed a question to ask students about the amount of water they drink after their meal. Then, there were many ways of asking proposed by TTC1-G1 group members, as presented in the following conversations.

DSM: When reviewing a previous lesson or linking to a new lesson, what do you think we should do? We can review the length...

VNK: ...Or we ask students about the size of each object, [letting] them notice how this bottle [appears] and how that bottle [appears], because we will definitely use this in the lesson plan. We, after that, proceed with putting water into this container and ask students [about that] in order to link to the new lesson.

DSM: You jumped the steps again.

VNK: As I said, [this is] to link [it] to the new lesson. What should we do, then? Because we also want to ask students about the size of containers... "Oh, teacher, this one is bigger; this one is smaller" [he responds on behalf of students]. "So, today we will learn about these things." However, [no matter the] mode, it is up to the teacher. Then, discuss how the water is; later, discuss the objects. We also want students to answer that, [regarding the] water, the volume is unchanged, but it changes its shape based on the shapes of the containers. Because students will see real objects and we use containers to discuss [this] with students.

DSM: It is okay, then, [that] we talk about it in advance. I mean, it has not been used yet.

VNK: It means to motivate them first about those containers, how it is between this one and that one. We stimulate students initially and [again, afterward].

SPC: If we are going to learn about water, then we first ask them, “Do you drink water when you are at home? How much do you drink?” It is better to ask that way; then, we reveal the plastic bag that contains colored water.

SSL: If you ask about how much they drink, you should have something to show them whether they drink more or less than this.

SPC: Some students will say they drink half of a glass of water, [while] some will say [they drink] a glass of water. They will never say that they drink in [the] amount of this liter or that liter. Children do not know; they will only say “one glass of water” or “2 glasses of water.” They only know a little quantity or more quantity…

VNK: Drink—what we should do next?

JNL: How much did you drink?

DSM: Do you drink much? Who drinks more [and] who drinks less, as such.

VNK: Not much—two bottles, but what we will say next? “After having breakfast or lunch, did you drink water? How much did you drink? So, today we will learn [about this].”

DSM: This [depends on the] students’ answers and, then, [the] teacher should have something to say, such as, “some students drink a small amount, but some students drink more,” as such.

VNK: We use this to link to the new lesson [or activity]. Therefore, “today we will learn about quantity comparison together.” This [will] already [have] entered [the teaching step].

DSM: “Drink,” “don’t drink,” “drink half of a glass”—this is only what we anticipate students’ responses [to be].

Activity to discuss with the whole class: Once the group members determined the questions to ask and the dialogue for interacting with students and obtaining their attention during the lesson, the group members discussed the main activity. This part of the discussion was the lengthiest. The main concept of this activity was to construct students’ conceptual understanding toward the volume of water—that it is unchanged even if it is placed in a different kind of object or any container shape.

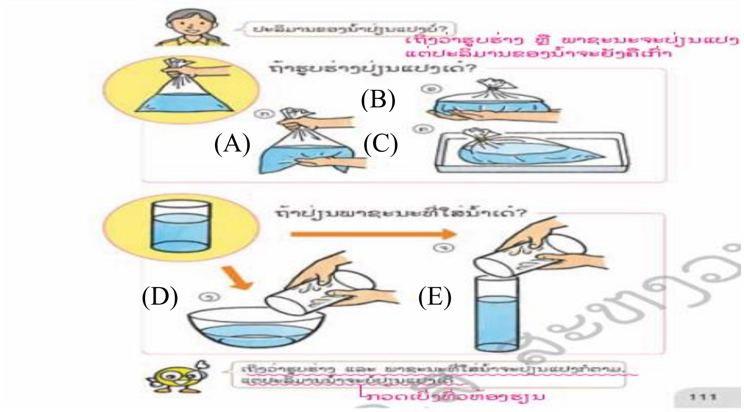


Figure 20. Unchanged amount of water in different containers (MoES, 2017, p. 111)

Intentionally, the group members followed the teaching guidebook (see Figure 20) by showing students a plastic bag with colored water inside, squeezing it or pressing up the bottom of the water bag, placing the water bag on a palm, putting it on a tray, and changing it to another container. Then, they allowed students to discuss if the amount of water inside the plastic bag as well as in another container was changed or unchanged. In this activity, students were required to notice and express their ideas based on what they observed through the demonstration. The following are some excerpts of the TTC1-G1's discussion.

VNK: [For the] teaching step, right, we have a plastic bag with colored water inside. We let students observe, then we suggest they discuss freely about the water inside the plastic bag based on what they see. This is the suggestion; it is what we want students to do. Here, the teacher asks [the] students, right?

JNL: [During] this part, [the] teacher will demonstrate; we have a water bag.

VNK: Right, but this is the suggestion; it is an order that the teacher will do, or can we remove this [part]?

SPC: [During] this part, we must show [them the bag] and ask, "[Do] you notice how much is it? What color is it, the water?" Allow students to answer before we proceed to this question. Then, [the] teacher can continue to ask students.

DSM: "What do you see in this water bag? Is it [a small amount]; it is [a large amount]," [the] teacher asks... it is a kind of asking.

VNK: Suggesting students [speak] freely [and] say whatever they want to say, because it [is in] this guidebook, also provides [an] open-ended question.

SPC: [... Let us] say [the] teacher holds up the water bag, pressing up the bottom of the water bag and asks students, "How is it changing?"

The group members—SPC, JNL, and DSM as well as VNK, who was typing the lesson plan—recommended the homeroom teacher follow. In this dialogue, their discussion was mostly about changing or not changing the amount of water inside the plastic bag. It concerned increasing, decreasing, or leaving it unchanged when the teacher was holding the bag, laying it down, or putting the water in a different container. The excerpts of the discussion are shown below.

JNL: Let [the] teacher just follow this [].

SSL: This is the teacher's activity, right—pressing or squeezing water?

DSM: Just follow this Figure 21A [and ask], "When pressing up, how is [the water in the bag]?" By asking students, "is the water increasing, decreasing, or unchanged? Then, let us see this B"; [then, the] teacher puts [the] water bag on [their] palm and [asks] students [to] notice how it [appears in that position.] C [involves] putting [the bag] on the tray and [walking] around to show students, [asking them] how it looks.

JNL: [The teacher asks] only one question: [asking if] the water is increasing, decreasing, or unchanged. After [the] completion of these three demonstrations, [the teacher asks], "How is the water?"

VNK: It means that, [when asking] the first question, we press up the water bag, and the teacher asks [the students what they] can see, [and] students respond. Then, [the] teacher puts the water bag on the palm and asks what students can see. After that, [the bag is] put on the tray; [students are asked] what [they] can see. The same question [is being asked each time] but [the teacher is] allowing students to talk [during each scenario]. Is [this format] okay?

DSM: [It should] not [only be a question of] what students can notice; we must specify deeper...

SSL: Specify its change.

DSM: At the beginning, we let students speak freely about what they can see, and students respond [with various answers]. Then, regarding the pressing [of the bag], [the teacher asks] what can students notice; is it increasing, is it decreasing, or [does it remain] unchanged?

DSM: Is it increasing or is it acquiring more? Is it decreasing or is it acquiring less? Is it unchanged or [does it remain] constant? [A specific] amount of water or the volume of [the] water. Then, we must ask, for example, if students respond that, in the case [when] we [are] pressing it up, we must ask how is it increasing? Why is it increasing?

SSL: Even adults responded that it is increasing.

VNK: These three types of containers... we ask deeper follow-up questions, right? Whether it is increasing, decreasing, changing or not. Three types of this.

DSM: I mean that we will not ask a deep question at the beginning in case that concept has not yet been addressed or when students notice how the water is when we press the water bag. [We ask a deeper question] if students do not know how to respond. Some students may say it is getting more [water]. However, if [the desired answer] is not [being expressed], we need to investigate [with a] more in-depth question. Mostly, nonetheless, it is likely to come out as, “oh! it is increasing like this or like that.”

Discussion on students’ group activity: The previous discussion about three ways of presenting the water bag was for interacting with the whole class. The group members of TTC1-G1 then designed the students’ group work. In the original lesson plan made by the homeroom teacher, however, she did not mention group work at all. DSM pointed out that it must have included group work during the activity of pouring water into a different container (see D & E). Nevertheless, SDV, the director of the attached primary school, expressed her first comment in a discouraging way that students should only be allowed to observe, as with the first activity. The teacher should not allow students to pour water from the water bag into a bottle themselves because she worried the students would spill it and make the room dirty. DSM and SSL supported this idea of not conducting the group activity. However, SSL changed her mind, and VNK suggested using group work to deepen students’ understanding. VNK even compared it to primary students’ ability at Luang Prabang province where he used to participate in lesson study training. If the primary students in Luang Prabang province are able to do the activity, then their primary students can as well. Consequently, it seemed that all group members agreed to allow students a group activity. Still, the key question used to interact with students was the same as the previous activity, such as, “How is the water inside the plastic bag? Has it increased, decreased, or is it unchanged? Why?” The following excerpt demonstrates:

DSM: Teacher VNK, we must place students in group work…then distribute the materials, and students will notice water in the glass. This must be well explained to the students; otherwise, it will cause a problem. Because it is colored water, they might throw it at each other. [On the other hand], should we stop doing group work? We can even change the topic now, because if we let students pour water themselves, it would be difficult for them.

SDV: Therefore, the teacher should distribute to Grade 1 students, unlike Grades 4 & 5, and allow students to observe only. Is this suitable?

DSM: We change the container, right?

SDV: Additionally, when changing the container, the teacher should do [it themselves] and not let students pour the water. If students do [the pouring], [the classroom] will be dirty and wet.

SSL: If so, then the teacher [should] only show the activity to students, then representatives report [the results].

VNK: If only representatives [conduct the] report, this will correspond to our previous lesson study practice [that was conducted in 2018]. If [only] representatives [are selected] to work, other students [without a specified role] will not pay attention at all.

DSM: No representatives, no representatives. Students will, for example—if we do [the activity using a] big container—students [will] come and observe together. [There would be] no representatives, so each child will [be allowed to] say something.

SSL: But [doing group work] deepens students' understanding, right? So, [a group activity] is better.

VNK: But in Luang Prabang [province], students work in groups, and students can [still] respond.

SDV: Let us try [it this way,] then, but the important thing is [that] we must explain [it to] them clearly.

DSM: Let us try it out. Divide into 7 groups, [ensuring that] each group has 5 members. Then, [the] teacher explains materials [and] what we have... [water, etc.] and explains [this] to students before distributing it to them.

SDV: Distribute materials before explaining what to do, right? Because if we distribute materials first, students will only focus on the materials.

DSM: Sister, we must explain step-by-step, correct? For example, let students pour the water into the container after distributing the materials. Supposing that we have water in the glass, let students pour into a big glass; then, let students answer. "Watch this: after filling the water, is the water increased or decreased or unchanged," right?

SSL: The teacher introduces materials. Should we not let the teacher demonstrate first?

DSM: We have water, a glass, and a bowl. As we said, this is what is difficult. It is okay if we demonstrate [everything] for them at once. However, [the water] must pour into this and into the bowl. Let them [observe the] pouring [of the] water from the glass into the bowl... "How is the water? [Is it] increasing or decreasing?" However, our objective is to inform students that when we put the same amount of water into other containers, it will not be changed.

VNK: But students need to [be able to] give a reason [for this].

JNL: Yes, they must give a reason.

DSM: When asking, students must give a reason why it is increased, why it is decreased, because of what, [etc.] We must ask for the reason in each phenomenon. We should not ask children about the reason at the end [of the entire activity].

VNK: Yes, that is right. Discuss in pairs—increased, decreased, or unchanged, why, we must ask "why."

DSM: In each response, Sister, if students respond, we must ask why it is increased, decreased. When they pour into the glass, "is it increased, decreased, or unchanged."

Lesson conclusions: The group members designed the lesson to be concluded with the activity they completed with the class discussion and group work activity. They wanted students to speak out about what they learned in this lesson. Then, the teacher needed to emphasize that "although the size and the shape of the container is changed, the amount of water will not be changed." This is the most important sentence of this lesson, and it is the concept they want students to understand. The group members also discussed which content students would be taking notes. However, both VNK and SPC confirmed that the lesson had no intention for students to take notes—only experiment. Considering time-consumption and students' language ability limitation, the group finally agreed not to provide space for writing in this lesson. Traditionally, the style of a Lao lesson plan included an evaluation and homework; for this matter, their discussion did not happen. See the group's discussion below.

VNK: After that, the teacher concludes the students' activity. How will the teacher conclude?

DSM: Although the container is changed, the amount of water will not be changed.

VNK: In this lesson in the Grade 1 textbook, students will not write anything. Lao language does not recommend taking notes, only understanding its concept, correct?

SPC: Regarding Grade 1, for this lesson topic, students will not take notes; there is only the experiment and real practice.

VNK: Because?

SPC: Because it is not a calculating part.

VNK: As Prof. Noboru Saito stated to RIES (Research Institute for Educational Sciences), Grade 1 students focus more on students' thinking. Mainly, the number is what they want students to note. For Lao language, if it is not necessary; they will not allow students to write on the blackboard because students will waste time on writing Lao language. They are writing but drawing; some students do not even know how to read…

SPC: In real context, actually, for Lao students, we need students to write. If they do not write, they will not know.

VNK: Because of that, now, they reform new curriculum.

SPC: Otherwise, it will be incompatible with Lao language.

VNK: Okay, [the] teacher concludes that—restates not concludes; teacher restates, re-emphasizes.

DSM: It is conclusion, is it not? Conclude the activity regarding what we did, and then students will say "pouring water," "pouring something," those kinds of things.

SPC: The teacher concludes the activity that we have done, what we could see, what we have noticed.

DSM: [First, the teacher allows] students [to] say what they did today, then the teacher can suggest further.

VNK: There will be uproar; it is better if it is not wrong. What next? The teacher continues asking [about] the water we put in the container, the water from the plastic bag that we pour into the container.

DSM: Is it changed or unchanged? Like this, [do it] in a hurry.

…

DSM: The amount of water is changed or not; the teacher must emphasize the [point] that it is unchanged.

VNK: [...the] teacher re-states this [point], right; teacher emphasizes that although the shape of the water container is changed, the amount of water will not be changed. Teacher and students conclude the lesson together, and that is all. Is this acceptable?

On March 11, 2019, a day before the teaching, three MTEs (VNK, JNL, & PHT) held another meeting to prepare and test materials. They prepared seven plastic bags with yellow water inside, seven big cups, and seven plastic bottles (with around 1/4 of the bottles' cut out at the top). Those materials would be used corresponding to the group work activity. Unfortunately, the primary teacher (SPC) who would teach the lesson was not participating on that date. Therefore, there was some concern among the group members about if the lesson would be conducted smoothly or not.

5.1.2 Research lesson 1 of TTC1-G1

On March 12, 2019, the day of the teaching, SPC taught the lesson for approximately 45 minutes. She mainly followed the original lesson plan that she previously made and partially followed what the group collaboratively modified together. The teacher began by checking students' attendance. The total number of students in this class was 28, but seven were absent for this lesson. The teacher checked the organization of the students before the lesson began. The teacher asked, "What is the subject today? What is today's date?" Then, she checked and scored previous homework for those who completed it. Next, she wrote the title, "Lesson 13, quantity comparison," on the chalkboard. The teacher asked, "Do you know what quantity comparison is?" Then, the teacher continued by asking, "Did you drink water in your home? When you first woke up, did you drink water? How many glasses of water did you drink?" Students randomly answered "1," "2," and "10" glasses of water. The teacher reminded students that they should drink water after eating. The teacher then immediately revealed a water bag and asked, "Have you ever seen this? What is this?" "It is water, yellow water," students replied. "What is the color of the water? Could we drink it? No, it was a poison," the teacher asked and replied herself. The teacher reminded students that this water could not be drunk. Then, the teacher continued asking a series of questions: "What is the amount of this water? Small amount or large amount? What is the shape of this water? What is the characteristic of the water? What do you see? How is the water? Where is the water?" The teacher asked students to notice and answer her questions. The teacher repeated those questions several times: "Do you understand what the characteristic of the water is? What was the shape of water? Where was the water? Now, if I pressed its bottom up, the water would be greater. If I held the water bag, it was increasing." The teacher asked several questions besides what was designed in the lesson plan. The teacher kept saying, "Why is the water increased when I pressed the bottom up? If it was a small amount of water, what does it mean? Could I say it was decreased? If the water was going up, we said it was increased. If the water was going down, we said it was decreased." This was the introduction for the lesson. Afterward, the teacher moved on to the main activity. She distributed a set of materials to all groups of students with the help of the group members.

Before allowing students to practice the activity, the teacher asked students, “How was the water? If an equal amount of the water was put into the different sized containers, was there any change? It was increasing, decreasing—how was it changed? Let us work in groups, then, each group will explain to me.”

Figure 21. Student activity in research lesson 1

Then, the teacher explained how to perform the activity. She emphasized that “when putting the yellow water from the water bag into a small glass, how was it? When putting it into the large glass, how was it?” Each group was expected to report the result to the teacher. After this, the teacher allowed the students to pour water themselves. At first, the teacher suggested students to pour into the big container (see Figure 21). The teacher interfered with students by asking, “How was the water, less or more? Increased or decreased?” Then, students were asked to pour from the large cut bottle into the small cut bottle. Again, the teacher interfered by asking, “How was the amount of water, less or more? Increased or decreased?” The teacher then asked each group to report. Unfortunately, there was no volunteer. Therefore, the teacher had to call on someone by name. The teacher called the first student, Putha (pseudonym), to report their group work in front of the others. The teacher asked her, “When putting the water into the big cup, how was the water?” “It was small,” the girl replied. “When putting the water into the small cup, how was the water?” the teacher asked, and the girl said, “Lots.” The teacher continued asking, “Why [was there] less and more water? Why?” The girl replied that it was “because the big cup is big, so there was a [smaller amount of] water. The cup was small, so there was more water.” The teacher tried to assist Puttha to provide the desired answer, explaining that “if [you are] putting the water into the big cup, it is decreased.

If [you are] putting into the small cup, it is increased." The teacher selected another girl, Budsa (pseudonym), to confirm. The same questions and responses were pointed out. Before selecting another student, the teacher kept repeating this expression. She emphasized that "putting the water into the big cup, the water will be decreased, [and when] pouring the water into the small cup, the water will be increased." Then, the teacher selected a boy to answer the question. First, the teacher demonstrated by pouring the water into the big cup and asked the boy, Chantha (pseudonym), "How is the water?" The teacher emphasized that "if the [water is put in the] big cup, then it is decreased. If [it is in the] small cup, then it is increased." After the group report was completed, the teacher concluded with the reason the water was changing when the same amount of water was poured into the different containers. This was because the water changed its shape according to the shape of the containers. If the container were small and long, then it would be increased according to the shape of the object. However, the amount of the water remained the same. The teacher noted that the water would not have gone anywhere; the container was big, so the water was decreased according to the shape of the object, but the volume of the water would remain the same.

5.1.3 Post-lesson discussion 1 of TTC1-G1

There were ten participants in Reflection 1 (5 MTEs, 2 pri-Ts, 1 representative from provincial educational bureau, and 2 JOCVs). As soon as the research lesson was finished, all MTEs and observers engaged in a reflection session in the attached school's office. The discussion lasted approximately 38 minutes. Firstly, the teacher who taught the lesson expressed that the lesson was not going smoothly; it stalled sometimes, and the lesson was about 70-80% successful. Then, other observers expressed their ideas based on what they saw. Most of the reflections focused on the questions the teacher asked students. For example, the teacher emphasized the same questions excessively. The question was overly broad that Grade 1 students could not answer, etc. The reasons why SPC received these kinds of comments might be because she did not follow the lesson plan that the group made. Consequently, many points of criticism regarding her teaching were mentioned, and she accepted those comments with a kind attitude. The group members confessed that the latest lesson plan was not given to the teacher, and she did not ask for it from the group members. Thus, that day's lesson was conducted in such way. Actually, the newest lesson plan was uploaded to the messenger group on the date of the lesson plan creation, March 7, 2019; SPC, who taught the lesson, knew that, but she said her office in the attached primary school did not have internet. Thus, what the group planned was not conducted yet. Their discussion on the post-lesson peflection 1 is as follows.

KON: What is the objective of today's lesson?

VNK: Only knowing unchanged quantity; pouring water into any shape of containers, the amount of water will be unchanged.

VNK: Based on your observation today, what did you see and discover? First, the teacher who taught the lesson reflects herself. Actually, I forgot to print out the lesson plan for her yesterday. Did you read [via a] computer?

SPC: No, I followed what I had previously planned. First, I would like to show my respect to this meeting. As for today's teaching, I do not know how [effective] it was; it was not 100[%]. It is uneven. Students do not know what is wrong either. It is [as if it was] unprepared. (laughs) I am worried about several things; there are several works, so it is not 100[%]. I thought it [was] not 100. However, I did [the best] I could do. My teaching—I cannot avoid shortcomings; everything should be correct and incorrect. [On a positive note, there were] many things students [understood] well. When doing [this] activity, some students do not understand [it]; they still talk to each other. It might be their behavior. I also did not understand this point in-depth. I regarded that this teaching is followed as the goal [is set], but it [did not reach] 100%, [but approximately] 70-80%. This [concludes] all of my comments. [I would appreciate other members'] comments [regarding my teaching] because I could not see my weakness [to know] which one is wrong, which one is correct. I rely on others' comments so that I will know where to improve myself.

VNK: Next, let others comment [on] her [instruction], starting with Ms. PTH.

PTH: I saw students remained noisy.

VNK: How about [a positive observation]?

PTH: [Positive observation], right. Students observed two things regarding more volume and less volume.

SPC: How about for improvement?

PTH: (silent)

JNL: The [positive note] is that the teacher follows the teaching steps, well receiving students' attention. There is a question, there is an answer, and there is participation of both teacher and students. There is also a small point to improve [upon]. I feel that the teacher repeats the same questions too often, because—at the beginning—the teacher asks what students can see, what the characteristic is. Students show interest, and respond in several ways. However, when the teacher asks the same questions repeatedly, then students lay down on the table…the teacher repeats the same questions too often, and they already answered; they do not want to say the same thing. The question is hard to understand as the teacher said, "What is the characteristic of the water?" Students do not know what context the question is implying. We only want students to say the color of the water, but the teacher asked the characteristic of the water, so students do not know how to respond.

DSM reflected on positives for SPC that students were well cooperative. They were quite responsive to the teacher's questions. The transitioning question about drinking water after a meal was well linked to daily life. The teaching-learning materials were well-prepared. Regarding the weak points, she also agreed with Ms. JNL. She added that the question was overly difficult and broad. Actually, the intention of asking about the water was simply to obtain students' responses about (a) where the water was and (b) what the color of the water inside the plastic bag was. Students sometimes did not know how to answer—if the water was increasing or decreasing—because there was not something in which to compare it. There was a lack of additional deeper questions to further investigate if students responded as the water was increasing, where the water came from, and if it decreased when the water was poured out. She further suggested that the teacher should not ask about increasing or decreasing until completing the demonstrations of all three types of the rotating water bag. DSM could see that students could grasp the concept of the amount of water when it was poured into a large and small container. The following is the details of DMS' reflections.

DSM: Today's teaching was the consequence of our lesson planning. Actually, it was our mistake not printing out the lesson plan. Regarding the materials, we sometimes did not have it all set because there should be three types for pouring water in. [We] wanted to see the comparison of these three types but we did not have a bowl as we discussed during planning. It was okay, though; we could still see the procedure... [There were] several good points. Students were quite collaborative; when the teacher asked some questions, students responded lively. They also had various responses. It was sometimes beyond our expectations. For example, "Did you drink water when you were at home?" "Yes, two to three glasses of water," students responded. The teacher also educated students that they should drink water after having a meal. Our materials were also well prepared, to some extent, despite the teacher humbly mentioning that it was not thoroughly ready. It was well done. However, there were some weaknesses, and I agreed with Ms. JNL's comments. The question was difficult [for them], but some students could answer. "Where is the water?" "It is in the sea," students replied. Sometimes our question was probably too broad and overly difficult. For example, "What is the characteristic of water?" I also thought [about] what kind of answer we expected from students; that is why we had to point out what was in this plastic bag and what is its color? Actually, students have already responded to all of those things. Therefore, we probably need not ask but continue with the next activity immediately, [because] the more the teacher asked, the fewer students would respond. Furthermore, students [regarding what students said about] more or less amounts of water, sometimes they did not know how to answer because there was nothing to compare with. If answering as "less amount of water," [what would this be] based on? If answering as [a great amount of water], then in which unit [would we] compare with? [We probably] do not need to ask until [we] finish all three processes, such as pressing the bottom up, putting [the bag] on the palm, and putting [it] on the tray. Then, the teacher could ask students if it contained less or more water. Nonetheless, the teacher might forget the objective we wanted to obtain, such as with the same amount of water: when it changes its shape when pressing, putting on the palm, or the tray; increasing, decreasing, or unchanged. Actually, with the same amount of water, even if we changed its shape, the amount of water remained unchanged…In the last activity, I was quite worried [the water] would be spilled out, but students did well…When they poured the water into the small glass, students responded well. The teacher asked why the water has a small amount because it is the large glass; why it has a greater amount of water, because the glass is small. Actually, the amount of water was unchanged. Students also understood that, when putting water into something small, its level would be increased because of its narrow area. However, we should focus more on the amount of water. For example, if it is increasing, where does the water come from? We must probe students further. If we ask more specific questions, there would be someone saying that word [unchanged]…we must compare the words "less amount" or "more amount" of water; [we] wanted to lead to the academic word. Less or more water is general [expression] but in mathematics, getting a greater amount of water means [it is] "increasing." Perhaps, the teacher wanted to reach the word "decreasing" but children did not know what the word "decreasing" was. Overall, today's teaching was well done [considering what was] expected.

Typically, the comments by VNK were also focused on good points and weaknesses, as JNL and DSM provided. Regarding the good points, he mentioned that the day's teaching was done well. Students responded well to the teacher's questions. Although the teacher did not have the modified lesson plan, the teaching still followed its direction. Nonetheless, there was still the weak point regarding the main question that was missing in this lesson. He also agreed to the comments of both JNL and DSM that the teacher's question was not specific or clear. Although all students observed the activity, they did not discuss with each other. For future improvement, each student in the group should be assigned a duty to address each material in the activity. VNK believed that this would increase students' discussions on the given activity. The details of his reflection are shown below:

VNK: Alright, I would like to give some comments. Today's teaching is close to the lesson we planned, correct? [I] have never thought that students would respond like this. Today's teaching is regarded as good teaching. Students are quite responsive to the teacher's questions and answer well based on their experience in daily life. However, it is okay [that it did not go as expected]; we never expect that students will answer this much. This is already good despite not printing out the lesson plan, [because] today's teaching is still following the modified lesson plan's direction. However, some main questions for students to consider are missing …I also agree with DSM's and JNL's comments that the question is unclear, the question [that the teacher] asks the students. [Additionally], when conducting the activity, when pouring the water, all students notice it. However, each student's discussion with the group is missing. They only put the water into [the objects] and only say it has a little water, it has more water, and some students do not speak at all—only observe. I think if we [use bottles in the materials the next time], [students] are responsible for this bottle. One [student] should be responsible for this bottle, and then explain how it is; give more duties to them. Doing so, I think there might be that word. I think I want to add this point.

After the additions of VNK, JOCV offered some comments to this lesson in three typical ways: good points, weak points, and suggestions for improvement. First, he provided positive comments about materials use and the explanation of the water regarding if it was drinkable or undrinkable. His negative point was that the long explanation of the teacher bored the students; the students had not reason to do the activity. He suggested further improvement could be made by drawing some figures on the blackboard, giving students a chance to write questions and conclusions. The teacher should also keep the materials after the activity is over. The excerpt of JOCV's comments is as follows:

JOCV: The teacher [used the materials] well. First, the teacher shows the water bag to students; this part is great. The teacher said this water cannot [be drunk]. This expression is also excellent; it is very important… However, the teacher's explanation is too long. Students listen and want to sleep, [because] they want to do the activity… The teacher should draw [some figures] on the blackboard [regarding] which one is bigger, then, move to the next activity. As I draw here, this is a big cup and a small cup. Then, the teacher draws on the blackboard to compare the cups (see Figure 22). If time allows, it would be better to let students write the questions and conclusions [in their notebooks]. When the activity is completed, the teacher should keep the materials, because students want to play with it.

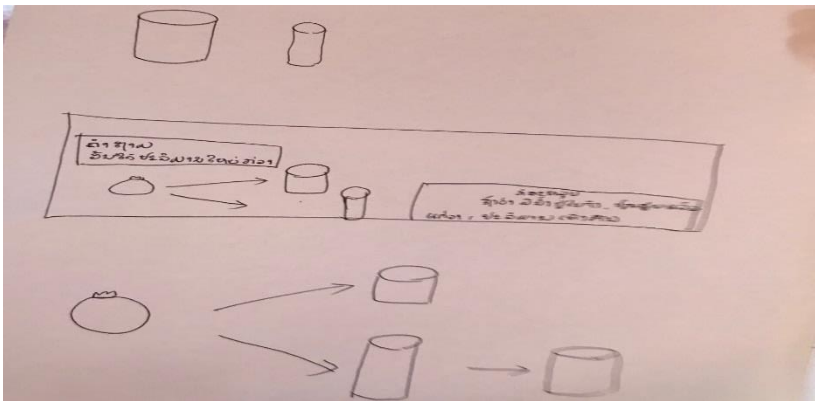


Figure 22. Drawing figure suggested by JOCV

SDV: What I wanted to say has already been said by others. First, I agree with all of the comments. Through my observation, it is good in general; we [did] as we prepared… However, I have some additional points… Before the activity, [would it be helpful] to discuss the materials first [and ask], "What is this?" We want to have a conversation with students. We want to compare the materials, [have them consider] is there any difference between two objects so that we can [relate this] to the point that, water—its amount—is unchanged, but it is changed based on the characteristic [of the different shapes of the containers]. I have only this point to share; for other points, I do agree with others.

DSM: When we are planning the lesson, we have already discussed that we must introduce the materials before [conducting the activity]. We have a glass of water.

SDV: [This] means that we forgot, right.

VNK: When I reached home, [I asked myself,] “What have I forgotten? Actually, I forgot to print out the lesson plan.”

SDV: It is beneficial, [despite not having a] lesson plan, [because] the teacher can teach every step.

VNK: No, we plan together, but it is also going well in the same direction, just forgetting some parts.

KON: … The [positive note] is that the teacher paid sufficient attention. The teacher is well prepared; although our group forgot to bring the lesson plan, the teacher teaches what is planned. This is regarded as the great point. All materials are well prepared for students, and students are quite excited to use the materials because they can touch the actual objects, practice, [and] they can do the experiment. When students make noise, the teacher can also [gain] control; all students sit tight [and] become quiet. This is [a positive] … However, before going through the activity of pouring water, [I] want students to manipulate [the water bag] or hold it themselves. Maybe our teacher holds the water bag up and explains this, but students do not have a chance to touch it to feel how it is… After that, if [students] pour into these two containers, “How is the amount of water? Does it change? [Has it] increased or decreased, and why?” The teacher should ask [them using] “more or less,” [because] students do not understand “increasing or decreasing,” “a little water or more water.” However, when they put [the water] in a glass, [they say,] “Oh! The level of water is high.” They will say “a lot of water”; when they put [the water] in this large glass, then it “has a little.” Therefore, students still cannot answer [our goal regarding] whether it has a small or large amount of water. However, students can answer that when using two water containers, [because] they see the level of the water is high; then, they can answer. Nonetheless, it does not matter; students will continue their interest in the next activity. The teacher may use this comparison. Because today is allowing students to have actual practice, conduct the experiment, experiment with how this water is, students also see a small and large amount of water. In fact, when the objects or containers are changed but the amount of water [remains the same], when the teacher teaches next lesson, “Oh! On that day you [students] said the water is increased-decreased. Is it really true? Let us [prove] it together” …. For me, if I teach, the question will be asked in this way.

VNK: This [lesson’s objective] is to get these three things [increased, decreased, unchanged] …only ask why it is increased or decreased.

BNK: Through my observation, you have done well. [I] have only some [comments] such as when you introduce [the water bag] at the beginning, we already know that the amount of water given to each group is the same amount. So, if possible, let students notice all three to four water bags to see that the amount of water is the same in each. We know that water has no color, no smell, no taste; it is changing [depending] on its container. Now, at the end [of the lesson], the teacher picks up only one point [or one example]. Actually, we already have all materials; however, when the teacher demonstrates and concludes, it appears that the teacher only uses one glass with filled with water and one empty glass. This makes [it difficult for students to answer]. So, the large glass has water and the small glass has water; then compare them together, show them at the end… [then, students actually] understand what to say… I have only that point; for the rest, I do agree with other teachers. The teacher is well prepared, [has] good materials, [and] only needs [improvement regarding] the questions. Just taking what we want as our objective would be enough.

5.1.4 Lesson planning 2 of TTC1-G1

The members of TTC1-G1 continued planning the second lesson on March 13, 2019. Six teachers (4 MTEs and 2 primary teachers) participated on this date. This second lesson was supposed to be taught on March 14, 2019. To be consistent with the regular curriculum, however, the group agreed to skip this lesson on March 14 but conduct exercises instead. Therefore, this second lesson was taught on March 15, 2019, continuing from the previous Lesson 13, quantity comparison (cont.). Just as with the first lesson planning, VNK acted as group leader as well as the member who typed the lesson plan on his PC. SPC, the homeroom teacher, was selected again to implement the lesson, while DSM, KON, JNL, and SDV assisted in sharing ideas and preparing the materials. Based on the teaching guidebook, the main objective was the same as the first lesson, but it also had a specific sub-objective about comparing the quantity (volume) in a direct and indirect way (see Figure 23).

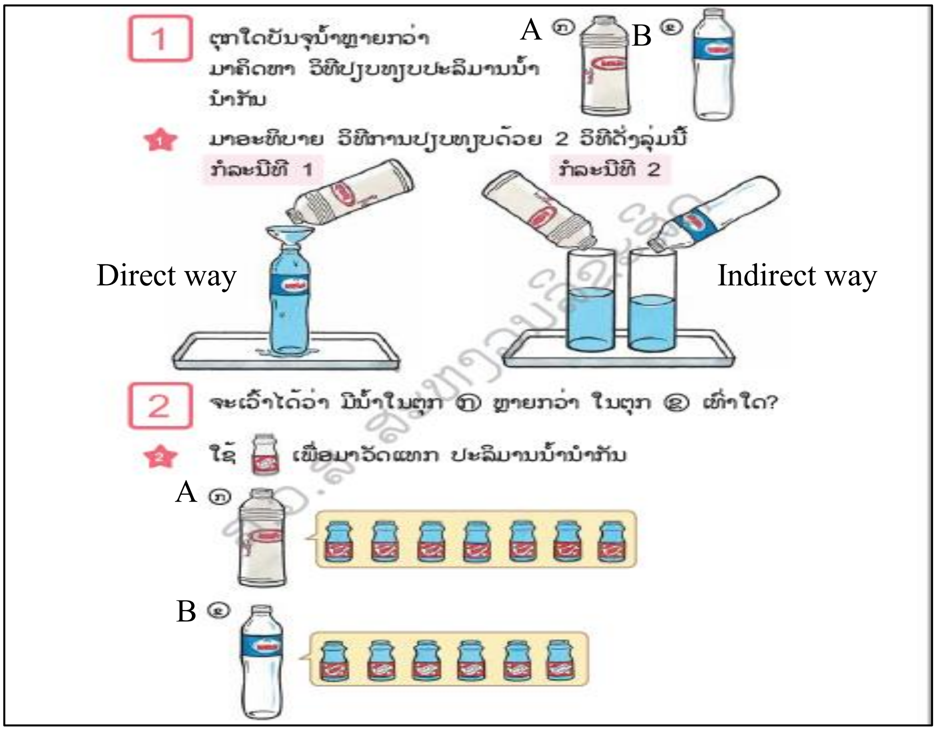


Figure 23. Direct and indirect comparison (MoES, 2017, p. 112)

The group members started the discussion about the materials. They considered using two different plastic bottles: A and B. Bottle A contains a volume of 700 ml, but they had difficulty obtaining slightly less than 700 ml for Bottle B. Initially, the group members considered dividing the students into seven groups and conducting a real comparison using concrete materials. They even estimated 15 plastic bottles for one group (2 big bottles and 13 small bottles) if they followed the Figure 23. In total, they would need around 105 plastic bottles (14 big bottles and 91 small bottles). The following details their conversation (please see Appendix F for full discussion).

DSM: Separate [students] into groups.

KON: Dividing [students] into groups is also good.

DSM: But our materials will not be enough.

VNK: Our materials are not enough. If we do not have enough materials, then [we must determine] what to do when [we are] demonstrating in the middle of the class. What should we do? Let students see this one at first [to observe] how much it has.

DSM: No, demonstrating in front of the class would be fine. Then, let each group come and see.

SDV: Will it be noisy?

SPC: It will be noisy.

KON: [We] should have enough equipment so that they can practice at the same time. [Then,] they are able to manipulate it, they have fun, then [we can] buy more packages.

JNL: One pack has six bottles.

KON: How many [do we need in total]?

SPC: Almost 22 bottles.

VNK: Now, one bottle [700 ml], how many cups is it? 4 cups?

JNL: Seven groups.

VNK: The same as usual.

JNL: Two, four, six here—each group [will] use 2 packs.

KON: Or should we cut the small bottle, [and] we give an assignment to our group members [regarding] who will cut it, who will buy it.

JNL: [I have these small bottles] because there was a wedding party behind my house.

SDV: Right—please collect it, then.

SPC: About 100 bottles.

JNL: One group needs 15 small bottles.

SPC: 7 x 15 = 105, one hundred [bottles]; 7 groups, it is enough.

VNK: Now, [should we use] this bottle [700ml] or a bigger bottle? If [we use a] bigger one, then we must use many small bottles.

DSM: [We should use] the bigger bottles, because three big bottles is enough, [and] we only want to know the comparison.

JNL: It means that we must follow the textbook?

SPC: We divide students into three groups.

JNL: Too many [students per group], SPC teacher.

DSM: They will not pay attention at all.

The group members continued discussing the materials and the students' group work because they still wanted them to manipulate the materials to perform a comparison using the actual objects. Nonetheless, VNK, the leader of the group, did not agree with the idea; he only wanted to have a questions-answers interaction between the teacher and the students. He argued that the teacher should occupy all demonstrations because he learned from the experience of a previous lesson that students would gain nothing if they manipulate the materials themselves. Their dialogue about this is illustrated below.

VNK: Mostly, the overall process of this lesson is only emphasizing asking-answering and conversation with students. If we do that, students will understand nothing at the end, similar to what we did on Tuesday (March 12, 2019).

KON: "Students, because the water is overflowing, it means that Bottle A has more water than Bottle B." If students can answer… then we can move on. If students cannot answer, then [we] have to ask why they responded that way, why it comes out this way—why.

VNK: So, here, we do not use student group work, right? The main process is the question, correct? Now, we will do [this] in a group?

KON: Working in groups is allowing students to have a real experiment, then, what can students acquire?

SPC: They will [develop] conversation with each other.

VNK: Because we saw the result from last Monday.

KON: If [we are] showing the bottle, [we] must show it [high] enough for students to see it; do not show it at a low level.

VNK: If the teacher starts the discussion [with students], the teacher will start with these two bottles, right? Whether which one has more or less volume than each other, correct? Let students guess: "Who thinks this bottle has more volume? Raise your hands up."

KON: And [ask] why [students think so]?

VNK: "Now, how can we know which one has more or less [volume]?" Mostly, it is the process of thinking that we want students to achieve. After that, what should we do to elicit students' ideas? Fill [the water in] it, then [begin] comparing the direct-indirect ways. This one—I think it would be better if the teacher demonstrates [the comparison] then asks some questions [to students]. Students do, we do; while they are doing, they will listen to our questions.

As a result, the group tried not to discuss the group work and acquired hundreds of plastic bottles to use as a unit to measure the amount of water. Rather, they were focusing on designing what questions to ask students in each teaching step. Additionally, KON found one statement mentioned in the teaching guidebook, stating that "if the students cannot think of it [which bottle contains more water than which bottle], the teacher [must] demonstrate [the] comparison straightforwardly, then demonstrates indirect comparison" afterward (MoES, 2017, p. 138). Therefore, the group members started considering what should be included when reviewing the previous lesson and lesson development, while the conclusion, evaluation, and homework portions were not yet discussed at this planning discussion meeting.

The group members considered what was taught on March 12, 2019 to review the previous lesson, which concerned putting the same amount of water into different shaped containers in which the amount of the water would be unchanged. The group was aware of previous comments from JOCV (reminding students about undrinkable water), SDV (describing the materials before distributing to students), and KON's comments (allowing students to manipulate the materials before demonstration). In this planning session, SPC did not fully join the discussion; she sometimes left the room because she had an additional class during this period. Once she arrived, VNK and others reviewed with her what they had planned, as below:

VNK: Here, I would like to review [what we have discussed]. The teacher holds up the colored water in the plastic bag and warns students not to drink it for a safety reason. The teacher asks students to jot down what they see and encourages them to answer. Then, the teacher pours the colored water into the Betagen bottle (Bottle A) and asks students, "How is the water?" If it is not appearing from the students' [ideas], we ask [them], "is the water changing?" We will relate to the previous lesson, [asking them] "is the water changing?" It means that it is increasing or decreasing from the original amount. [Alternatively,] we ask in three questions, such as "is the water increasing, decreasing, or unchanged?" For connection [from the previous lesson review to the new lesson], the teacher uses the Betagen bottle and the water.

DSM: Please make it loose and let the air out [from the plastic bag].

KON: After tightening [the water bag], then immediately demonstrate it. Squeeze it and say, is it a lot of water? … press the water bag [and ask], "Who agrees that the water is increasing? See, it is the same. It is the same water. Yes, it is. Please understand that it is only a shape; the water is still the same. It is not increasing. If we add more, and then it will be increasing. It is not coming from the sky; it is here. It is not going anywhere. Now, I [the teacher] want to know what do you [the students] think—will it be full? Please try to think. Please make a guess. Is it full or has it overflowed? Let us see together. Let us get started." The children will be interested. "Now, we have two bottles.

[Which bottle] do you [the students] think has a small or large amount of water? This one is taller, while this one is larger. What do you think?"

Of the main activity in the lesson development stage, KON described how the teacher would teach the lesson. He seemed to want students to know the direct and indirect comparison by manipulating the materials themselves using the teacher as the facilitator. However, VNK implicitly mentioned that this kind of measuring the amount of the water using a small bottle as a unit would be taught after this lesson. DSM claimed that they did not have enough bottles. Therefore, the group continued designing the questions to interact with the students in their own way but not following KON's suggestions. They sequenced the lesson in the following way. Firstly, the teacher would hold up the water bag to discuss increasing, decreasing, and unchanged statuses before concluding that the amount of the water was unchanged. Secondly, the teacher would allow students to notice the empty bottles to see similarities and differences among them. Each demonstration would be integrated by a series of questions. Thirdly, the teacher would fill Bottle A with the water to discuss direct and indirect comparison. Because of the time limitation, this lesson plan had not yet been completed at this session. The remaining parts such as the main activity, conclusion, evaluation, and homework would be continued the following day. Before closing this session, VNK reminded other members that there would be a trial lesson on March 14, 2019 that SPC would demonstrate. Some excerpts of their discussions are presented below:

DSM: How are the bottles [A and B] are different?

KON: Large bottle, small bottle, long bottle. "Alright, how about you? How are they different?" After that, "Who agrees Bottle A has more volume? Why? Why do you think so?" The answer depends on the students' ideas. "Now, let us see which one will contain a larger amount [of water] than others. What will you do [in order to know that]?" Now, it is time for the children to think… I think of pouring this bottle into this bottle (he anticipated students' answer), supposing that this is students' idea. Then, it would be good if they can consider it. Some children might say, "Put the two bottles near each other," or should we set it up for them? After students' thoughts [regarding if] this one has less or more water... "Okay, let us see together which one has more or less [water]." Now, the teacher demonstrates, right? "Let us observe together. Okay, children, these two bottles have equal size. Which one contains a larger amount of water? This one belongs to this one; this one belongs to this one; 'Ah! It is equal. This one has more [than others].'" Then, the teacher says, "this is a direct comparison or indirect comparison," right?

JNL: No, we are not telling [the students] if it is direct or indirect. [We are] just informing [them about] "more or less."

SPC: [We are asking] in what way students know, correct? As you know how students know—we know from the inside—we are not asking if this is a direct or indirect comparison; we are not asking that way.

JNL: Only quantity comparison.

KON: Oh! Students must know direct and indirect way.

VNK: No. Students know it, but in their thinking process, whatever method they use to compare [depends on them]. They will put two bottles [near] each other, or dividing into several small bottles is okay; it is up to them. However, when we conclude it, we take those ideas; we take this student's method, that student's method, then, [consider] are these two methods different? However, [it] has the same answer. Thus, it is regarded that this method is a direct comparison while the other is an indirect comparison.

… …

VNK: In this lesson, students want to know which one has more or less [amount of water]. Of course, they will notice based on the teacher's demonstration.

KON: However, for the rest, students will conduct real practice. How is it going in the exercise?

VNK: For the real practice, they will [certainly] do it, but this lesson is only one hour.

KON: Okay, we only teach this, right? However, in the next lesson, let us recommend SPC to teach this one [real comparison], suggest students to bring small bottles with them, every student should bring [bottles]…

On March 14, 2019, five MTEs (VNK, SSL, JNL, DSM, & KON) and two primary teachers (SPC & SDV) participated. SSL was a member of the team, but she did not regularly participate. VNK expected to have a trial lesson on this date; in fact, there was no teaching demonstration; instead, they continued planning the lesson of what remained from the previous day. The group designed a storyline to interact with the students. They designed a series of questions to handle the possible responses from the students based on the group's anticipation. Their concept of this lesson could be summarized in the following four steps. Firstly, they wanted to discuss the two bottles, A and B, and which one had more or less water. The students would make a guess based on their visual observations without touching it. Secondly, the teacher would ask about the method students used to determine if Bottle A contains more or less water than Bottle B. Thirdly, the teacher would demonstrate the comparison by pouring the water directly from Bottle A into Bottle B. The teacher might ask why the water overflowed. If it was overflowed, as SPC adds, "What does it mean?" Finally, the teacher would demonstrate by pouring the water into Bottles A and B, following with some questions. As VNK said, "Now, the teacher demonstrates indirect comparison by [pouring] the water into the two bottles… then, the teacher says, '[They are] the same type of containers but contain [a] different level of water.'" "Why do we have to tell them? Let them [determine] themselves how it is going," JNL responded. Then, the group briefly discussed how to conclude this lesson. However, the group did not consider much regarding the concluding and evaluating parts. Some of their discussions on this portion are shown in the below dialogue (please see Appendix F for full discussion):

KON: Put the water into those two bottles.

SPC: And then asks students that.

VNK: Which bottle has more water, Bottle A or Bottle B?

KON: [Which bottle] do you (students) think has more water than [the other]?

SDV: It depends on their answers.

VNK: Question 4 (Q4) is, "How do you know," right? By putting it next to each other; by comparing it. Now, we want the word, "comparison," to come from the students, [but] will they be able to say it?

KON: They do not even understand the word, "comparison."

VNK: As I said, [how do we determine] that? How do you know that?

KON: The teacher has already taught about comparison, correct?

JNL: They do not even understand the word, "comparison," yet.

VNK: Now, we want to get [this response] from students' ideas.

SPC: We want to get the exact word, "comparison." Let them say the word, "comparison."

… …

DSM: We want to know only two bottles, Sister SPC, when you pour out water from the big bottle to the smaller bottle and it will be overflowed.

KON: Well, if it is overflowed, then how [will the] student answer that?

DSM: Well, if it is overflowed, then you should ask [students], "Why is it overflowed?"

VNK: "It is overflowed." What does it mean?

DSM: The one (Bottle B) that is overflowed means that this one (Bottle A) contains more water. We want to get that response. We only have this, right… Actually, these [are] not necessary; simply reviewing the previous lesson would already be enough.

… …

VNK: Now, the teacher demonstrates indirect comparison by filling in the water into the two bottles… Then, the teacher says, "[These are] the same type of container but contain different levels of water," right.

JNL: Why do we have to tell them? Let them notice [this] themselves.

DSM: As demonstrated yesterday, [we] pour water from this bottle to this bottle, then [ask], "Which one has more water?"

VNK: Alright, alright. The teacher demonstrates indirect comparison by pouring the water into the similar containers and asks that.

SPC: "How is the water?"

VNK: "Notice, how is the water?"

DSM: Just [ask] which one has more. "Which one contains more water?"

… …

VNK: Okay, only that, right? Next, [we] move to the conclusion. Our conclusion is that we recap the activity we have completed. "What have we done today? How do [we] know which bottle contains more water than another?" Let them repeat, right? [Then,] the teacher briefly says that if we want to know which bottle contains [a larger] amount of water than another, [we] must compare, [in a] direct and indirect way…the teacher concludes what has been demonstrated and reveals the answer at that time, as well.

KON: For the exercise, then, let students compare [in a] direct and indirect way.

VNK: For [the] evaluation, the teacher allows one to two volunteers to explain the comparison.

KON: Okay, allow only one to two students, right?

VNK: Because when we (students) do the activity, it is also [an] evaluation. Regarding the homework, we take the original words from SPC.

5.1.5 Research lesson 2 of TTC1-G1

On March 15, 2019, the day of teaching the second research lesson, there were only three MTEs who observed the class, including JNL, PHT, and VNK. Two other MTEs, DSM and SSL, attended another training, while KON and SDV were busy with family matters. The researcher also did not observe the lesson because he observed the TTC1-G2 conducted the same date and time (see appendix C). However, he recorded the video and reviewed it the following day. In reviewing the videos, the researcher noticed that the lesson was conducted similarly to the teaching of the first research lesson conducted on March 12, 2019.

SPC started the class by checking who was absent. In this lesson, three students were absent. She then asked the students about the date, subject, and lesson unit. This lesson continued from the previous lesson unit—Lesson 13, quantity comparison (cont.). Then, the teacher spent approximately 10 minutes reviewing the previous lesson by asking about the yellow water in the plastic bag. The teacher warned the students not to drink this water. She then asked if it was increasing when the teacher pushed the bottom of the bag up, if it was decreasing when the teacher released the bag's bottom, or if it remained unchanged. For those expressions, the teacher asked for a reason why, as demonstrated in the following conversation:

Teacher: If water of Oishii then we can drink, correct? If it [has a] color, can we drink?

Students: No.

Teacher: If Oishii, then, we can drink it. If [you look at] this water in this plastic bag, [what does its shape look] like?

Students: Small.

Teacher: Small. If I press its bottom up, how is the water?

Students: Large.

Teacher: Large. Is it a large [appearance]?

Students: Large.

Teacher: Large. Where does it come from? Why is it larger?

One Student: Because the teacher pressed its bottom up.

Teacher: Because teacher pressed its bottom up. Then, how [does it affect the water]?

Students: [It makes it] more.

Teacher: If I release its bottom, how is it?

Students: Small.

Teacher: Is it changing or not changing?

Students: Changing.

Then, the teacher concluded the reviewing of the previous lesson:

> But, children, this—the water is the same quantity. Why is it large? Because the teacher presses its bottom up, right? But the amount of this water is not changing; it depends on the object that contains it. [When] water is in the larger object, then it will be decreased. If [its container] is small, it will be increased, right? It will be more or increasing if the

container is big. If [the container] is large, [water] will be decreased. Do you understand, children? If you understand, then, we will learn the next topic.

Then, the teacher moved on to the main activity. She warned students to be quiet before showing the two empty bottles. One was an empty milk bottle and the other was an empty water bottle. After that, she had conversation with the students for approximately 10 minutes regarding these empty bottles. She asked the students to compare using their eyes and tries to answer the teacher's question, "Please notice which bottle is bigger, which bottle is smaller?" Then, the students replied; some said "water bottle," and some said "milk bottle." The reasons the students gave to the teacher were "the milk bottle was big, fat" while the water bottle was "slim and tall." The teacher still kept asking the same questions repeatedly. The following are the excerpts of their conversation.

Teacher:	... the milk bottle, how was it?
Students:	Short, big.
Teacher:	Short. How is the water bottle? Please answer all together.
Students:	The water bottle is long.
Teacher:	How is the milk bottle?
Students:	It is short.
Teacher:	How about this one? The water bottle is small, and the milk bottle is big, correct?
Students:	No.
Teacher:	Please answer together which bottle is big or small.
Students:	The water bottle is small; the milk bottle is shorter.

Then, the teacher immediately asked a question for students to predict that "if teacher pours water into these two bottles, which bottle do you think will contain more water than the other?" The teacher then showed two bottles full of water. The teacher asked the students to raise their hands if they thought the water bottle was bigger than the milk bottle. Nearly every student raised his or her hands. Only one student raised his hand for the second bottle (milk bottle). Then, the teacher demonstrated to confirm her question. She poured water from the milk bottle into the (cut) Bottle A; then, she poured water from the water bottle into the (cut) Bottle B. These two cut bottles, A and B, were the same size and height. Then, the teacher demonstrated by pouring the water into those bottles. Apparently, one boy said, "Bottle A has more, teacher," as illustrated in the conversation below:

Student:	A has more, teacher.
Teacher:	(laughs) Okay, who notices what?
Students:	A has more water. (in unison)
Teacher:	A-HA—Bottle A has more water than Bottle…
Students:	B.
teacher:	Is it?
Students:	Yes.
Teacher:	Whose answer is correct?
Students:	Putsadi. (in unison)
Teacher:	Why does it have more water, then?
One girl:	Because the milk bottle is fat.
Teacher:	Because the milk bottle is fat. How about this tiger head bottle?
Students:	Slim (in unison).

The teacher and students already correctly answered that Bottle A contained more water than Bottle B, because they observed those two cut bottles that the teacher just recently put the water in. However, the teacher was still searching for two students to confirm. She asked, "Why [does it have] more water than [the other], why? Please stand up. Why does it have more water? Why, because A and B are how? How is Bottle A?" Thus, two boys stood up and answered her questions.

However, the lesson did not end there. The teacher continued the demonstration by pouring the water from the milk bottle (Bottle A) into the empty water bottle (Bottle B). Then she asked, "Why is it overflowed?" "Because the milk bottle has more water," the boy replied. The teacher ignored the answer but asked the class, "Why?" The answer was the same as, "The milk bottle is fat, the water bottle is slim," etc., as shown in their dialogue below:

Teacher:	When I pour [the water], then, it is overflowed. Why is it overflowed? How is the water bottle?
One student:	The water bottle is tall, but it is small and has a little water (a girl student)
Teacher:	How about the milk bottle?
One student:	The milk bottle is short, and it contains more water. (a girl student)
Teacher:	It is short, but why does it contain more water? How?
One student:	Because the water bottle is slim and milk bottle is fat. (a girl student)

The teacher kept asking those questions repeatedly about Bottles A and B until the time was up. She then informed her students to remember “the comparison of these is to let children know that this is direct comparison (pouring water into the cut bottles, A & B), and this one is indirect comparison (pouring water from Bottle A into Bottle B).” The teacher then concluded the lesson as follows:

> This is quantity comparison [used] to know which one has less or more…Water, it does not change its shape. [However,] when it is in any container, then it will change according to that container. Do you understand? If we put [water] in the plastic bag, then it will be in the shape of the plastic bag, right? If we put water in the bottle, then it will be in the shape of the bottle, right? If it is in the water bottle, then it will be in the shape of the water bottle, but it is the same amount; [it is] just transforming according to the shape of the container. Please understand that, children.

5.1.6 Post-lesson discussion 2 of TTC1-G1

Once the teaching was completed, the group members of TTC1-G1 organized a reflection session at the office of the attached primary school after a short break. Three MTEs (VNK, JNL, & PHT) and one primary teacher, SPC, attended this reflection meeting. The discussion started by self-reflection. SPC commented about herself that the lesson was done well. Most of the students understood comparison while only a few students did not pay attention to the lesson. She realized that students who lacked attention on this mathematics lesson also lacked attention on other subjects. Then, JNL commented on SPC’s teaching in an encouraging way, stating that this day’s lesson was much better compared to the research lesson on March 12, 2019. The classroom atmosphere was enjoyable, and the students were well cooperative. However, JNL suggested further improvement, saying that follow-up questions were needed to investigate the reasons why the students thought Bottle A contained more water than Bottle B. JNL also noticed that SPC did not sufficiently follow what was planned because SPC conducted indirect comparison before the direct comparison. Subsequently, the lesson ended earlier than expected because the students already acquired the answer from the indirect comparison. After that, VNK reflected on SPC’s research lesson. Before going into details, he reminded everyone that the discussion in the reflection session should be focusing on students’ thinking whereas reflecting on the teacher was additional. His positive points included that the students were quite curious about what would be happening, especially when the teacher was demonstrating the comparison. There were various responses from the students such as Bottle A contained a larger amount of water than Bottle B. Regarding improvements to be made, he agreed with JNL's comments about unfollowing the sequence of the lesson plan that the group planned together. He additionally added that the teacher should ask students more in-depth questions after pouring the water from Bottle A into Bottle B. The full discussions are shown below:

SPC: I express respect to [everyone in this] meeting. Regarding my teaching today, based on my own observation, I thought I [was] quite well prepared. However, I [did not] know what the result would be, [but I think it was quite] good. [How was it] for other observers? I do not know; I taught by following the steps we planned together. For me, the lesson can achieve the objective.

VNK: How about your teaching? Do you have anything more to add?

SPC: My observations [were] that the students' response is okay. There are some students [who] do not pay attention. Their habit is the same in every subject. Most of the students understand comparison. There are only a few students [who] do not understand. Those students [who do not understand] are the same in every subject; their habit is the same. They grasp this, grasp that, look for this, look for that; they are this way in every class. It is a children's habit; we cannot control them to sit tight and listen as adults; they always change their thinking. I have only that point.

JNL: In my observation, it is improving if [we] compare to the previous lesson, [meaning] the classroom learning atmosphere [improves]; students are well cooperative. At the beginning, most of the students are actively responsive with the teacher. I feel the classroom environment is more enjoyable than the previous lesson. Regarding the teacher's teaching, it is also improving because the teacher is well prepared. I only [have a suggestions for] when we hold up the water bag... and the teacher notes that when [the bag is] pushed up, then, the water is increased, [and] when [the teacher] releases it, then, it is decreased. Children already understand that when pushing [the bag] up, it is increased or decreased, because Sister [the teacher] already concluded afterward. Because Sister [the teacher] has already emphasized that if [she] pushes it up, it will be increased; if [she] puts it down, it will be decreased. Students have already understood that. Because our objective here [is that]—whether pushing it [up] or putting it down—the amount of water will not be changed. It remains the same, [therefore,] this is the previous lesson. However, students' responses are good, when asking, "Is it increased?" "Yes, it is increased." Then, they give a reason that because the teacher pushes it up, it is increased. Moreover, the important thing is that the teacher emphasizes which one is drinkable and undrinkable. Students, drinking, they also say eating…again the question [regarding] which bottle is bigger, then, students answer in unison; some students respond, “that bottle, it is taller; it is slimmer. That bottle is larger, shorter.” At that point, [I] want [the teacher] try to investigate more questions [about] Bottle A and Bottle B. First, the teacher may ask; then, students may say it is big or it is small. Then, ask them to give a reason why the students think this bottle is big or that bottle is small, and nearly all students say Bottle B is bigger. There is one student [who] says Bottle A contains more [water than Bottle B], and the teacher did not ask for a reason why that student thought this. Although only one student responds this way, before the teacher’s demonstration the teacher should say, “If so, let us compare together.” Another point is that our lesson plan is [meant] to prove direct comparison before indirect comparison, but the teacher proves indirect comparison before the direct one. Usually, comparing the direct way will stimulate several responses because they have not known the answer [previously]. However, the teacher proves the indirect way first, so students see the answer then, [give this answer, and] the lesson is finished earlier. I can feel that. I have only that [to say]; I feel that it (the teaching) is better than before.

VNK: However, what we comment in the reflection, we will interpret students’ thinking as points for discussion, and reflection on the teacher is optional. Actually, [when] we do [lesson study] this time, we will only look at the problem, but it is not explicit yet. Let me say something. I came [to the lesson] a little late because I am busy with family work. However, I can see that, when the teacher is interacting with the students, students are alert. I regarded that this teaching is effective teaching because when the teacher is demonstrating by pouring the water, all of the students stand up. This means that the students have interest in what the teacher is doing. I notice one student, even though we do not ask ... there is one student in the middle [who] says that Bottle A is fat; it contains more than Bottle B, so I jot down his/her responses. There are some students also giving the reasons. This point is what we want to get from the students. However, as the teacher mentioned that some students did not pay attention to what we are doing, this is regarded as our unsolvable problem. So, what should we do for the next stage to improve that so that the students will participate? As it is, students are well participated; they look for the answer from the teacher’s question (note: perhaps, he means the students try to answer the teacher’s question). However, I want to give additional comments to the teacher. Our lesson is planned to teach from direct comparison and, then, ask for the reasons from the students why the water is overflowed, because we planned that way. Maybe the teacher became nervous, and [had the attention of the class]. Therefore, she then teaches the indirect comparison before the direct one. However, students can notice easily when we demonstrate the indirect comparison. [If] they see it, they can answer it immediately. Nonetheless, for the direct way, we want students to know why it is overflowed. Then, we can conclude that there are two ways for comparison. We want students to think [and find the reason] themselves. Comparison—we do it in two ways. First, we pour water from Bottle A into B. Here, the teacher may ask more questions. In general, imagine our students have more participation [in this lesson]. This is my first time to see that, even [if] we did not ask them, students still answer it. For the previous lesson, they only play with others; fight [with] each other. I have just observed this first time. Although we have not asked a question, they still discuss with their friends that [the bottle] is big; it is fat; that one is tall, slim, and they discuss with each other. I regarded [the outcome] as well done.

5.2 Description of lesson study practices at Pakse TTC

From the preliminary survey in 2018, Pakse TTC briefly adopted "Open Approach," a combination of lesson study and Open-Ended Approach (Inprasitha, 2011, as cited in Khammeungkhoun, 2017, p. 29), to improve mathematics teaching in attached primary school. This approach also has three main steps—PLAN, DO, and SEE—the same method adapted by MoES. However, in the practice details of each step, it is quite different. This is especially true in the step of "DO," as it includes four sub-steps of teaching to manipulate the teaching-learning activity: posing an open-ended problem, students' self-learning, whole class discussion and comparison, and summarizing students' mathematical ideas. This idea was brought to this TTC because of one MTE—who received their Master of Mathematics Education from Khon Kaen University in Thailand, supervised by Associate Professor Maitree Inprasitha—proposed this idea to his colleagues. Furthermore, some MTEs of this TTC experienced open-class visits and observations in the primary school networks of Khon Kaen University during the 2016-2017 academic year. Moreover, professor visited this TTC to share this approach to some teacher educators. Subsequently, since then, this approach has been practiced frequently among MTEs in collaboration with their attached primary school. In 2018, during the preliminary survey, Pakse TTC had two groups that had a schedule of conducting lesson study every Tuesday and Thursday afternoon. However, as of 2019, there is only one group still practicing lesson study with its attached primary school. Ideally, lesson study at this TTC is a weekly practice. However, it also depends on their availability. Usually, the lesson is selected by continuing from the latest lesson. As of the 2019-2020 academic year, they usually gather on Monday afternoons to plan a lesson, which is then demonstrated Tuesday morning.

5.2.1 Lesson planning 1 of TTC2-G3

The entire schedule of lesson study practice in this TTC is demonstrated in Table 22. Since this TTC has already constructed their own practice schedule, the researcher respectively followed their program of planning a lesson on Monday afternoon and teaching the lesson on Tuesday morning. In the afternoon of March 18, 2019, four MTEs (KHL, VVL, VLV, & SLK) and one primary teacher (SMN) collaborated to plan a lesson. Before lesson planning 1 began, the researcher explained why he was visiting and how he would collect the data. Actually, they were already acquainted with the researcher from the preliminary survey the previous year. Therefore, there was not any issue related to the data collection or the group's collaboration with the researcher. Once they accepted the researcher's objectives, they immediately proceeded with lesson planning.

Table 22. Schedule of lesson study practice at Pakse TTC

No	Activities	Number of participants	Date
1	Planning 1	5 (4 MTEs, 1 Pri-T)	March 18th, 2019
2	Teaching 1 & reflection 1	5 (4 MTEs, 1 Pri-T)	March 19th, 2019
3	Researcher's comments	Individually right after the interviews	
4	Planning 2	7 (6 MTEs, 1 Pri-T)	March 25th, 2019
5	Teaching 2 & reflection 2	6 (5 MTEs, 1 Pri-T)	March 26th, 2019

Their plaining began with the homeroom teacher, SMN, reporting on the latest lesson to the group; she had recently taught up to page 121 of Lesson 14, subtraction (cont.), but had not yet finished. If the lesson study continued from there, it would involve the exercise on page 122. Following the report, the group immediately started discussing student difficulties and mathematical problems. Regarding the previous lesson about subtraction, 12 - 3, KHL, the leader of the group, asked what SMN had already taught and if students could solve it via decomposition. SMN expressed that students could solve it using decomposition but could not explain the steps of composition. In addition, she had only taught 12 decomposing into 10 and 2, but not in the reverse way (i.e., decomposing 12 into 10 and 2 or 2 and 10). KHL emphasized that the subtraction was significant because it dealt with remembering. He wanted students to not only be able to calculate but also decompose it, as displayed in their discussion below:

KHL: This topic is highly important, because it is about subtraction with borrowing. It is about the borrowing of subtracting two digits with a 1-digit number. The ones place a value of minuend as smaller than subtrahend, so [students] must remember. Therefore, most of the students must count their fingers, which is their basic calculating method. For example, [regarding] 13 - 9, where [would they] take 13 because we have only 10 fingers. However, for some students who understand, who often use their hands, they might keep 10 in mind.

SMN: Right, right, as Loui (student's name)—he can do decomposition but cannot put the answer into the space provided. However, its result is correct; it means that he used to calculate as KHL said. He can decompose correctly, but cannot put in here, cannot explain, but his answer is correct.

KHL: Typically, if they can keep the number 10 in mind, it means that students already know decomposition. For example, [with] number 13, s/he can already see 10 and 3. Nonetheless, now, what should we do to make students write it out, not just remember [in that way]? As for 10 and 3, as they see 10 and 3, when they subtract by 9, they will choose the larger number to subtract. Therefore, drawing a diagram is important for students. If we practice [decomposition] often, students will understand how to write decomposition…

Although the lesson on page 121 of the Grade 1 mathematics textbook was previously taught, KHL still wanted the teacher to reteach it because he was not sure if the students could really perform decomposition. Thus, the group agreed to reteach this lesson using "12 - 3" as the review of the previous lesson and adapting the exercise as the main activity. KHL, roughly, gave further suggestion that after reviewing the previous lesson, the teacher should summarize two ways of decomposition before moving to the lesson development stage, offering a hint for the students to apply when solving the main activity. During the lesson development stage, he wanted to create a word problem. He tried to collect ideas from other MTEs to design the main mathematical question. Therefore, the group decided to use a mathematical problem that students could solve using two methods of decomposition by selecting the number sentence "15 - 7" from the exercise as the main mathematical problem in this lesson. Then, the group members had an argument about creating the word problem to suit this mathematical sentence. They considered many possibilities: whether they would use candies or mangoes or put students' names in the word problem to get students to feel as if it was their own problem.

Occasionally, KHL emphasized that the teacher must ensure that the review summary of the previous lesson includes two methods of decomposition. He even advised the teacher to provide some exercises or homework to the students to practice on their own and be prepared for the next day's lesson. The following dialogue is taken from their discussions regarding this matter.

KHL: 15 mangoes, right? For example, there are 15 mangoes; 7 mangoes are eaten. How many mangoes are left over?

VLV: For the mangoes, we can only eat, right? What else can we do?

KHL: It would be difficult [for one person] to eat 7 mangoes.

… …

KHL: Please try to think more about the word problem.

VVL: Order; find the remaining mangoes.

KHL: Will the students understand how to solve it using two methods of decomposition?

SLK; Oh no! They will not understand.

VVL: However, students can do it if they understand [during] the previous lesson's review.

KHL: For the calculation, yes; reviewing the previous lesson is important.

… …

SMN: There are 15 mangoes; give [them] to friends.

VVL: 7 [mangoes] are eaten.

SMN: Eat 7?

VVL: Just giving [the mangoes] would be fine.

KHL: Let us suppose any names—Student A, Student B, any student's name in this class. We can also use candy. However, please be careful with the review part, [because] it is important. When summarizing this part, the teacher must do it pleasantly. For example, 12 - 3—"Which one is subtracted by which one? Can we subtract 2 by 3? Why can we not?" We must let students say it. If they cannot do it, then, what should we do? If they cannot do it, then, we have already known 2 is less than 3. Can it be subtracted? If it cannot, because [2] is less than [3], we want to hear that [from the students]. Next, what should we do if they cannot do it? In order to know if the students understand that it is about decomposition...

SMN: Decomposition.

KHL: Now, after decomposing, we have this. For example, they can only [decompose] one way, right? The teacher must [explain to] the students that can we do this a second, alternative way? Put 2 here, put 10 at the front, or put 10 here and put 2 at the front. “Can we do it or not? Why?” We want them to understand that we can put [numbers] at any positions…when writing they can put any positions. Let us see our command question sheet. Shall we take only one [problem] or more? Will the students understand the two ways that I offer? Look at this—when summarizing the reviewing part, the teacher should say that we can write it two ways: this way, and this way.

SMN: Will the students do it in two ways on the activity sheet, as well?

KHL: Yes. Let us see. We want to see if the students can really deepen [their understanding] when we already carefully explain that we have two ways; will they understand that these two ways below are coming from the above one? However, we are not telling them—actually, it is implicitly telling itself, but we do not tell [the students].

SMN: They would definitely be confused because they become accustomed to only putting 10 at the front.

KHL: So, you must conclude this one clearly.

SMN: Yes, of course.

KHL: Today, you provide them some homework about this, but not much—two problems for each topic. The meaning of the homework is not to write an answer; the homework is about practicing the skill.

After some long discussions, the group decided on the word problem to suit this number sentence: “Thao Itim has 15 oranges. He gives 7 oranges to his friends. How many are left over?” (see Table 23).

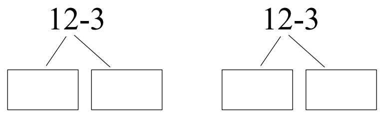
Table 23. Main lesson content extracted from the lesson plan 1 of TTC2-G3.

Objectives of today's lesson:

- Students will be able to subtract by decomposing number into 10 with any number
- Students will be able to make simple diagram

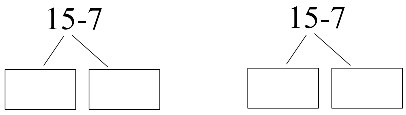
Reviewing previous lesson:

Teacher lets students calculate 12 - 3 together

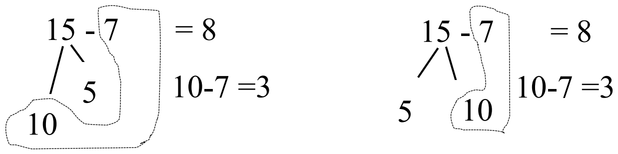


Main activity:

Thao Itim has 15 oranges, he gives it to his friends 7 oranges, how many are left over?



Expectation



During the planning, it seemed each member already understood their role well, even if the leader had not yet assigned their duties, because they put themselves to work interactively. For example, VLV and VVL worked together to create the one-page lesson plan; KHL and SLK helped each other create the students' worksheets, and SMN shared ideas with the group. The researcher observed that each member looked more skillful in his or her preparation. This is, perhaps, because—based on personal inquiry—the TTC2-G3 group already practiced a weekly lesson study of approximately 23 lessons during the 2018-2019 academic year (S. Seomany, personal communication, August 27, 2019). Nonetheless, while other members were preparing documents, SMN—who would teach the lesson on March 19, 2019—seemed somewhat worried with her students' performance because she often left the group to visit the classroom. Therefore, she gave some homework to the students and suggested they solve it using decomposition, because the leader of the group advised her to do so. The homework she gave to the students included the following problems: 11 - 9, 13 - 4, 15 - 3, 12 - 8, 14 - 6, 11 - 8, 13 - 9, and 12 - 3. When conducting lesson study, TTC2-G3 followed the one-page lesson plan format that was quite different from their usual lesson plan. This lesson plan was a summary of some key contents of the teaching method and main activity. It included the objective of the entire lesson, objective of the current day's lesson, main lesson content, student thinking anticipation, teaching steps, list of materials, teaching activity (reviewing the previous lesson, four steps of open approach, warning, and homework), and planning members.

5.2.2 Research lesson 1 of TTC2-G3

On the morning of March 19, 2019, after setting up the Grade 1 classroom (30 students in total, 13 girls), SMN started teaching by reviewing the previous lesson, 12 - 3, and asking students to solve it using decomposition. The teacher spent approximately 10 minutes completing the previous lesson review to prepare students for the next activity. Two students helped the teacher solve this using Method 1 (decomposing 12 into 10 and 2; subtracting 3 from 10 to get 7; 2 and 7 then become 9), and one student helped the teacher using Method 2 (decomposing 12 into 2 and 10; subtracting 3 from 10 to get 7; 2 and 7 then become 9). Before moving to the main task, SMN emphasized that students would be using these two methods to solve next mathematical problem. A moment later, the teacher stuck semi-concrete materials (15 oranges) on the green board and told the word problem, “Thao Itim has 15 oranges. He gives 7 oranges to his friends. How many are left over?” As soon as the teacher’s words ceased, some students already procured a verbal answer; a few students said, “9,” but many students said “8.” SMN ignored those answers and immediately posted the word problem on the green board below the manipulatives. Below the word problem, she posted an instruction for the students: “Calculate by decomposition using two methods.” Then, she asked all of the students to read a few times before distributing 13 worksheets to each table (see Table 24). During the distribution, she often asked the students to use two methods, as was done moments before in the previous lesson’s review. Then, the students started working in pairs. While the students were working, each observer moved around the class, checking students’ work. They sometimes posed questions to each individual pair to stimulate them to think toward the task. Of course, they did not tell the students how to do the activity or assess if their method was right or wrong. They sometimes sat next to the students to watch how they conducted the activity. SMN also moved around the room, checking her students’ work, asking some questions, and offering clues when necessary. Approximately 17 minutes later, SMN started collecting and posting students’ worksheets on the green board for a report. At first, SMN selected the pairs who made the most mistakes to explain for the class; this was followed with the second set of pairs with the correct answer but mistakes in the process. The third set of pairs acquired some correct answers and some mistakes, and the fourth set of pairs had no mistakes in either the answer or process. The teacher spent approximately 15 minutes for the students’ report. Then, SMN concluded the activity with a large, white paper by summarizing “15 - 7” into two methods using a diagram. Afterward, she asked the students to take notes of what she summarized. However, the leader of the group, KHL, was not satisfied with the summary the teacher gave. Thus, he posted his version of the summary on the green board, replacing what

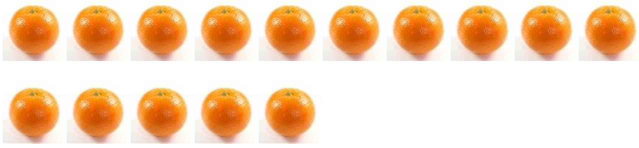
SMN had added, without saying anything. SMN helped him arrange the board in properly to make it easier for the students to take notes. The teacher allowed the students approximately 10 minutes to take notes; then, the class ended with a time of approximately 55 minutes.

Table 24. Student worksheets of lesson study practice 1 (TTC2-G3)

Name: ……………

Name of activity: a delicious orange

Situation of the problem: Thao Itim has 15 oranges, he gives it to his friends 7 oranges, how many are left over?



Order: do calculate by decomposition in 2 methods?

Answer: The remaining oranges are________

5.2.3 Post-lesson discussion 1 of TTC2-G3

Immediately following research lesson 1, TTC2-G3 held a brief meeting for reflection in the office of attached primary school. The group leader, KHL, opened the reflection session. Then, SMN reflected on her teaching that day, specifically the part that had required further development. She found that, despite offering clear explanations during the previous lesson review, many students did not perform well. This was especially the case in the second method, because this was their first experience. Thus, the students still had difficulty solving the subtraction by decomposition using the second method. Then, SLK commented that the teacher's communication was not sufficiently clear, causing confusion for the students. SLK noted that the teacher emphasized that students were to solve the main problem as they had in the previous lesson review. As a result, some pairs decomposed 15 into 10 and 2. The second issue was that when the students drew a diagram to group the pairs of numbers for the operation, they constructed the same diagram between the two methods (meaning the diagram was drawn at the same position in both methods). PVL also agreed with SLK's ideas that although the students could decompose the number 15 into 10 and 5, and the reverse, they still drew the same diagram to pair the number for operation. However, the results of the operation were correct, which meant the students only remembered the diagram's position. KHL explained the need to perform decomposition instead of the counting fingers method. His first comment implicitly criticized the teacher's previous lessons. He stated that the teacher only mentioned decomposing a number into 10 with any number, but not vice versa. KHL's second comment was that when teaching subtraction using decomposition, it does not need to explain how to draw the dash line or diagram (see Table 24), stating this wasted time and that the textbook only included it to show the teacher which number operates with which number. The third comment related to the students' mathematical solving method; they only remembered the number's position, because when they drew a diagram, they still paired 5 with 7, which could not be subtracted. However, the students still had a correct answer. There were also additional comments and suggestions. For example, a suggestion was made to use the equal sign, for where to write the number sentence, explaining how to conclude the lesson, and to train students to improve their explaining skills (see full reflection in Appendix G).

5.2.4 Lesson planning 2 of TTC2-G3

On March 25, 2019, six MTEs (KHL, SKH, PVL, VVL, VLV, & SLK) and one Pri-T (SMN) collaboratively designed lesson plan 2. Because TTC2-G3 was conducting weekly lesson study, this day's lesson planning continued from the previous lesson, which was the remainder of lesson 14, subtraction (cont.). In the textbook, this day's content comprised the exercises discussing word problems. There are three-word problems about subtraction written on page 124 of the textbook (see Table 25). Their lesson planning, including preparation, took two hours. Of these exercises, the group viewed them as the representation of three types of subtraction. Thus, if one of them is removed, the group feared that the intention of the book summarizing three types of subtraction would not be covered. Therefore, they agreed to use these three-word problems in this lesson. First, they roughly designed the objective of the day's lesson that was to review students' understanding about the meaning of subtraction. At this moment, the group's leader, KHL, has not yet arrived. One member of the group, SKH, wanted to save time, so he proposed using three-word problems on one worksheet. However, other members disagreed because they wanted students to think deeply; by putting three activities on one worksheet. A one-hour lesson would be hasty, and students might face difficulty reporting their work. The group also discussed whether solving these three-word problems would require the decomposing method or not, but SKH argued that decomposition was already being overused, so these problems may not require decomposition. After the lengthy discussion, the group separated to prepare the student worksheet, design how to run the activity, and compose the lesson plan onto a PC. Twenty-two minutes later, KHL arrived. The group then considered that the first word problem could be used as a lesson of the day, while the second and third could be activities. After that, the group discussed Question 2 (see Table 25), regarding why they placed "7" ahead of "15." It was interpreted as awareness that a large number cannot be subtracted from a small number. The group worried that students may produce the number sentence "7 - 15" instead of "15 - 7." Consequently, the group agreed to follow Question 2 while being aware that if they discover some students produced the sentence this way or asked the teacher, they would then approach students and investigate with more questions. For example, SLK proposed to suggest students attempt the sentence again. PVL also questioned if this type of investigation would be enough. Is it possible? Additionally, SLK mentioned that the teacher should not tell students first, only interfering this way if they ask or when we notice them writing "7 - 15." Regarding the third word problem, KHL was concerned that students would only use the basic counting method, but he wanted more than one method to be used. Then, the group shared an idea, and the leader proposed three methods: pairing, counting, and vertical calculation. At this point, the group faced the question of how to stimulate students to discover these two methods aside from counting. The leader left this question to the teacher who would teach this lesson.

Through a lengthy discussion, the group agreed to follow the leader's idea that the first word problem would be used to review the previous lesson, as they have already learned this similarly. Initially, they wanted to combine two-word problems or two activities on the same worksheet. Then, they separated them into different worksheets because it possessed a different intention. Furthermore, considering the availability of their materials, they slightly adapted Question 1 using oranges instead of cookies, because they already had oranges from the previous lesson. They also realized that the general objective of Lesson 14 did not cover these three types of word problems. Therefore, they modified the lesson objective so students would be able to apply subtraction using decomposition, and the objective of the day was to review student's understanding of the meaning and method of subtraction. Near the end of lesson planning 2, VLV—whose duty was usually to type the lesson content onto a PC—was surprised when the leader called on her to teach the day's lesson. She was a bit shocked, initially attempting to avoid teaching saying that she had not closely considered the details of each step. Eventually, she accepted the challenge. Actually, she used to teach primary mathematics regularly, so she had confidence in teaching. However, in those cases, she usually knew she was teaching in advance, while this time she was ill prepared.

Table 25. Main problems in the textbook

15. Write number sentence and find an answer together 1. There are 11 cookies, if 9 cookies are eaten, how many cookies are left? 2. There are 7 pigeons and 15 sparrows, which type has more amount for how many? 3. There are 13 red and green apples in total, there are 6 red apples, how many green Apples are there? (MoES, 2017, p. 124)

Through the researcher's observation, lesson planning 2 was similar to lesson planning 1 regarding the process, content focus, and issues, because of the issue with the previous teaching's conclusion being unclear. This time, as well, some members tried to ask about or raised this point for discussion. Unfortunately, it did not get attention from the members, and the leader of TTC2-G3 only suggested it as a general expression, as shown in the following conversation:

PVL: Conclusion, how to conclude...

SMN: How to conclude...

…

KHL: [We should] conclude in two ways because it is different content (2 activities are different story)

…

KHL: Conclude based on the worksheet; [when the] first worksheet [is] finished, then conclude and distribute [the] second worksheet.

As with the previous research lesson 1, it is predictable that the group leader would not be satisfied with the conclusion part and might interfere with the teaching. This was especially true because they only carefully considered the activities and materials but were not focused on the conclusion, which is when students would be taking notes.

5.2.5 Research lesson 2 of TTC2-G3

On the morning of Tuesday, March 26, 2019, prior to the start of the lesson, the tables for student group work were already set up in six groups. The MTE teaching this day, VLV, began the lesson by setting the classroom in general (greeting, writing the date and lesson topic). To obtain the students' attention, the MTE told them to clap their hands once, twice, and continued by asking what the last lesson entailed. Most students replied, "oranges and apples." This day's lesson had four observers (KHL, SMN, SLK, VVL, & SKH) and two practicum student teachers. Once the students were ready, the MTE started by posting figures of 11 oranges on the blackboard. Then, the MTE verbally said, “We have 11 oranges. Students ate 9 oranges. How many are left over?” Most students said, “2 oranges.” “How do you know that?” The MTE asked. A student replied, “[It is what I] thought; I thought from my [experience at] home.” The MTE asked, “Please show me, what makes you think this?” One girl stepped up to the blackboard and, using counting drawing sticks, she wrote the number sentence correctly: 11 - 9 = 2. All of the students clapped their hands. The MTE asked further if there anyone had a different idea other than counting drawing sticks. The second student came to the front and used the same method, so the teacher educator asked him to make a vertical calculation. Then, the MTE wrote “11 - 9” and asked the whole class what to do next. There was a voice that said, “decomposition”; the MTE immediately asked her to demonstrate decomposition, and the student did so correctly (decomposing 11 into 10 and 1) in both the decomposing diagram and explanation. The MTE still needed additional methods of decomposition. Unfortunately, the third student was unable to do it, simply doing what the second student had done. Therefore, the MTE called on the fourth student, and she correctly decomposed 11 into 1 and 10, meeting the MTE’s expectation. However, the fourth student’s answer was still incomplete calculation. Finally, before moving on to the next activity, the MTE addressed some small mistakes and concluded two methods of decomposition. The MTE spent 20 minutes reviewing the previous lesson before she moved on to Activity 1 by showing a picture of birds. The moment that the students saw the pictures, some students said, “small and big birds. There are more small birds than big birds.” The MTE immediately posted a question on the blackboard: “Please find out which type of bird has the larger amount and how many [birds are there]?” Then, the MTE spoke the word problem: “There are 7 pigeons and 15 sparrows. Which type of bird has the larger amount, and how many [birds are there]?” Two students answered, “sparrows,” and said, “[there are] 7 sparrows.” One student answered, “The small bird has a larger amount than the big one.” The MTE ignored those answers but asked them to read the question together to confirm if they knew what answer they should have. Shortly, the team members distributed worksheets, bottle caps, and markers to each group. The MTE explained again to make sure that they knew what to do before each group began. While students were working in groups, each observer moved around the room trying to stimulate each group so that they would determine the answer they wanted. They sometimes asked questions such as, “How [do you do] it? How do you know,” taking some photos, etc. The group leader also walked around, asking some groups, “How do you know which one has more than the others?” He even suggested that they “write the number sentence and answer.” Twenty-three minutes later, it was time for students to report their work. Each observer assisted the others when taking students' worksheets and posting them on the blackboard. The MTE selected two groups to report based on what they wrote on their worksheets (see Figure 24). It seemed that each group could come up with "15 - 7," using decomposition to solve it. Therefore, the MTE concluded the activity by writing "15 - 7" before moving on the second activity.

For Activity 2, the MTE started by showing a figure of green and red apples following by a verbal word problem: "There are green and red apples, 13 apples total. There are 6 red apples. How many green apples [are there]?" (For both activities, the MTE did not write the problems on the blackboard, but it was available on the worksheets). Then, she put the question on the blackboard that "find the way to find the green apples" before distributing second materials to each group. As with Activity 1, all observers tried to encourage each group, stimulating them by asking some questions to help them to contemplate the problem. Furthermore, the researcher noticed KHL and VLV discussing something while students were doing group work; it was likely about how to conclude the lesson. KHL even wrote something on the teacher's desk. Approximately 12 minutes later, it was time for students to give their reports. All six groups posted their work on the blackboard. During that time, the classroom atmosphere was quite noisy. Therefore, the MTE only selected Group 2 to explain their method. Then, the teacher re-explained to the whole class again before allowing them to take a break. The class was completed after this. While students were taking a break, the teacher concluded Activity 1 by drawing a decomposing diagram of "15 - 7"; the conclusion of Activity 2 was the word sentence, "the difference of two things equals the number of the larger items subtracted by the amount of the smaller items." This was so for the students to copy into their notebooks later.

Figure 24. Students report in activity 1 of research lesson 2 of TTC2-G3

5.2.6 Post-lesson discussion 2 of TTC2-G3

Once the students left the classroom, TTC2-G3 started its reflection session within approximately 20 minutes. At first, VLV, the teacher educator who taught he lesson, offered two comments about her own teaching, noting that today's lesson did not achieve its objective because of too many activities. She claimed that they usually use one activity, but this lesson contained three activities. The second comment noted her preparation. She thought she still did not know what to say when teaching or how to conclude the lesson in a way that students understand. Then, SKH shared two comments. The first point was that students wrote their decomposition diagrams in different formats, also noting that the teacher wrote hers differently. The teacher educator should have a fixed writing format and not depend on students' ways of writing. Whatever the students wrote, the teacher educator should have maintained the same format and concluded with that pattern. The second point was that students did not understand the four steps of subtraction using decomposition. Students sometimes answered correctly but, also, sometimes expressed it incorrectly regarding 5 - 7 or 7 - 5 or 15 - 7. He suggested the correct number sentence—15 - 7—should be taught in the following four steps: "(1) 7 cannot be subtracted from 5; (2) decompose 15 into 10 and 5; (3) subtract 7 from 10 [to get] 3; [and] (4) 5 and 3 is 8." The primary teacher, SMN, also agreed with VLV, who demonstrated that the lesson contained too many activities with three different situations; the lesson lasted almost 90 minutes. The third observer, VVL, commented that time was wasted in reviewing the previous lesson. She also agreed with SKH that students had difficulty not with mathematics but with Lao language. Students could decompose the number into 10 and one number but had difficulty explaining their method. There is a need for them to practice their explanation skills on their own. SLK mentioned that reviewing the previous lesson might be difficult for students because the lesson objective was only to practice or gain understanding. Providing students with a single, clear method for solving subtraction would likely be sufficient. At this point, the group leader, KHL commented that students could not complete those two-word problems. This implied that they had challenges with previous knowledge. He added that basic counting methods such as counting drawing sticks or finger counting were not useful for this lesson, because it was not what the lesson intended to accomplish. Regarding reviewing the previous lesson, he emphasized that the teacher educator should know how to lead students toward what she wants, which is decomposition. He suggested that the lesson implementer should stall students if she discovered a student was repeating the previous student's method, then, immediately ask the student to change to another way. If the student, however, could not do this, the teacher educator should quickly change to another student. That would be a better way to save time. KHL further added that the teacher educator should be flexible with the time. If the allotted time is up, then she could use the second activity as homework. He also noticed that students still could not perform decomposition despite the lesson taught previously. He additionally explained that the intention of the lesson was not the answer, even if some students acquired the answer immediately after the lesson implementer said the word problem aloud. Instead, the point was for students to understand the difference in subtraction—as well as the difference of two items, while we know the total number of the two and the number of one. This difference is equal to the number of the larger items subtracted by the number of smaller items, which was the objective of this lesson.

5.3 Description of lesson study practices at Khangkhay TTC

Basic background from the preliminary survey in 2018 revealed that lesson study practice at Khangkhay TTC is utilized to solve problems of teacher educator's and teaching's behavior relying on the mean and standard deviation (for more details, see Chapter three). They created some steps of lesson study practice themselves, including forming a group; observing some or every member's class to identify issues (most of which concern a teacher educator's behavior); gathering all the issues found by the observers to create a checklist; selecting one teacher educator to construct a lesson plan and teach it; observing the teaching using the checklist to evaluate if the problems have been solved; reflecting based on the checklist; making a lesson plan for the next lesson; observing the second lesson to reevaluate teaching; and reflecting on the teaching again based on the checklist. The same process is repeated until it meets satisfaction (usually two or three times).

For this main study, lesson study practice at Khangkhay TTC was conducted from April 1 to 12, 2019. Prior to meeting some MTEs, the researcher met the director of this TTC and the head of Natural and Science Office to discuss his purposes. The researcher wanted to do this so that the information would reach the head of the mathematics unit to gather MTEs. The head of the office listed two possible groups that could construct lesson study. The first group was comprised of MTEs that are teaching student teachers belonging to Kindergarten and Primary Office (TTC3-G4) and the group of MTEs teaching pre-service teachers that depend on the Natural and Science Office (TTC3-G5). More details of each group's lesson study practice are described in the following sections.

5.3.1 Lesson planning 1 of TTC3-G5

On April 2, 2019, the head of the Natural and Science Office hosted a meeting (pre-planning) in his office to discuss their plan to conduct lesson study. Eight participants of this group (PHK, BCH, LVN, SLY, CHP, SKH, BPG, & PHV) attended. Table 26 demonstrates the entire schedule of lesson study practice at TTC3-G5. This short meeting lasted approximately 25 minutes, and PHK, head of Natural and Science Office, was the leader of this group. At the beginning, he explained the researcher's purpose to all group members. Then, they started initial planning by randomly inquiring if some MTEs' classes are appropriate and, perhaps, more convenient for this practice. Initially, the group proposed conducting lesson study with pre-service physics teachers. BCH, however, proposed a second option to conduct with primary students because she thought that conducting lesson study with children would be more effective than with teenagers or adults—in this case, pre-service teachers. Unfortunately, PHK disagreed with BCH's ideas because he thought it would be overlapping with the second group that had already been doing this with the attached primary school. CHP also disagreed with BCH's idea because he was concerned about the nature of the classroom and relationship between the teacher and children that might weaken the lesson and increase tension in the classroom. Therefore, PHK chose the first option to conduct lesson study with pre-service physics teachers, assigning LVN to teach the first lesson as it was her regular class. This first lesson was only meant to identify any problems within the teaching. Therefore, there was no group lesson planning at this stage. Regarding who would teach the second and third lessons, they tentatively contemplated MTEs BCH, SLY, and SKH, but the final decision was made after the first lesson.

Table 26. The schedule of lesson study practice of TTC3-G5

No	Activities	Number of participants	Date
1	Pre-Planning	8 MTEs	April 2nd, 2019
2	Observation and reflection	8 MTEs	April 3rd, 2019
3	Planning 1	6 MTEs	April 4th, 2019
4	Teaching 1 & reflection 1	8 MTEs	April 8th, 2019
5	Intervention	8 MTEs	April 9th, 2019
6	Planning 2	5 MTEs	April 9th, 2019
7	Teaching 2 & reflection 2	6 MTEs	April 10th, 2019

On April 3, 2019, the day of LVN's lesson observation, all group members observed this lesson to identify potential problems. The topic of Lesson 6 was radical equations and inequalities. This first-year physics class had 27 pre-service teachers, six of them being female. This observation took 90 minutes. LVN started by reviewing the previous lesson, selecting some student teachers to solve systems of linear inequalities $\begin{cases} 4x - 5 < 13 \\ 3x + 4 > 16 \end{cases}$. After checking the correct answer, she later told student teachers to look at a formula in their textbook. Then, she solved one example corresponding to the formula. Immediately following the example, she divided student teachers into four groups and gave them four math problems of radical equations. She sometimes allowed them to solve it with their group, and a representative of each group wrote the solution with an explanation on the blackboard. The teacher educator concluded the lesson of the day by emphasizing the formula to remember.

Immediately following the teaching, TTC3-G5 organized a post-lesson discussion. This reflection session was 50 minutes in total. The leader of the group, PHK, who acted as facilitator, gave an opening speech before assigning LVN to provide comments for herself followed by others from observers. In this meeting, SLY was absent because he had a class. LVN pointed out general views that she had followed the lesson plan well in all steps. Most her student teachers could solve it; only some of them could not, and that was because of their limited background of math knowledge. She also commented that male student teachers performed better than female. Then, it turned to observers to express what they saw. BPN generally expressed that the teaching was good, also agreeing with the idea that student teachers had a limited math background. However, she noticed another issue with the teaching material that used an LCD projector; the letters displayed by the LCD projector were small and mixed with the handwriting when projected onto the blackboard. Thus, it was difficult to read. LVN received many comments, most of which were behavior-related regarding her difficulties with explanations, lacking smoothness with the materials, blackboard use, etc. Finally, prior to proceeding with the discussion about the next plan, the group leader summarized some problems that required solving in the next lessons (see Table 27).

Table 27. Problem of the first observation (based on TTC3-G5's observation sheet)

Problem from observation
1. The objective of the lesson plan was not clear 2. Teaching material was not well prepared 3. Evaluation was not clear 4. Transitioning from previous lesson to new lesson didn't get student attention 5. Teacher explanation was not clear 6. Instruction how to do activity was not clear enough

7. Teaching material management wasn't smooth
8. Teaching materials did not help students to understand lesson well enough
9. Teaching activity was not well improved student thinking
10. Blackboard use was not good enough

After the problems were summarized, the group leader continued explaining alternative solutions for them that could be used in the next lesson. For example, he supposed that if the problem was the student teachers' math background of exponential equation, the teacher educator should explain the definition and properties of exponential equation during the previous lesson review and allow student teachers to discuss. Regarding the problem of blackboard use, the group leader suggested the members use large white papers to display data from the LCD projector. Once they understood how to solve those points, they proceeded with discussing the plan for the next lesson. However, the content of the conversation was not deepening in the mathematical problem or student-teacher thinking, but rather in how many groups student teachers should be separated into, how many math problems each group will perform, etc. Toward the end of this meeting, some group members recommended SKH to construct this lesson plan alone, then discuss it as a group on April 4, 2019. For the next lesson topic, the group simply followed the regular curriculum. Therefore, as the next lesson remained within Lesson 6, radical equation and inequalities, the second topic of "inequalities" would be the focus.

On April 4, 2019, six MTEs united in a laboratory room to plan lesson plan 1. During the lesson planning, they automatically separated into two groups: one to discuss the lesson plan and the other to design the observational tool. As SKH was a selected teacher educator to demonstrate the lesson, all materials became her responsibility, including the lesson plan. Consequently, the content of this colloquium—especially of the group lesson planning—did not concern designing the mathematical task, but rather placed more focus on how student teachers would work and report their results, how to divide student teachers into a group, teaching steps, and allocating time intervals for each step. This could have been the confirmation discussion if SKH had composed a lesson and prepared all necessary materials. However, SKH had difficulty designing a math question for the evaluation step to test if student teachers could apply the formula to solve a mathematics problem. Therefore, the homeroom teacher, LVN, had to design one math question to assess student teachers understanding of that day's topic. The following is an excerpt from their planning session.

SKH: When we divide students into a group, I am somewhat concerned that high-performing students will be in the same group.

BCH: Then, choose a high-performing student as a main member for each group, can it be?

PHK: That's right; Please take a note now that this student is a leader of the group.

SKH: Student A, B, C. (A, B & C are anonymous)

…

SKH: Dividing students into a group is not challenging, but I worry a good student will [still] be in the same group.

PHK: Then, use those good performers as a main leader of each group; for the remaining [students], just count: 1, 2, 3.

Based on SKH's idea and some input from the group members, the main concept of their lesson plan for lesson study cycle 1 is illustrated in Table 28.

Table 28. Main content of lesson plan of lesson study cycle 1

Objective: to remember each type of inequalities and be able to use its step to solve inequalities
Step 1. Reviewing previous lesson (7 minutes) $x-\sqrt{x+1}=5$ (solved by student) **Step 2. Teaching new lesson** *<u>Sub-step 2.1 new lesson</u> (5 minutes)* Type 1. $\sqrt{f(x)}>g(x)\Leftrightarrow\begin{cases}g(x)<0\\f(x)\geq 0\end{cases}\cup\begin{cases}g(x)\geq 0\\f(x)>[g(x)]^2\end{cases}$ Type 2. $\sqrt{f(x)}\geq g(x)\Leftrightarrow\begin{cases}g(x)<0\\f(x)\geq 0\end{cases}\cup\begin{cases}g(x)\geq 0\\f(x)\geq[g(x)]^2\end{cases}$ Type 3. $\sqrt{f(x)}<g(x)\Leftrightarrow\begin{cases}g(x)>0\\f(x)<[g(x)]^2\\f(x)\geq 0\end{cases}$ Type 4. $\sqrt{f(x)}\leq g(x)\Leftrightarrow\begin{cases}g(x)\geq 0\\f(x)\leq[g(x)]^2\\f(x)\geq 0\end{cases}$

Example: $\sqrt{x-1} > 3-x$ (solved by teacher as an example) (10 minutes)

Sub-step 2.2. group work (divide into 8 groups, 2 groups for 1 problem) (57 minutes)

① $\sqrt{4x-8} \geq x-5$

② $2-x < \sqrt{x^2-4x+3}$

③ $\sqrt{x^2-x-12} < x$

④ 4. $\sqrt{3x-x^2} \leq 4-x$

Step 3. Conclusion (2 minutes)

Step 4. Evaluation (7 minutes)

$\sqrt{x^2+2x-3} < x-2$

Step 5. Homework (2 minutes)

These five steps of lesson plan are the standard of the Lao lesson plan used nationwide. However, most Lao teachers and teacher educators are likely to include an additional step between Steps 1 and 2; this is the transitioning step or inducting step, which happens before moving on to the new lesson in Step 2. Especially when the teacher educator must observe the class, the teacher educator will pay particular attention to that activity. The concept of this lesson plan is that the teacher educator will select one or two student teachers to solve a math problem in Step 1 until they reach the correct answer, which must be done within 7 minutes. Then, the lesson implementer will display those four types of formula sheets and solve one math problem as an example. At that point, the student teachers will be separated into eight groups while two groups solve the same math problem. Then, a representative from the four groups will explain for the other four groups, who can also add to it if they have something different. Then, the teacher educator will confirm the correct answer and conclude the lesson by restating the formula to remember. In teaching Step 4, the teacher educator will use one math problem to evaluate if student teachers can apply the formula to solve it. Afterward, the teacher educator will provide some exercises as homework, and the class will be completed.

5.3.2 Research lesson 1 of TTC3-G5

On April 8, 2019, the day of teaching lesson plan 1, eight MTEs participated in the observation. All were given the observation sheet provided by the group members. The teacher educator, SKH, began the lesson by writing the topic on the whiteboard. This was followed by teaching Step 1, reviewing the previous lesson, and solving $x-\sqrt{x+1}=5$. Once the teacher educator wrote the math problem, she selected a student teacher to solve it first. However, the first student teacher could not solve it, so she asked another student teacher to restate the formula of the radical equation as a clue for the first student teacher. The lesson implementer, SKH, also explained the formula again after the student teacher's explanation. At this point, the first student teacher tried to apply the given formula to solve the math problem again, but he still could not do it. Therefore, SKH allowed him to ask his friend for help. Then, the second student teacher came to the front and tried to solve this math problem. Still, the second student teacher was unable to solve it. Subsequently, the teacher educator had to select a third student teacher, who finally solved it correctly. By the time the right answer was acquired during the previous lesson review, 40 minutes had passed. At this point, the teacher educator moved to the new lesson—inequalities, in this case—by displaying a large white paper that contained four types of math formulas. To strengthen the student teachers' understanding, the teacher educator explained each formula again and demonstrated one math problem as an example for the whole class. Once the student teachers understood how to apply the formula, the teacher educator divided them into eight groups. How the teacher educator divided the student teachers into groups was quite comical. At first, she called eight high-performing student teachers to draw a lottery to obtain the name of an animal to be used as a symbol of the group. Then, all student teachers repeated the lottery drawing. When a student teacher obtained animal name, such as "cat," that student teacher was asked to make a sound like a cat calling to the group's leader. Then, the leader was to make the cat sound in response to the members so they would know their group's location. However, most student teachers did not make a sound as suggested, probably because it might be funny or they were overly shy. After all members united in the group, the teacher educator distributed two large white papers to each group for writing their solution for the report, also assigning a duty to each group member. For example, one member should solve the math problem, one should write the solution on the paper, and the other group members should monitor if they solved it correctly. Afterward, the teacher educator distributed the math question to each group, setting the timer for 15 minutes for solving the problem. Then, each group explained their work at the front of the classroom. After each group explanation, the teacher educator also re-explained to confirm the student teachers' understanding. Because time was nearly up, the group that obtained a wrong answer missed a chance to explain their work, especially 4. $\sqrt{3x-x^2}\leq 4-x$, so the teacher educator solved it for them. In the last five minutes, because of the time limitation, the teacher educator roughly explained how to solve this math problem, $\sqrt[4]{3x - x^2} \leq 4 - x$, as an evaluation. However, this was not actually in the lesson plan. It was likely an idea the teacher educator came up with while teaching. Following this, the class was completed.

5.3.3 Post-lesson discussion 1 of TTC3-G5

On the same day, immediately following the teaching, the group held a post-lesson discussion. Per usual procedure, the teacher educator who demonstrated the lesson first comment should be made followed by observers' comments. SKH evaluated her own teaching in three main points: time management, general classroom setting, and teaching. (1) Time management was not well controlled because of multiple mathematical problems; also, reviewing the previous lesson did not go as expected during the practice, as the time allocated was less than 10 minutes. (2) On general classroom setting, she accepted that she forgot to check student teachers' attendance. (3) Regarding her teaching, she noted that she had not followed the lesson plan especially well during the evaluation step; student teachers could not understand the process of solving inequalities, so they did not explain sufficiently during the conclusion. She thought the aforementioned issues were because of her insufficient explanation during the lesson and not providing enough examples. PHV commented that this day's teaching was well done, explained well, and was clear and smooth. However, student teachers appeared exhausted. Another point was the weakness of the lesson plan. She accepted that the group did not plan sufficiently for cases in which student teachers could not solve during the previous lesson review. The teacher educator should conclude herself to save time. Finally, the last point concerned wasting time during explanations, as the teacher educator wanted explanations for every student teachers' group work. To improve this, she proposed the teacher educator only explain once after all group work had been completed. More comments are summarized in Table 29.

Table 29. Comments of the reflection 1 of TTC3-G5

Comments in reflection 1	
1. Repeating student explanation wastes time 2. Time management not well 3. Wasting time in evaluating previous lesson 4. Solve problem with wrong teacher 5. Following only curriculum	7. Lesson planning used difficult math question 8. Pointing out individual student teacher to solve is a mistake 9. No collaboration during group work

6. Lesson itself is difficult	10. Evaluating student is not well practiced

Through the first cycle of lesson study practice of TTC3-G5, the researcher was rather impressed by their collaboration to practice lesson study as requested despite not having a prior plan. Every time, the number of participants was constant. However, the employed lesson study procedure was quite strange compared to the literature. While they organized a meeting in every step of the PLAN-DO-SEE cycle, the quality of the discussion was extremely weak. Their understanding of lesson study differed greatly from the literature. Nearly all of the comments criticized the lesson implementer's every movement. In lesson planning 1, the researcher noticed that the teacher educator selected to teach was responsible for every preparation. Therefore, the reason why they grouped together during the lesson planning was simply to agree and witness the lesson selection, number of groups in which to divide student teachers, and number of activities. There was rarely or no contribution regarding mathematical curriculum analysis, mathematical content, learner mathematical thinking, or student teacher misconceptions in professional knowledge. In addition, when observing the research lesson, it was regarded as an opportunity to find a weakness, downside, shortcoming, disadvantage of the teacher educator's behavior, etc., in order to offer criticism during the post-lesson discussion. Consequently, no one was voluntarily willing to teach the lesson because the MTEs were afraid of being criticized and preparing numerous materials alone. Through this situation, the researcher realized the need to provide the TTC3-G5 group with documents regarding the lesson study literature with a deep and clear explanation of each step of lesson study because their concept of lesson study was still quite superficial. If the author were to leave them in their current situation, even if they conducted lesson study as they previously did more than 10 times, their discussion and perspective on the lesson and teaching would likely remain unchanged.

5.3.4 Lesson planning 2 of TTC3-G5

On April 9, 2019, the researcher organized a meeting with eight MTEs of TTC3-G5 for the intervention. This intervention took approximately 90 minutes during the morning session. Prior to the intervention, the researcher shared his comments regarding the previous lesson study practice. He commented that the 12 items (see Table 30) were merely at the surface of lesson study practice and that lesson study did not usually use such a checklist. Second, when the teacher educator or observers mentioned student teachers having a limited background of mathematical knowledge, they should not simply state it as a general opinion but specify the exact point the student teachers made mistakes. This is because the researcher observed that they performed quite well with only small errors or mistakes. Furthermore, while observing the class—especially when student teachers were completing activities—observers should not just sit tight at the back of the class but rather move around to see what they are doing, their difficulties, misconceptions toward the math problem, thinking, and so forth. The researcher also raised the point of mathematics difficulties that student teachers encountered as an example for TTC3-G5 to consider. Afterward, the researcher gave each member the lesson study guidelines with a deep explanation and began an open session for Q&A. Some of the topics discussed were as follows: how to find a title for lesson study, how to analyze curriculum before planning a lesson, how to make a lesson plan, teaching methods, what to observe, and what to reflect on, etc. During the discussion, the researcher received two questions from MTEs: 1) When we anticipate student teachers' answers, if student teachers come up with ideas other than what is anticipated, is the lesson plan still effective? 2) If we anticipate many answers from student teachers, do must we solve every anticipation? The researcher's answer was "yes" for both questions.

In the afternoon of April 9, 2019, TTC3-G5 started planning Lesson 2. At the beginning, only three MTEs (PHV, SKH, & SLY) collaborated to design the lesson plan. Later, two MTEs arrived near the end of the discussion. The leader of the group did not join this time for an unknown reason. This discussion lasted the entire afternoon session—approximately three hours. This lesson simply continued from the previous lesson with a topic of exponential equation, which was Lesson 7. At this time, they were quite intense with designing the mathematical task. The overall dialogue of TTC3-G5 also followed five steps of the Lao teaching standard as the previous lesson plan had. However, they were keener and collaboratively designed the mathematical task. The group began by discussing a math problem for the transitioning activity into a new lesson. PHV proposed, "$5^2 = 5^x$, find x?" as a question for connecting to the main content. However, SLY was concerned if student teachers could solve it or not because he thought they had not yet learned it. PHV realized that they had already learned the concept in high school, so at least some of them must be able to recall it. Then, SKH supported the idea, adding that they should ask the student teachers what kind of equation it is. At this point, they discussed further up to the group work or pair work. Suddenly, they realized they should start from the beginning of designing the mathematical task for reviewing the previous lesson. SKH and SLY considered discussing radical equation and inequalities as a reviewing part. PHV, however, did not agree with the idea; she would prefer using "$5^2 = 5^x$" as the previous lesson review activity because student teachers had already learned the other concept in high school. Additionally, if reviewing radical equation and inequalities, the content would not be connected to this lesson. After a long debate, lesson plan 2 was finally completed, as illustrated in Table 30. Furthermore, the following is a portion of their conversation during lesson planning 2.

SLY: Shall we use this, " $2^{x+1} = 2^4$"? (as an activity to transfer to a new lesson content)

…

CHP: What condition is necessary to solve an exponential equation? (a question to ask student)

SLY: If we will ask like that, then we will not have to write it twice.

PHV: If so, then, should we ask them this question because, we mostly refer to the properties.

CHP: The property of the same base.

SKH: They will not say, "$a^x = a^y$"; I do not think they can say this property.

SLY: Alternatively, we should raise a question for discussion. For example, if we want to solve an exponential equation, what should we do? Before we solve the exponential equation, what should we do first? If we do not introduce the property of "$a^x = a^y$" then, what kind of question should we ask them so that they will say, "we should transform it to be the same base," [as we want them to answer].

PHV: I think this kind of question cannot elicit the expression, "the same base."

SKH: I think [it] can. For example, what condition is important to solve an exponential equation?

SLY: I do not think they will say, "2 & 2"; I do not think they can express the same base.

PHV: [It] must have the same base, right?

SLY: They [would not] say [this]; they cannot think of that, trust me.

This short conversation illustrated that MTEs greatly considered student teachers' mathematical knowledge background concerning whether they would come up with the expected expression if they asked those kinds of questions. The main concept of this lesson was that, to solve an exponential equation, learners should first be able to transform the mathematical expression into the same base of both sides. This is the most significant expression for solving an exponential equation. Then, they remove the base and only calculate its exponents to find the value of x.

Table 30. Lesson plan 2 of TTC3-G5

Lesson 7: Exponential equation (60 minutes)

Objective: students will be able to transform and find the solution of exponential equation

1. Reviewing previous lesson (5 minutes)

1. $5^2 = 5^x$ (solved by student)

2. $2^{x+1} = 4$ In order to solve this problem, what kind of properties do we need? (what method will we use?)

2. Teaching new lesson (40 minutes)

1. $2^{7-3x} = 64$ students solve it individually (10 minutes)

2. $\left(\frac{1}{27}\right)^{5-x} = 9^{x-8}$ Student solve it in pairs (10 minutes)

Teacher selects 3 pairs to present in the blackboard

3. Conclusion

The property of exponential equation is $a^x = a^y \Leftrightarrow x = y$

4. Evaluation (3 minutes)

How can we solve this problem? $(0,2)^{2x=1} = 5^x$

5. Homework (2 minutes)

In this lesson plan, if the researcher compares it to the two earlier lesson plans, a change would be evident. At least, the quality of the discussion in lesson planning is deepening and increasingly intensive to the mathematical content and learners' awareness. MTEs were committed to contributing their wisdom to the lesson plan. The allotted teaching time and number of tasks were also reduced. Additionally, they did not leave everything to the teacher educator in charge of demonstrating the lesson; they worked together as a team. This implies that they started adapting themselves and gradually changing their concept of lesson study.

5.3.5 Research lesson 2 of TTC3-G5

On April 10, 2019, the teaching day for second lesson, SLY was the teacher educator who demonstrated this lesson while five (PHK, PHV, SKH, LVN, & YYG) were the observers. SLY began by introducing the observers as special guests, dividing the blackboard into two parts, asking if student teachers had any questions related to the previous lesson, Lesson 6.

Learners responded that they had no problems, and the MTE continued to the new lesson by directly asking what the value of x of $5^2 = 5^x$ was. Student teachers answered simply and quickly, “2,” immediately after the question. The teacher educator continued, asking, “How do we know if it is 2?” One student teacher said, “It referred to the definition of exponential equation.” The MTE asked the entire class if they obtained the same answer. Then, he showed the second question, 2^{x+1} =4, on the board and asked the class, “If we want to solve this problem, what strategy will we use?” Then, one student teacher answered that “we need to transform 4 into 2^2.” From the beginning, the researcher observed that same student teacher—who was sitting at the front—responded to the MTE’s questions. Because the student teacher replied with the correct answer, the MTE directly introduced the class to the new lesson—exponential equation in Lesson 7. The MTE wrote the lesson title on the blackboard with the additional question, “Have you ever learned about exponential equation before?” However, there was no answer from student teachers. Then, he directly distributed the worksheet to each student teacher. The question on the Worksheet 1 was to find the value of x of $2^{7-3x} = 64$. Every student teacher was required to work individually for 10 minutes. At that time, only six minutes had passed, and the first activity had already started. While the student teachers were working, some observers began walking around to see the student teachers’ work. MTE mentioned that student teachers must solve it based on their own understanding. The teacher educator checked some student teachers’ individual work, using the supportive expression, “good, good, good.” At this moment, the researcher noticed that none of the observers took notes; they were simply checking work or looking around with an empty hand (perhaps they might later take a note when they went back to their seat, hopefully). The MTE, while he was checking, sometimes claimed, “Most of the male student teachers had already acquired an answer, only some females were left [to answer the question].” Later, when the first activity’s time was up, the MTE directly showed his answer on the large white paper and stuck it on the blackboard. He asked if student teachers’ answers were the same as his. Then, he asked, “Which part of this answer [on the sheet] did you want to ask [for help]? For those who could not solve it, are there any questions? Is there any difference with this solving method?” However, no one responded. The MTE then allowed two minutes to take notes of the answer. Thus, there was no report from the student teachers for the first activity.

While the student teachers took notes, the researcher observed that some groups of student teachers continued discussing the problem among them. Perhaps, the MTE, SLY, did not notice that. The lesson then moved on to the second activity. The MTE asked student teachers to work in pairs and announced that he would select three pairs to report their work on the blackboard. Then, the MTE distributed the second worksheet to each pair, giving them 10 minutes to solve the problem. The question was “finding the value of x of$(\frac{1}{27})^{5-x} = 9^{x-8}$.” As with the first activity, the observers looked around the class and randomly checked student teachers’ work. Again, however, the researcher did not see any note taking or picture taking from the observers. Once time was up, the MTE chose three pairs to write their solution on the blackboard. Afterward, the MTE asked a representative of the pairs that had more mistakes than others to explain their results. This was followed by the pair with few or no mistakes (see Figure 25).

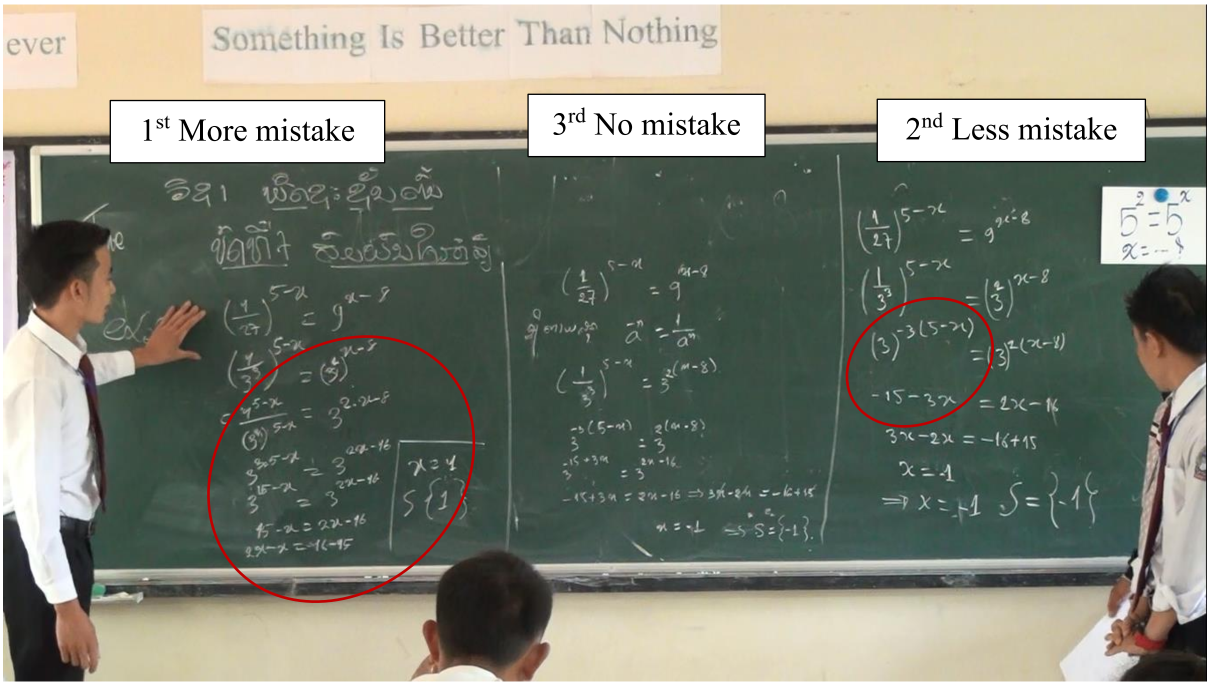


Figure 25. Student teachers report pair work of TTC3-G5

Once each student teacher finished their explanation, the MTE immediately located where each group made mistakes, and he agreed with Group 2’s answer (see Figure 25, in the middle of the blackboard). Therefore, he erased the two wrong answers to the left and right of the blackboard and allowed student teachers to take notes on the correct one. By this time, it was nearly the end of the class, so the MTE concluded by saying, “that was a technique for solving an exponential equation.” The MTE asked an additional question to confirm the student teachers’ understanding of the property of exponential equation that “if we wanted to solve an exponential equation, we should refer to which properties?” Student teachers replied, “$a^x = a^y$.” The MTE emphasized that “we should remember that property when transforming into the same base then taking the exponents [that are] equal to each other in order to solve the problem.” To make sure the student teachers understood, the teacher educator posted a question for evaluation: $(0.2)^{2x-1} = 5^x$. He asked, "If we want to solve this exponential equation, what we should do first?" One student teacher—sitting on the left-hand side at the front—answered, "We should transform 0.2 into 1/5 then we will get 5 powered by negative 1, when the base is the same. Then, we take the exponent of both sides equal to each other." At that moment, the MTE and all of the student teachers applauded him because it was correct instruction. Then, the MTE asked if they still had any questions to discuss, but there were no responses. Therefore, the MTE assigned some homework. Before the class was over, the MTE warned all students to take care of themselves during the Lao New Year as well as to prepare for examination; then, the class was over.

5.3.6 Post-lesson discussion 2 of TTC3-G5

As with the first lesson study practice, TTC3-G5 held a reflection session after the research lesson ended. This discussion lasted for approximately 30 minutes. After the group leader, PHK, gave an opening speech, the teacher educator, SLY, started evaluating his teaching. He first gave his general impression that the teaching was 80%, effective. To some extent, the student teachers understood the lesson well, and he followed each teaching step quite efficiently. Next, an observer, YYG, commented that the teaching was respectable. Firstly, however, more explanation was needed in Activity 1. Because the MTE simply posted the answer sheet on the blackboard without any explanation, some student teachers were still confused about it. Secondly, student teachers had difficulty with multiplication. He discovered that they did not use parentheses in the multiplication. Consequently, when they multiplied it, some numbers were missing. Therefore, the teacher educator should also clearly explain this point (he referred to the first more mistakes, see Figure 25). The second observer, PHV, commented that the teacher educator obtained the correct answer from the learners with the transitioning activity, 2^{x+1} =4, which was 2. However, the teacher educator did not investigate with additional questions for why we must change into 2 power by 2. Subsequently, it affected the first activity,$2^{7-3x} = 64$, with many student teachers writing it as "8^2." She also agreed with YYG that the teacher educator did not explain the first activity, including how or why he came up with the answer on the answer sheet. Furthermore, the teacher educator could identify the point when student teachers made multiplication mistakes, but the he neglected to explain at that point. Finally, the last point was that although the teacher educator identified student teachers' mistakes, he did not modify them to correct it so that others could locate exactly where the mistake was made. The third observer, LVN, also observed that some student teachers could not remember the exponent properties. She criticized that if the teacher educator had explained more on the point of $2^{7-3x} = 64$, then student teachers would perform better than this. In addition, the teacher educator did not explain or conclude first activity well, which caused some student teachers not to do well with the second activity. Similar to the two observers above, the teacher educator should point out where and why the student teachers made mistakes. The last point concerned Homework 1 and 2 that the teacher educator assigned; there was no relationship between this day's lesson and the exercise. At this point, the researcher also observed that the group did not discuss this point (perhaps the MTE randomly told the student teachers without properly checking them). The fourth observer, SKH, also criticized that the lesson implementer should better explain Activity 1 so that the student teachers can apply it to Activity 2. She generally criticized further that the teacher educator's explanation was incorrect at some points, while the arrangement of the student teacher's solution for Activity 2 was not in the correct order. Thus, the teacher educator should rearrange it in order based on the level of the mistake. During the teaching, tone student teacher arrived late but the teacher did not approach him; thus, the teacher educator should also improve this point. Finally, although student teachers were working in pairs, they actually worked individually without discussion. Eventually, the group leader, PHK, commented that it was a good teaching activity. The student teachers enjoyed it, and they did not become exhausted. Nonetheless, there is a need to review previous knowledge of the properties of exponent before conducting the other activities. When looking at it from the student teachers' side, they can only solve one that is similar to the example. If the base changes, they find it difficult to solve. He agreed with YYG's comment about the need to better explain Activity 1 as well as explaining the student teachers' mistaken points. More suggestions are also needed during the math problem evaluation so that student teachers could attempt to solve it at home. Many student teachers made mistakes, but the teacher educator could not bring them to the blackboard all. Thus, it became the teacher educator's weakness.

In sum, the overall comments of this teaching were criticism on the teacher educator's clarification of each activity, while little focus was placed on the student teachers' mathematical difficulties and their background of the properties of exponents.

5.4 Description of MTEs' views on their professional learning

At Savannakhet TTC, the interview was arranged in the small room that MTEs used to store mathematics teaching materials. Therefore, it was quite convenient for the researcher to work in this room as no one was using it. Working at Khangkhay TTC was also quite convenient because they provided a special room for the interview with nobody interrupting.

However, at Pakse TTC, it was a bit difficult for the researcher because the interviewee was employed within their office. Sometimes, the discussion was paused for a while when others asked something related to their work.

Each MTE in each TTC was expected to engage in the interview after each procedure of lesson study practice. For example, they were asked to be voluntarily interviewed after lesson planning 1, research lesson 1, and post-lesson discussion 1. However, practically, it was difficult for them to immediately partake in an interview session following each process, and most of them cooperated after each cycle of lesson study practice. Five main questions were asked during the interviews with MTEs: 1) What did you learn when planning the lesson with your colleagues? Please give some specific examples; 2) What did you learn when you observed/implemented the research lessons? Please give specific examples; 3) What did you learn through the post-lesson discussion? Please give some examples; 4) What do you think about the issues of this lesson study practice? Please give some examples; 5) What do you want more understand of regarding lesson study? Moreover, follow-up questions were asked when their descriptions were not clear to the researcher. For example, "Please provide more details about not being able to see while others were able to see it?" As SKH said, "There are four steps. What is it about?" The MTEs responses to those questions varied based on what they had just experienced from the actual lesson study practices. Mostly, they described what they accomplished. For instance, JNL replied as follows: "[We] exchanged ideas with each other; one more thing I [now] understand [for] how to teach children… Initially, we discussed that we used to only teach adults. When we make a lesson plan, we face difficulty in the introductory part of the lesson…" (please see details of the discussions in Chapter six and Appendixes F & G).

CHAPTER SIX: ANALYSES AND DISCUSSIONS

This chapter consisted of two main parts, analyses and discussions. The analysis part attempted to demonstrate the MTEs' professional learning through triangulation data analysis. This triangulation data analysis included research lesson analysis, discussion protocol analysis, and interview data analysis. The research lesson analysis expressed changed and unchanged points. The discussion protocol analysis demonstrated the emergences of the MTEs' professional learning in both teacher role and teacher educator role (if available) supported by some evidence. In addition, the interview data analysis also demonstrated the emergences of the MTEs' professional learning through the main categories, subcategories, and examples that are supported by the MTEs' utterances as the evidence. Finally, this part concluded by conceptualizing the tendency of the emergences and judgments the depths of the MTEs' professional learning. While the discussion part, the study attempted to elaborate on the MTEs' professional learning and issues in comparison with previous studies within those four domains, including knowledge, teaching-learning resources, instruction, and collaboration.

6.1 Analysis of lesson study practice in Savannakhet TTC

6.1.1 Emergent changes in the research lessons of TTC1-G1

Data analysis found out that although the teacher had no lesson plan 1 in hand, she still remembered some parts of the content. At least she delivered the introductory and conclusion part as well as utilizing teaching materials. While the main content of this lesson has been skipped but was pointed out at the conclusion part. As a result, the students were convinced to understand the lesson in another direction. Additionally, the unplanned questions were given to the students. Whereas, in the research lesson 2, the students were just sitting and waiting to answer the questions raised by the teacher. However, when critically look at the both research lessons, some changes occurred. At least the teacher had the second lesson plan in hand that she often looked at it and followed it quite well. In contrast, there were some unchanged points, such as the content of the lesson plan, and the way of teaching was relatively unchanged. There was nothing on the blackboard for the students to jot down into their notebooks. The teaching was teacher-centeredness as like the first research lesson. The teacher was talkative and asked too many questions as the first lesson. More importantly, the main mathematics content was still missing in this second research lesson. Those changed or unchanged points were probably affected by how the first and second lesson was designed. The following section demonstrated the emergent points of the MTEs' professional learning during the first lesson planning.

6.1.2 Protocol data analysis of lesson planning 1 of TTC1-G1

In the lesson planning 1, the data analysis only found the MTEs' professional learning as the role of teacher. This finding included the emergence of knowledge, teaching-learning resources, and instruction. First, there were two kinds of emerged knowledge, including curriculum knowledge and subject matter knowledge. The curriculum knowledge has been captured when the MTEs interpreted the meaning of the lesson's objective in order to build a central understanding of both the whole concept of the lesson and the goal of the lesson that the MTEs wanted to achieve. The MTEs even verbally modified the objective in the teaching guidebook to make it easier to understand and to be suitable for the level of primary mathematics. However, this verbal modification of this lesson objective has not been adopted in this lesson plan, because, perhaps, they were afraid of making a mistake if they put away from the teaching guidebook. While the emergence of the subject matter knowledge was showed when the MTEs elaborated on the concept of this lesson to each other. For instance, even though the shape or container of the water has been changed, the amount of water remained unchanged. This expression would, then, internally form the subject matter knowledge about this lesson concept to the group members. Second, the emergence of the teaching-learning resources, especially about teaching materials, was revealed when the MTEs collaboratively adapted some existing local materials to suit the lesson and when the group members discussed how and when the teacher and students would utilize these local materials. For example, the water and milk bottles that could be easily found everywhere. This is very important for the teacher to plan in mind how she would handle or manage the class to make use of materials smoothly especially when demonstrating the materials and asking the questions interactively. Third, the emergence of the instruction that included instructional sequencing. The MTEs paid much attention to making a connection in each teaching step. This claim was evident because, initially, the MTEs discussed each other about reviewing the previous lesson. Then, they designed to show up the water bag to the whole class to talk with the students about the amount of water and its color inside the water bag. The group members expected the teacher to demonstrate three ways of presenting a plastic bag, such as, pressing the bottom of the water bag upward, putting it on a palm, and putting it on a tray. After that, the group members discussed the group work activity and designed what questions should ask as well as teaching materials manipulation. They, then, collaboratively designed how the lesson should be concluded.

6.1.3 Protocol data analysis of post-lesson discussion 1 of TTC1-G1

Holding in mind the situation of the lesson plan 1 was not given to the lesson implementer, the data analysis still found MTEs' professional learning in two roles, MTEs as the teacher role and MTEs as the teacher educator role. In association with the discussion during the lesson planning 1, the MTEs' professional learning as the teacher role found the emergence of knowledge and instruction. This knowledge included only students' conceptions that were expressed by the MTEs' discussion about how the students understood either the amount of water or the shape of the water containers. The MTEs could see students' conceptions about the connection between the height and the volume of the water. When the level of the water is getting higher, then the amount of water is also getting to increase and vice versa. In addition, the MTEs were also able to capture the students' reasoning why the volume of the water increases or decreases. Through the MTEs' lens on the students' conceptions, the amount of the water was influenced by the size of the water containers in which it could be measured through its level. Actually, it was not.

In terms of the emergence of the instruction as the role of teacher, the evidence indicted this domain included description of instructional components, teacher's instructional behavior, and suggestion for using teaching materials. These instructional components included the expression of students' responses, students' collaboration, and their participation in the activities. These also included the illustrations of well-prepared the lesson plan, teaching materials, and well-followed the planned lesson. However, those aspects of the instruction were just simply listed down by the observers without its details. The teacher's instructional behavior also indicated the emergence of this instruction as the group members criticized the teacher about not using questions properly because the teacher repeated the same question several times even though the questions were already responded. This emergence implied that the teacher just kept asking the questions without considering the students' responses, as well as the content of the questions itself, which was sometimes too broad and challenging for the grade 1 students. Probably, what the teacher asked was not based on the lesson plan but additionally added at the moment during the teaching. Furthermore, the suggestion on using teaching materials was given by allowing the students to manipulate the water bag themselves because showing up the materials per se wouldn't guarantee if the students would understand quantity preservation.

While the MTEs as the role of teacher educators, the study found the emergence of teaching-learning resources and the instruction. The teaching-learning resources was expressed by the suggestion of strategy for student engagement, such as dividing students' duties in the group work and allowing students to manipulate the teaching materials. Regarding the emergence of the instruction, the MTE suggested the strategy for improving instruction about the quantity comparison. The MTE suggested that demonstrating the three different ways of water bag, such as, pressing it up, putting in a palm, and putting in a tray, were needed before asking the questions if the plastic container contains more or less amount of water. Furthermore, there was a need to ask further profound questions to make the lesson concept clear to the students.

6.1.4 Protocol data analysis of lesson planning 2 of TTC1-G1

Data analysis revealed the emergence of the MTEs' professional learning in two roles as like the post-lesson discussion 1. As the role of teacher, the study found the emergence of knowledge, teaching-learning resources, and instruction. However, as the role of teacher educator, the study found the emergence of instruction only.

Of the teacher role, the knowledge domain consisted of the students' conceptions only. This point was evidenced by the awareness of students' language ability and their misconceptions toward the comparison of amount of water. The MTEs argued regarding previous students' situations when making a comparison that the students didn't consider the size of the containers but paid attention to the remaining water in the bottles. Those arguments made the MTEs realized the necessity of designing proper questions to extract students' thinking. As for the evidence of the students' language ability, the group members expressed their concerns if the students have already known or understood the meaning of the word "comparison" because they expected to get the word comparison out from the students' responses. Actually, based on the researcher's analysis, in the previous lesson, in lesson 11, the students have already studied about the length comparison. The students might have already had a concept of comparison to some extent. However, the group members didn't realize this point.

Regarding the emergence of the teaching-learning resources, as the role of teacher, the strategy for the students' engagement was evident. The MTEs emphasized how to involve students in the designed instructional sequencing; notably when the teacher demonstrated pouring water from the bottle A into the bottle B. The second point of the strategy to interact with the students was the discussion of the method that students may use to compare between the two containers. The group anticipated students' responses in several ways. For example, they may compare it by their necked eyes through placing the two bottles side by the side of each other and measuring them by a small bottle or cup. However, the MTEs didn't have in-depth discussions about why the students would respond in such ways. At these points, the researcher would interpret that if the students replied that they knew by noticing or just looking at the two bottles, then the students might do guessing or estimation in which it might be a subjective method. If the students pointed out the way of placing it side by side, then the students might use previous knowledge of length comparison by seeing which one has a higher level of water. In this method, the students might consider only the level of the water but not the size and shape of the objects. And if the students responded about using a small bottle as a unit to measure it, then, they would see both guessing and length comparison were not certifying the accuracy of the quantity. Hence, this latter method might be, perhaps, the main objective of this lesson that the MTEs want to get from the students.

Furthermore, of the teacher role, this study also found the emergence of instructional sequencing when the MTEs emphasized the coherence of the instruction. Because the MTEs designed the content of the instruction as like a story. They wanted to have productive conversations and well connected in each stage. They even discussed the scripts how the teacher was supposed to say and what likely the students would respond to the teacher's talks or given questions. The group members designed the sequence of the instruction in a teacher-centered way. They agreed not to let the students manipulate the materials. Instead, the teacher would do all the demonstration while the students were designed to notice and respond to the teacher's questions only.

Data analysis also found the emergence of the MTEs' professional learning as the role of teacher educators in which it was demonstrated by the evidence when one MTE proposed the alternative instructional strategy to the group members. The MTE suggested an alternative idea to directly tell the students about the unchanged amount of the water because he thought that it was already the previous lesson. After that, he suggested to let the students focus on predicting between 2 different bottles if one would contain more water than another one. And finally, he proposed his idea to the group members to use a small cup to measure the different amounts of water in the big bottles. Unfortunately, his alternative view didn't get any support from others.

6.1.5 Protocol data analysis of post-lesson discussion 2 of TTC1-G1

Data analysis found the emergence of the knowledge and instruction domain in terms of the teacher role and found out the appearance of the instruction domain in terms of the teacher educator role. This knowledge about students' conceptions was expressed by the evidence of when the MTEs generally perceived that some students had more engagement in the teaching-learning activity, at the same time, some of them did not do so. As the lesson implementer, SPC commented to her students that "…there are some students don't pay attention…[but] most of the students understand comparison…". This homeroom teacher could notice the general picture of her students while she was teaching. VNK also noticed that "students are on alert…they stand up; it means that the students pay interest in what the teacher is doing…one student in the middle says that bottle A is fat it contains more than the bottle B…" He further added that "…although we haven't asked a question, still they discuss with their friends that it is big, it is fat, that one is tall, slim and they discuss with each other…" This MTE had at least paid attention to student participation. He could even identify which students could respond to the teacher's question. Those illustrated that although the MTEs didn't explicitly interpret students' learning, difficulties, misconceptions and/or the meaning of the students' expressions, those reflections hindered the necessary students' conceptions subtracted from this research lesson 2. Furthermore, this study also discovered the emergent instruction in terms of the role of teacher, that was, an unordered instructional sequence. This term could be explained by the discussion of the demonstration of indirect comparison before the direct comparison. One of the MTEs criticized that if the teacher put the two bottles next to each other at the beginning, then the students could quickly identify the difference in the amount of water when they look at the level of the water in each bottle. However, if the teacher demonstrated by pouring the water from the bottle A into the bottle B as the first activity, then the students would wonder why it was overflowed. This would raise a lot of rooms for discussions among the students.

The instruction has also emerged in the role of teacher educators. The evidence of this emergence was hard to find. However, at least one MTE suggested the homeroom teacher improve her questions to stimulate students to think as well as asking the students to demonstrate the comparison themselves to conclude the achievement of the lesson. As JNL suggested that "…I want the teacher to try to ask more deeper questions how the water bottle and milk bottle is… ask students what kind of comparison it is. Let them come to the front to compare using the bottles…"

6.1.6 Interview data analysis after lesson study 1 of TTC1-G1

Through the interview data analysis, the study categorized the MTEs' professional learning into three themes, such as teaching-learning resources, instruction, and collaboration (see Table 31). First, the views of MTEs classified in the teaching-learning resources because, at least, they pointed out about students' participation in teaching-learning activity. They were able to see that students showed interest and well engaged in the activity. Those points hindered the promising to deepen their focus on students' learning or thinking at the next level. Second, the emergent views about instruction included subcategories of teaching materials, classroom management, questions, and language use in the classroom. Prior teaching delivery, it is mandatory for the teacher to clearly understand the lesson plan not only the content of the lesson itself but also the flow of the lesson, learning tasks that students would be working on, main and sub-questions that would be used to investigate students' thinking including how to organize blackboard nicely. While the teaching-learning activity is ongoing, the teacher needs to be well classroom manager in order to get all students involved in the learning tasks. Third, the MTEs perceived collaboration as their professional learning because they had an opportunity to share and exchange some ideas with others to find a tune for the better lesson plan of a particular lesson topic as well as to build a central idea for a common understanding about the lesson plan. Moreover, MTEs perceived that they got some ideas from others because different people see different things with different interests. Other people's views and suggestions could also help MTEs see what they couldn't see.

Table 31. Views on MTEs' professional learning in lesson study practice 1 of TTC1-G1

Main theme	**Subcategory (No. of Codes)**	**Coding examples**
Teaching-learning resources	Student participation (4)	Students do activity well
Instruction	Teaching materials (6)	Using concrete teaching materials
	Classroom management (5)	How the teacher controls the class
	Instruction (4)	Blackboard use
	Questions (4)	Questions are too difficult for students
	Language (2)	Appropriate language for children
	Understanding lesson plan (1)	Teacher doesn't understand lesson plan
Collaboration	Sharing ideas (8)	Sharing common understanding on lesson plan
	Getting from others' views (7)	Learning from other suggestion
	Collaboration (2)	Well participation of members

Regarding the issues in the lesson study practice 1 (see Table 32), the data analysis found the issues about collaboration, instruction, task design, and points for observation. MTEs perceived that non-trial lessons made today's lesson different from the original group design. In addition, prior to the day of the teaching day, the group agreed to meet each other again to check the readiness of everything. However, the primary teacher didn't come, and the group also didn't change the teacher who would teach the lesson. The MTEs criticized that the teacher spoke too much during the teaching, but some important questions were missing in the lessons. Moreover, there was nothing written on the blackboard. The group members also argued that the teacher didn't demonstrate how to do the activity to students at first before allowing students doing pouring water activity. Regarding the task design, MTE had the issue of designing an introductory part of the lesson. Regarding the focal point for observation, they don't know how to observe. As JNL honestly claimed that "…the issue is how to observe, I don't know when to focus on teacher and when to focus on students. I only observe generally…"

Table 32. Issues of lesson study practice 1 of TTC1-G1

Main theme	Subcategory (No. of codes)	Coding examples
Collaboration	Preparation (6)	No lesson plan is given to teacher
	Collaboration (2)	We make lesson plan, but she teaches
Instruction	Teacher behavior (6)	Teacher speaks too much, no key questions
Teaching-learning resources	Task design (3)	Difficulty in designing introductory part
Points for observation	Points for observation (1)	Don't know focal point to observe lesson
Collaboration	Time and workload issue (1)	Time consensus and busy issue

6.1.7 Interview data analysis after lesson study 2 of TTC1-G1

From the results of interview 2, the study found out only the emergence of the instruction domain that included teacher behavior, instructional technique, and questioning skills (see Table 33). The teacher's teaching behavior included some criticisms. Such as, the teacher didn't follow the lesson plan well, the teacher didn't give much opportunity to students to discuss the activity, and the teacher's ability to capture students' responses, and not following the lesson plan well because the teacher taught direct comparison at first before the indirect comparison. While the questioning technique, one of the group members perceived that she gained professional learning about this questioning technique by firstly asking indirect questions before deepening the questions in some interesting area. She further added that making good classroom atmosphere, technical skills to call student attention and student participation in the activity were the points that she got from the lesson study participation.

Table 33. Views on MTEs' professional learning in lesson study practice 2 of TTC1-G1

Main theme	Subcategory (No. of codes)	Coding examples
Instruction	Teacher behavior (7)	Not well followed as planned
	Question (3)	Teacher should ask more deeper questions
	Instructional technique (2)	Technique to attract students' attention
	Student participation (1)	Students are pretty well participated in activity
	Language (1)	Using the word "containing" instead of "quantity" may confuse students
	Sharing idea (1)	Exchange experience for best lesson

Regarding the issues, it is not necessary to demonstrate in a table because of the amount of data itself is too little. The issues that occurred in the 2nd lesson study practice based on MTEs' perceptions were teaching materials, how to get student attention in a lesson, workload, and time to meet each other. VNK mentioned about the issue of teaching material is that they didn't have something to cover tables during students doing the activity of pouring water so that the tables would not get wet when the water spilled out. Whereas JNL found the issue in getting students' attention during the teaching. She wants to know how to handle this situation to get all students involved and commitment in the given activity.

6.1.8 Summary of the MTEs' professional learning of TTC1-G1

The MTEs' professional learning in this TTC is summarized into two roles, teacher role, and teacher educator role. As the teacher role, the highest level of the emergent professional learning remains in level 1 because the curriculum knowledge and subject matter knowledge were emerged only by chance and limited when the MTEs elaborated the meaning of lesson objective and lesson content to the others during the lesson planning 1. Although the students' conceptions tended to occur in each process of lesson study cycle, it simply described students' participation in the activities and the concern about the students' understanding in some words and given questions. At this level, the teaching-learning resources, especially about teaching materials and student engagement tended to emerge only during the lesson planning 1 & 2. Interestingly, in the level 0, the MTEs put the emphasis very much on the instruction domain specifically in the post-lesson discussion 1 & 2. The MTEs emphasized the lesson implementer about improper asking questions, teaching behavior, classroom management, unordered teaching sequence, suggestion on using materials, and appropriateness of the materials. Consistently, this level 0 also included the emergence of the MTEs' professional learning in the role of teacher educators. This study found out only the suggestion of strategy for student engagement, alternative instructional strategy, and suggestions for instructional improvement. This finding implied that there are a lot of rooms for the MTEs to improve in this role in order to reach the highest level of their professional learning through lesson study practice.

Arguably, the weakness of curriculum analysis might be the main cause of all those limitations because failure in curriculum analysis impacted the weakness of lesson design, lack of main lesson content, and lack of main mathematical tasks. Furthermore, the situation of strictly following only daily curriculum prescribed in the textbook made ignorance of the curriculum analysis that limited the MTEs' opportunity to see the lesson concept as a whole in a long-term goal for student learning in the concept of quantity. However, well curriculum analysis doesn't necessarily mean that the MTEs would be critically analyzing students' mathematical thinking and making a connection to the mathematical concept or leading to the creation of the teaching theory. This claim is something that needs further investigation.

6.2 Analysis of lesson study practice in Pakse TTC

6.2.1 Emergent changes in the research lessons of TTC2-G3

This first lesson was done very well in terms of allowing students to think and explore during the research lesson. In general look (i.e., the number of tasks, time spent in the lesson, student engagement in the tasks) their focus on mathematical thinking and mathematical content were very impressive and suitable for the first-grade students. The mathematical task of the first lesson was also nicely created by the team members by adapting from the exercise. In the original content, it was only a number sentence of 15-7, but the team changed to the word problem "Thao Itim has 15 oranges, he gives it to his friends 7 oranges, how many are left over?" This mathematical problem was very important for the students to think about the concept of subtraction contextually because it was somehow related to the students' real-life situation. However, looking deeper into the process, some issues occurred. The group members didn't interest in the diversity of students' mathematical thinking or several solving methods. Rather, they ruled the students to solve by decomposition in two ways. As a result, the students were indirectly forced by the teacher to go such a path by providing worksheets with clear blocks of decomposition. Besides, during the teaching in reviewing the previous lesson part, the teacher already demonstrated these two ways of decomposition. That was like a guide for the students to follow. The more obvious statement was that the teacher often emphasized the students to do their worksheets by following the same method in the introductory part. Moreover, while the students were doing their worksheets, the team members tried to assist students by asking some additional questions. It was hard to say that their solutions in the worksheets were the students' ideas or the team members' input because they were like teaching in a team. Another issue was the conclusion part. The status of unclear in the making lesson plan made the conflict between the teacher and group leader in concluding the activity to summarize the final idea for the students to take note.

Regarding the second research lesson, at least there were some changes. For example, the MTE acted as the primary teacher's role to conduct the lesson; the number of mathematical tasks was increased. Nonetheless, several things didn't change as well, such as there was no difference between the mathematical problem in reviewing the previous lesson and the main mathematical problems in both two research lessons. The conclusion part remained an issue as the first research lesson, and the way of teaching and supporting students were not changed. They also rejected students' basic counting methods but stuck on the decomposition method as the first lesson because it was implicitly mentioned in the curriculum or textbook. Of this second research lesson, the MTE faced difficulty with moving from the activity of reviewing the previous lesson to the main tasks. She was trapped by way of students' solving method because most of the students came up with only counting method instead of the decomposition method that they used to learn in several previous lessons. Those difficulties slowed her down the second task unfinished. Regarding the mathematical tasks, this lesson called more interesting mathematical thinking than the previous research lesson because it contained two aspects of subtraction. For example, "there are 7 pigeons and 15 sparrows, which types of bird has more amount, and how many?" and "there are green and red apples totally 13 apples, there are 6 red apples, how many green apples?" Consequently, the observers or team members had to work harder to stimulate the students to be able to solve those questions. As mentioned earlier, this lesson was like a team teaching rather than an individual lesson because the observers acted more than the observers' role.

6.2.2 Protocol data analysis of lesson planning 1 of TTC2-G3

As the role of teacher, the protocol data analysis found the emergence of the MTEs' professional learning in the knowledge, domain, teaching-learning resources, and instruction. The knowledge contained curriculum knowledge and students' conceptions; the teaching-learning resources contained lesson content conceptualization, mathematical task design, and strategy for students' engagement; the instruction contained only instructional sequencing; and the collaboration contained collaborative lesson planning and preparing materials to support the mathematical tasks. The following are the details of each emergence in each domain.

The curriculum knowledge is evidenced by the interpretation and modification of the lesson objective. The MTEs interpreted the implication of the main objective to suit the main content of this lesson. They even created sub-objectives in which it was very important to narrow down the focus of the lesson and to be consistent with the mathematical problem. The group brought the word "decomposition" into this lesson as the main term even though there was no any sentence mentioning about it in the main objective. The decomposition is crucial to enhance students' conceptions about subtraction by borrowing because using the concept of decomposition; the students don't have to borrow from the tens place value. Rather they could subtract 10 by the subtrahend, which was decomposed earlier, before adding its result with another decomposed number in which it would be the final answer. The curriculum knowledge had also emerged when the group members considered other word problems, which were another type of subtraction. For instance, the question of "how many are left over?" This statement is to find the remaining objects and "how many more?" This statement is to find differences. Those mathematical problems implied to capture a variety of students' mathematical understanding about the subtraction. However, the group members concerned the difficulties to elicit students' mathematical thinking when they discovered the lesson related to such a problem has not yet been taught. Hence, in connection with this lesson, they conceptualized ahead for the next teaching topic within this lesson.

The students' conceptions had emerged when the group members made assumptions about students' difficulty and ability if they could solve subtraction using decomposition techniques. The group concerned that the students would get confused if the teacher changed the position of the number from a usual place, 10 at the front, to the new place, 10 at the back; because the students were taught only one-way direction of the decomposition so far. To overcome this, the group members emphasized reviewing the previous lesson as the most significant point in order to give the students a clue or an example to solve the main activity. Still, they were concerned if the students could see the teacher's attention and figured out the hint while the teacher had to be patient not to tell the students directly. This situation was considered as a critical moment in how the teacher would facilitate the students to go through as what the group members wanted and how the students would see the connection and utilize the reviewed part to solve the new mathematical problem. The students' conceptions had also emerged when the MTEs had an awareness of the students' mathematical ability and prior mathematical background. The evidence was obvious when the MTEs could capture that the students could calculate the number sentence of subtraction very quickly using their familiar or traditional method. For example, the homeroom teacher expressed her observation that her students could also do decomposition but had difficulty to explain their strategy even if their answers were correct. The MTEs further anticipated that when the students dealt with the subtraction about borrowing (the ones place value of the minuend is less than subtrahend), they would use a method of counting fingers to solve it. However, they might face difficulty when the number of minuends greater than 10. The MTEs also perceived that even if the students could do the decomposition, they would have some difficulties to put it in the provided empty spaces in the worksheet. Positively, KHL interpreted that even though the students might use their basic skills of counting fingers, if the students could keep 10 in mind and use counting on method, that meant the students had basic background of the decomposition.

Besides the emergence of knowledge, the study also revealed several pieces of evidence regarding the emergence of teaching-learning resources. First, when the MTEs conceptualized the main lesson content if they could modify what has been already taught by the homeroom teacher. The group members were not pretty sure if the students have really understood the subtraction using the decomposition. It implied that the group wanted to evaluate or re-check if the students had a conceptual understanding of what they have been taught so far. Consistently, even though this lesson topic was already taught, it was only one-way of the decomposition. As the homeroom teacher confirmed that "when I practice them, I only put 10 here in the front, they are familiar with this [format]. If we do this format [by putting 10 as the second term], it would be another new thing for them." Consequently, the MTEs agreed to modify the lesson to use two ways of decomposition as mandatory for the students to solve the main mathematical problem, and these two ways became their expectation from the students' mathematical thinking. It inferred that the MTEs' professional learning has occurred through the main lesson content conceptualization. Second, designing mathematical tasks became central to this lesson topic after the conceptualization of the main lesson content. The MTEs discussed several possible subtraction expressions by randomly selecting from the available exercises in the textbook. They even proposed 12-3, 12-7, 15-6, 15-3, before decision making to select 15-7 as the main mathematical problem. The group then contextualized this abstract mathematical sentence into the word problem in order to make a connection between the real-world and mathematics world. They proposed some terms of concrete materials to visualize the students when they read this word problem — for example, mangoes, butterflies, flowers, and finally, oranges as their preference. As KHL interpreted 15-7 into the word problem that "… there are 15 mangoes, 7 mangoes are eaten, how many mangoes are left over?" Whereas, VVL proposed another option like there are 15 butterflies, "7 butterflies are flying away, how many are left over?" These discussions showed the emergence of the MTEs' professional learning through mathematical task design. Third, the MTEs discoursed about teaching materials for a worksheet design. The group members used pictorial materials to represent the real objects, the orange, in this case. The group provided both colored figures put in the students' worksheets and for manipulation on the chalkboard. Fourth, the strategy for students' engagement has obviously revealed in the MTEs' discussions in the lesson planning meeting. The MTEs figured out several strategies to help the students to come up with these two ways of the decomposition, perhaps, the right answer as well. These strategies included randomly assigning some students' names to put in the mathematical problems; by asking a series of questions to investigate students to think even deeper. (i.e., 12-3, "can we subtract 2 by 3? Why we can't?" -KHL); by emphasizing the homeroom teacher to explicitly introduce the two ways of decomposition; by designing a worksheet with drawing some blocks for the students to fill in; by considering the students to work in group, in pairs, or individual, and how to handle the students' discussions about their works; and by giving some exercises related to the main problems to practice at home a day before the actual lesson.

The instruction domain rarely emerged in this lesson planning 1. It was discovered when the MTE discussed the instructional sequencing, especially when he suggested the homeroom teacher to follow the Open Approach, the one that they usually used when they practiced weekly research lesson. The MTE suggested that the teacher should allow "students an opportunity to talk, arranging students in order to present their works."-KHL.

As the role of teacher educator, there were emergences of the teaching-learning resources and the instruction. The emergence of the teaching-learning resources was evidenced by the strategy for student engagement that was demonstrated when the MTE asked the team members to think about the strategy to engage students in solving mathematical tasks. The MTE simulated the group members to find out other strategies if the students' solutions were not corresponding as expected specifically to make students realize to use the decomposition method. In addition, the MTE also offered an alternative strategy to interact with the students about the subtraction using the decomposition method. As demonstrated in KHL's suggestion in the following statement

> When concludes the reviewing previous lesson part, the teacher must make it clear to the students. For example, 12-3, we subtract which one by which one? Can subtract 2 from 3 (2-3)? Why it can't be? Must allow students to say. If students cannot do it then what should we do? If they cannot do then [we might say] we already know that 2 is less than 3, can it be subtracted? If no, its meaning is less than, we want to hear that. Now, what should we do next if the students cannot do it in order to make students know about the decomposition … Now once they decompose it, we got this way, and students only get used to only one method, the teacher must say that can be write in this way, put 2 here and put 10 here or put 10 here and put 2 at the front, can we do it or not? Why? The importance is to make students know that we can put any position…

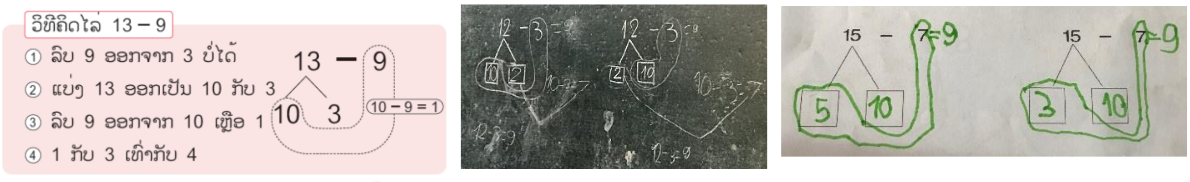
The study also expressed a little emergence of the MTEs' professional learning in the instruction domain that was expressed by the suggestion to make it clear about reviewing the previous lesson so that the students would follow it in order to solve the main mathematical task. In this case, one of the MTEs suggested the homeroom teacher makes it clear the way of solving the previous lesson into two methods of decomposition before moving on to the main activity. The emergence of the role of teacher educator was also illustrated when KHL asked the group members to think of an instructional strategy of the main lesson as well as when he suggested alternative instruction by using an Open Approach (Inprasitha, 2015) for this lesson study practice. As KHL suggested that "… we might do this way, and the teacher must conclude it clearly into two methods … Show it clear the decomposition from left-right, right-left … How about the teaching step? What to do about the situation of the problem?"

6.2.3 Protocol data analysis of post-lesson discussion 1 of TTC2-G3

In this process, the study found the emergence of professional learning in two roles as the lesson planning 1. As the role teacher, the protocol analysis found only the emergence of the knowledge (mathematical knowledge and students' conceptions). While as the role of teacher educator, there was only the instruction.

As the teacher role, mathematical knowledge had emerged when the leader of the group pointed out the necessity of the decomposition. For example, when the number is getting larger, a basic method by counting fingers may not be applicable. Therefore, to decompose a large number of more than 10, there are several possible pairs that a large number could be separated.

As KHL reflected that “can it be decomposing in other numbers? Yes, it can, but it should not be less than number 9. So, the simple way… if decompose 12, then it will be 10 and 2 or 2 and 10…” It implied that for this lesson, especially in the reviewing previous lesson part, the number 12 could be decomposed into several pairs such as 11 and 1, 10 and 2, 9 and 3, 8 and 4, 7 and 5, 6 and 6 and so on. However, to be easy for the students to understand, decomposing into a group of 10, in this case, the pair of 10 and 2, was selected to be the best representative of other pairs. The second point expressed the emergence of the mathematical knowledge was about drawing a line to cover the pair numbers for operation after the decomposition because the teacher strictly followed an example from the textbook (see Figure 26). So, KHL suggested her removes drawing those complicated lines because he noticed that the students spent much time drawing those unnecessary lines. Through this situation, it inferred that the homeroom teacher would gain a new way of representing subtraction by decomposition, not just exactly following the textbook.



a). From textbook b). Teacher’s teaching c). Student’s work

Figure 26. From the textbook to teaching and student learning

Of the knowledge, the MTEs’ professional learning regarding students’ conceptions was also revealed when the MTEs discussed some points of the students’ confusion. Even if the answer was correct, the MTEs could see a noncorresponding point between drawing the diagram to identify which number subtracted by which number and writing subtraction expression. The consistency between these two things implied how well the students understood subtraction by decomposition. The MTEs noticed that the students learned by remembering the position but not by understanding the content because when the position of the number was changed the students still drew the diagram with the same position as the first method. The MTEs would have seen that the students were unable to see the relationship between drawing lines and subtraction number sentences. Nonetheless, although they made a mistake in drawing, the students understood something that was the subtrahend must be subtracted from the greater number of the minuend. Therefore, the students wrote 10-7=3 in the second method (see Figure 27).

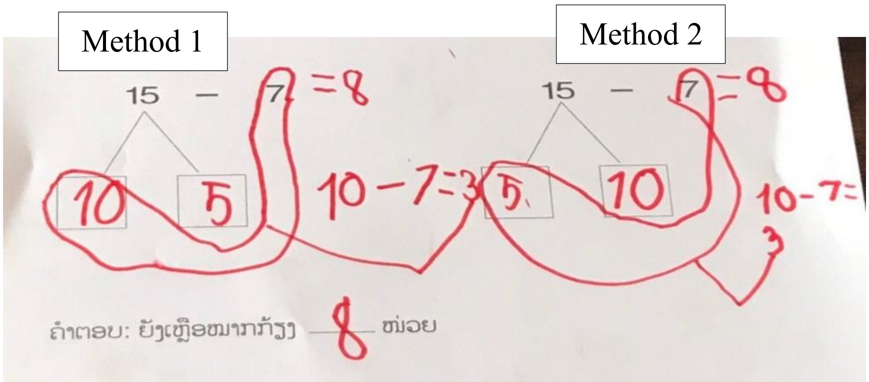
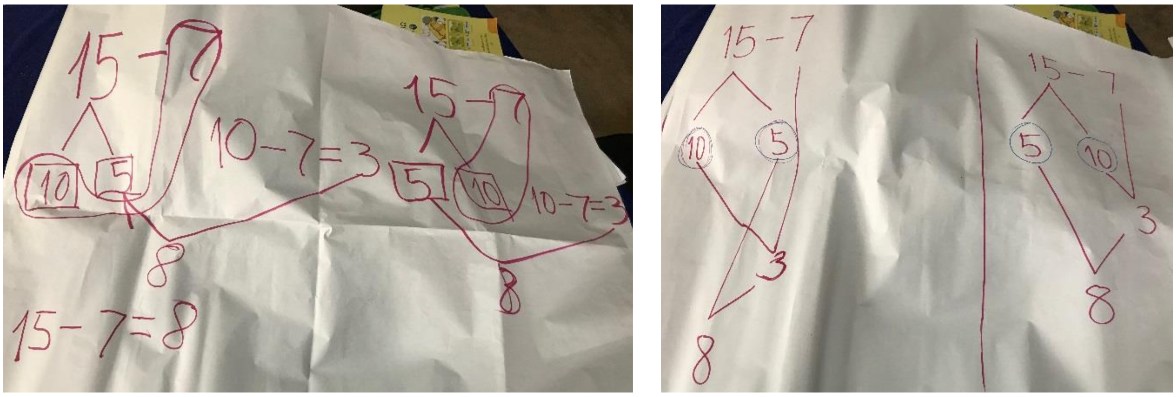


Figure 27. Students' difficulty in solving subtraction.

Students' unordered processing skills in solving subtraction by the decomposition was also another concern of the group members in which it was the MTEs' Professional learning regarding the students' conceptions. MTEs noticed that the students did a calculation before the minuend has been decomposed. They argued that it was, perhaps, because the teacher had shown the equal sign while they were doing reviewing the previous lesson. Consequently, the students automatically wrote the equal sign in the subtraction expression even if the given worksheets didn't prepare for them (see Figure 27). Then the students would pay concentration on finding the answer in the first place by solving the subtraction expression before the decomposition. KHL also observed that the students could quickly solve the mathematical problem using their basic skills of counting method as soon as the teacher has posed the question in which it implied that the mathematical problem was not much challenging the students' ability. As he commented that "Here, here, when you put the equal sign in the subtraction expression, then the students will not concern about the decomposition in the first place, but they will pay attention to finding an answer. Therefore, don't put it". This statement implied the weakness of anticipations about how the students would likely to do, what kind of students' misconceptions or difficulties toward the given mathematical problem would be occurred. Rather they simply listed the correct answer or procedure that the group needed. See MTEs' anticipation about the students' work in the appendix L.

As the role of the teacher educator, the MTEs' professional learning regarding the instructional strategies had emerged when KHL and VNK gave some suggestions. First, there was a need to frequently emphasize these two methods of decomposition so that the students would be aware of it when they were solving the main activity. Second, the need of an elaboration about these 2 methods "what is the difference between the method 1 and 2? … must be given to the students so that they will see how it is different from the first method…"-KHL. Third, the teacher's communication with the students in the introduction stage needed to be improved in order to avoid the students' misunderstanding toward the mathematical task. "Because the teacher mentions that do as reviewing the previous lesson does. So, the students understand that to decompose into 10 and 2, even 15 they also decompose into 10 and 2"-VNK. Fourth, finding additional time to practice this important topic to the students by drilling on the exercises and training the students to be able to express their ideas property. And finally, the suggestion of how the main activity would be concluded by drawing the lines in simple ways.

However, there were some issues occurred in this lesson study practice 1, such as their planning was not clear enough especially in the conclusion part. Because the teacher encountered difficulty most of the time when the researcher observed the lesson. In fact, there was no details discussion about the conclusion during lesson planning. As a result, as of today's lesson, there was miscommunication or misunderstanding on the conclusion part between the teacher who taught the lesson and the leader of the group (see Figure 29). One more noticeable incident, second, was about the content of reviewing the previous lesson, the way of teaching, and the content of students' worksheets including the homework given to the students prior to this lesson has been taught. This lesson might have no originality because the teacher and group members tried to facilitate everything in order to get the students' answer of two methods of solving subtraction by decomposition. For example, the first evidence, the day before the teaching, the teacher gave some homework like 11-9, 13-4, 15-3, 12-8, 14-6, 11-8, 13-9, & 12-3 with an explanation to them to solve it by decomposition. During reviewing the previous lesson of today's teaching, the second evidence, the teacher already demonstrated how to solve it in two methods by the decomposition. More interestingly, she emphasized the students that the next activity was needed to use these two methods as well. The third evidence, the worksheet, it was clearly separated into two methods already. What the students needed to do was just putting the number into the blocks. And the last one was that while the teacher was telling or reading the word problem, most of the students already got an answer verbally even prior giving them the worksheet as well as while the students were working in pairs, the team members approached each pair to input some questions so that the students would come up as what the group expected. Therefore, it could be argued that those preparations seemed to limit the students' opportunity for their mathematical thinking.



a). Concludsion by the teacher b). Conclusion by the leader

Figure 28. Conclusion of the main activity

6.2.4 Protocol data analysis of lesson planning 2 of TTC2-G3

The data analysis found the emergence of curriculum knowledge, subject matter knowledge, and students' conceptions in terms of the role of teacher. As the role of teacher educator, the data analysis also found the emergence of curriculum knowledge and teaching-learning resources. Each of the findings is demonstrated as follows.

As the role of the teacher, (1) the emergence of the curriculum knowledge was expressed by the modification of the objective. The team members realized that the entire objective of the lesson was not probably met all types of subtraction in that lesson. Originally, the overall objective was "for students to understand subtraction method and able to calculate subtraction between a 2-digit number with a 1-digit number to get a 1-digit number as a result". Toward this objective in comparison to the given content, the MTEs found some subtraction number sentences that were not conformed to the objective. As a result, the objective was modified to suit this lesson that was "students are able to do subtraction process by the decomposition." While (2) the emergence of the subject matter knowledge was shown by the descriptions about the concepts of the different meanings of subtraction. The MTEs clearly distinguished the difference between the previous lesson and this lesson when the researcher asked a question of why they used the same subtraction number sentence. KHL explained its different meaning that the former lesson focused on identifying 5 could not be subtracted by 7 because 5 was smaller than 7. Whereas in this lesson, it focused on finding which one has more or fewer numbers than the other. As he said that "… the former 15-7 concentrated on unsolvable 5-7, so 15 must be decomposed into 10 and 5. While 15-7 in this lesson … in general concept … is the same but in terms of way of thinking is diverse…" The subject matter knowledge was also expressed through seeing the difference meaning of subtraction like more or less, finding the difference, and the small group separated from the big group. They also realized that subtraction by borrowing was not suitable for the first-grader children. It must be replaced by decomposition.

Whereas, (3) the emergence of student conception was expressed through the way of handling when students came up with unexpected preferences. The team members tried to figure out what students would respond when they read the mathematical problem about “there are 7 pigeons and 15 sparrows, which types of bird has more amount, and how many?” They predicted that the students might do direct calculation or comparing by pairs. However, the homeroom teacher concerned that her students would come up with 7-15 instead of 15-7 because they might notice number 7 as the first term and number 15 as the second. Therefore, if that was to be happened, the MTEs must think of a strategy to handle the situation by providing some suggestions and give further investigating questions. The emergence of students’ conceptions was also expressing through anticipating students’ ideas and through describing how students would respond to the given mathematical problems. The group members, especially the leader of the group, predicted students’ possible ways of responding to the given mathematical problem. He concerned if the students would be able to make the correct subtraction number sentence because the first term was 7 pigeons and the second term was 15 sparrows. For the second mathematical problem, “there are green and red apples totally 13 apples, there are 6 red apples, how many green apples?” the team members also anticipated the method that students might use that were counting and pairing. They expected at least three methods, counting, pairing, and vertical subtraction.

As the role of teacher educator, the emergence of curriculum knowledge was expressed when the KHL encouraged team members to think of another objective to suit the main lesson content and when he provided a hint to the members to think further. As he said that “why do we have to write like the textbook, can we make a new one? … why don’t we write a new one that suits what we are doing, so how to compose the sentence?” After that, he provided an alternative idea as he said that “why don’t we write students will be able to subtract numbers without borrowing using the decomposition, why don’t we do like that” He even further argued about the objective in the textbook that it didn’t make sense in the mathematical concept. So, he criticized the members for thinking about it critically, as KHL pointed out that “… here they write 2-digit numbers it implies the objective for students to subtract 2-digit numbers with a 1-digit number and get result 1-digit number. This doesn’t make sense… I want to ask does it have mathematical meaning?”

In the role of teacher educator, the teaching-learning resources were also discovered by the MTEs’ conversations when the MTE asked the team members to think of other methods that they wanted students to use to solve the mathematical tasks. This statement was supported by the evidence when the KHL said that "do you still have other methods that you want students to do?" In which it was probably related to the students' anticipation. Further evidence was demonstrated when the MTE asked the members, "how to ask them if we want more than counting method?" And "if the students come up with 7-15, in terms of a teacher, what should you do?" This was a deep question that stimulated the team members to think about pedagogy to facilitate students to change from 7-15 into 15-7. In addition, this MTE provided alternative choices about students' anticipation of what they may likely to come up with. This emergence was supported by the evidence when KHL pointed out that "students have already learned about pairing things, then subtraction. At first, the students will use the method of counting fingers, then let them do subtraction, then pairing, vertical subtraction; we need at least three ways of solving it."

6.2.5 Protocol data analysis of post-lesson discussion 2 of TTC2-G3

In terms of the role of teachers, the study found the students' conceptions and subject matter knowledge. While in terms of the teacher educators, the study found the emergence of teaching-learning resources. The students' conceptions were articulated by the discussions about students' difficulties in solving and explaining about the subtraction by the decomposition. The MTEs were able to see students' limitations in following the model made by the teacher educator even though today's lesson was similar to the previous lesson. What the group members wanted to get from the students was not simply calculation; instead, they wanted students to be able to manipulate the subtraction in several ways. The MTEs also claimed that even though the students were able to do the decomposition, their skills of explanation were still weak. As VLV commented that "regarding the decomposition, we need to practice them more … they can decompose, but when they explain, they couldn't do it … students need to practice more, the step of explaining by themselves … it will affect the next activity…" Furthermore, the emergence of the students' conceptions was demonstrated by the MTEs' expression about diverse ways of students' writing and understanding the solving steps of decomposition. One MTE was able to figure out the messiness of students' handwriting to express their way of solving subtraction. He noticed the differences when the students tried to follow the model made by the teacher educator. As well as students' difficulty in explaining four steps of solving subtraction by the decomposition. SLK pointed out that "the way of writing number is very complicated. Students are not yet understood the activity. Three students have three different ways even the teacher also writes in another way … It means that our students still don't understand four steps…"

While the subject matter knowledge was expressed through the descriptions of four steps of solving subtraction by decomposition that students couldn't remember. As SKH expressed his idea regarding these four steps that in order to calculate 15-7, "…first, 7 cannot subtract from 5... Second, decompose 15 into 10 and 5. Third, subtract 7 from 10 [equals 3] … Fourth, add 5 with 3 become 8…finally we can conclude 15-7 [equal to 8]."

Regarding the role of teacher educator, in this lesson study process, the study found the emergence of suggestions about a strategy for student engagement that was demonstrated by two aspects. First, the suggestion about introducing a clear solving method of the mathematical task in the part of reviewing the previous lesson as a model for the students to follow. As SLK commented that to solve the task "making students understand [solving method], if we review it again, it might be too difficult isn't it, it will cause students' confusion; we may utilize [introduce] a clear method to the students immediately" Second, the alternative strategy to deal with the students when they come up with unexpected solving methods in the reviewing part. The lesson implementer was suggested to not allow the students to use the same method. If the firs student already came up with the counting method, the second student shouldn't be repeating the same thing. If s/he did, the teacher educator should quickly stimulate s/he to think another method or switch with other students who have different ideas for not to waste time. As KHL expressed his alternative strategy that "…drawing like this is fine but don't you understand this is useless … if the first student decomposes into 10 and 1 and the second student also writes 10 and 1, then the teacher educator must stop them immediately, don't let them continue…"

6.2.6 Interview data analysis after lesson study practice 1 of TTC2-G3

In this section, first, the MTEs' views on their professional learning were clarified following by the clarification of the issues based on the MTEs' perspectives. Data analysis revealed the MTEs' views in the knowledge, teaching-learning resources, collaboration, instruction, and preconceptions through the first lesson study practice (see Table 34). The knowledge included students' conceptions as a subcategory while the teaching-learning resources included lesson planning and making teaching materials as the subcategories. The following are the details of each component supported by some evidence from the MTEs' utterances.

The knowledge, especially student conceptions, the group perceived that students have difficulty in learning because they learned through memorization without understanding the meaning of the subtraction. In this lesson, students were required to solve the subtraction problem using decomposition in 2 methods. For example, solving 12 - 9 by decomposing it, some students solved this by decomposing 12 into 10 & 2, then subtracted 9 from 10 remained 1, 1 & 2 became 3. However, when the teacher changed the method of decomposition by decomposing 12 into 2 and 10, students then circle 2 and 9 for subtraction pairs instead of 10 and 9. It means that when the number is changing its position, the students still remembered the previous position. The circle students made represented the number sentence of 2-9 in which it was impossible for the grade 1 mathematics. As KHL, the leader of this group pointed out that

> It is apparent that students do not learn from their thinking; they learn through memorizing. As can be seen, when students decompose 10 and 5 or 5 and 10, when they circle the subtraction pairs, they still circle 5 and 7, it means 5-7. It means that students remember a position that they used to be practiced because they are taught such a way.

Another student conception was that some students didn't use 2 methods of decomposition (method 1 is decomposing 15 into 10 and 5; method 2 is decomposing 15 into 5 and 10) to solve subtraction, rather they used counting fingers instead and some used counting drawing sticks. This way of solving subtraction can also get the correct answer, but it is not the MTEs' objectives to use in this lesson.

The teaching-learning resources were one of the main themes of the MTEs' professional learning in lesson study practice 1. This included subcategories like lesson planning and making teaching materials. The MTEs perceived that they have learned how to make a lesson plan on one-page, creating task questions, sequencing instruction, making teaching materials, and instructional design to teach the lesson about subtraction. One-page of lesson plan that MTE mentioned contains several parts, such as, name of teacher, name of school, date and time, lesson topic, name of activity, objective of the whole lesson, objective of today's lesson, main lesson content, student thinking anticipation, order of teaching activity, a list of teaching materials, and details of teaching activity. The details of teaching activity include three parts, such as the activity of reviewing the previous lesson, four steps of Open Approach and warning as the final step.

Additionally, four steps of Open Approach include posing word problems or problem situations, students solving problems themselves, report and discuss the ideas together, and conclude students' ideas together. At the end of the one-page lesson plan, there is a name list of the group. Other than the one-page lesson plan, the MTEs also mentioned their professional learning about creating a mathematics problem. In this lesson, the mathematical problem is "Thao Itim has 15 oranges, he gives it to his friends 7 oranges, how many are left over?" This problem is adapted from exercise, 15-7. MTEs claimed that if they just simply give 15-7 to students, they will not know how much students understand subtraction. So, the group makes it like a word problem.

While the theme of collaboration, the MTEs collaboratively studied the textbook before proceeding with the lesson design. After that, each of them expressed their ideas regarding that topic before the leader of the group made a decision or strongly recommended utilizing these ideas. They discussed each other on how to promote student thinking. This was very much related to instructional design because they consulted the flow or sequence of activity. And finally, they had consensus ideas of the lesson plan. Through the researcher's observation, they spent time very much on designing learning tasks, designing and making teaching materials but there was very little or no discussion about anticipating students' ideas, how to handle if unexpected ideas occur, and how to conclude the lesson.

Although professional learning in this group is deeper than the other two groups, they also had criticism on instruction specifically when the teacher kept repeating what students already understood in the activity, which was wasting time. Sometimes the teacher communicated with students in an unclear way, especially a question asking what students are going to find out in the activity; unorganized blackboard when presenting students' mathematical ideas and unclear conclusion part because it is not matching with the objective of the lesson. Further than criticism, surprisingly, this group was not only doing teamwork in lesson design but also in teaching in the team especially being actively helping each other in handling teaching materials, approaching each group while students were doing group work to encourage them by asking some questions so that students will reach what the group wants. And at nearly the end of the lesson, the leader of the group also helped the teacher to conclude the lesson because the teacher herself faced difficulty in summarizing it.

Table 34. Views on professional learning in lesson study practice 1 of TTC2-G3

Main theme	Subcategory (No. of codes)	Coding examples
Knowledge	Student conceptions (7)	Student learning by memorizing
Teaching-learning resources	Lesson planning (8)	Making one-page lesson planning
	Making teaching materials (3)	Learning task and materials
Collaboration	Collaboration (9)	forming consensus ideas for a better lesson plan
Instruction	Instruction (12)	unclear conclusion of the main content
Preconditions	Lesson study (1)	Lesson study process like Plan-Do-See steps

Regarding the issues (see Table 35), the analysis from the interviewed data found some issues related to the students' conceptions, teaching-learning resources, instruction, and collaboration. First, it was the issue of the students' conceptions, especially their language ability, as well as the way they solved subtraction. Sometimes the students did not understand what the teacher wanted them to do. "They cannot read the Lao language; they still don't understand the meaning what the teacher requires them to do, the teacher also explains them; still they have a problem"-SMN. The students tended to solve the subtraction at first before decomposing the number. That implied that the students have already had some skills in the calculation. They may, probably, use counting finger method or counting drawing sticks. In Lao primary mathematics curriculum, solving subtraction by decomposition is a new method for both the teacher and students. Therefore, both of them might face similar issues.

While the issues of teaching-learning resources were related to the lesson plan in which it was not yet providing enough details for the teacher to follow since it was compacted in only one-page. It didn't provide what the teacher should say or ask some deeper questions to investigate students thinking except the main task. As this excerpt from VLV expression that "lesson plan is very important, if we don't know its details, it will be stuck, as this one-page lesson plan, it only shows general guidance, but there are no details what teacher should say this way or that way." She further clarified that "the lesson plan has no enough details, to make it details, after completion of planning we should scrutinize again which point should be improved or removed. However, Yesterday, it was like in a hurry…" Because of the lack of detail in the lesson plan but a list of teaching steps, when the teacher did a research lesson, the teacher could follow its steps well. However, the teacher was likely to say what the group members didn’t recommend her to say during the teaching. Thus, there was a need for details of the lesson plan.

Furthermore, the leader of this group showed his concern regarding its sustainability. The leader worried if this kind of lesson study practice would stop somedays when the group members never come to support them. Based on the personal communication between the researcher and the teacher who taught this lesson, she mentioned that in regular teaching, she didn’t make any lesson plan, including a one-page lesson plan. She just followed what it was in the textbook. Also, in term of teaching method, she said she just followed the teaching guide book, she used Open Approach only when they had lesson study practice with the group members; or, perhaps, when they had visitors to observe the class as like the case of the researcher visited them (S. Seomany, personal communication, June 26, July 12, 2019). Therefore, the future of this approach in this school was unpredictable.

Table 35. Issues of lesson study practice 1 of TTC2-G3

Main theme	**Subcategory (No. of codes)**	**Coding examples**
Teaching-learning resources	Lesson planning (5)	Lesson plan is not well clear yet, lesson plan not clear how students will solve math
Instruction	Teacher behavior (3)	Teacher not well followed as planned, not fluency in teaching steps
Student conceptions	Student conceptions (2)	In consideration student language ability, student get results first before decomposition
Collaboration	Time and workload issue (2)	Must call every time through social media apps, workload issues
Sustainability	Lesson study sustainability (1)	Worrying of its sustainability

6.2.7 Interview data analysis after lesson study practice 2 of TTC2-G3

In this section, in association with the views of MTEs in the lesson study practice 1, the study also found both the MTEs' professional learning and issues related to these four major themes, such as knowledge, teaching-learning resources, instruction, and collaboration (see Table 36). The following are the details elaborating on each point.

Table 36. Views of professional learning in lesson study practice 2 of TTC2-G3

Main theme	Subcategory (No. of codes)	Coding example
Knowledge	Subject matter knowledge (1)	Different meaning of subtraction
	Student conceptions (17)	Students count rather than decomposing subtraction
Teaching-learning resources	Lesson plan (11)	Appropriateness of sentence length in math task
Collaboration	Sharing ideas (9)	Sharing about not to use borrowing but taking away
Instruction	Teaching behavior (11)	Teacher educator couldn't be patient enough to tell students
Preconceptions	Lesson study (1)	Better understanding open approach

Data analysis found the emergence of the knowledge domain that contained subcategories of the conceptions about students' learning abilities, difficulties, and mathematical knowledge. The MTEs expressed their concerns about students' ability, whether they will be able to interpret the word problems of this lesson into subtraction number sentences or not. For example, the word problem "there are 7 pigeons and 15 sparrows, which type has more amount for how many?". This word problem is different from what they are used to learn because there are no familiar words like taking away, removing, eating or giving others, etc. VVL justified why the students didn't pay attention to the teacher educator's explanation is that they focused on reading word problems on the worksheet. The MTEs also had an awareness of whether the students could use manipulatives (bottle caps) to demonstrate their mathematical thinking related to the word problems of pigeons and green apples to confirm their correct answer between decomposition and bottle caps demonstration. While the conception about the students' difficulty, the MTEs could see student difficulty in relating their previous knowledge to a new situation, the difficulty of using materials to demonstrate the differences between two things and difficulty explaining their work. VVL clarified about relating previous knowledge to the new situation that "what we expected from reviewing the previous lesson, about the oranges, because it is already old lesson, 11-9, we want them to write decomposition immediately, but students still use counting drawing sticks method" Although, the group members of TTC2-G3 helped the students by investigating several questions until the students got an answer; still they had another difficulty manipulating bottle caps to confirm the results from the decomposition. As one of the members noticed that there was only one group that can do it, for the rest, they just played with it.

Whereas the students' conceptions, the primary students tended to use the method of counting drawing sticks for calculating subtraction even though they have already learned decomposition more than 10 hours before this lesson. Their basic skill of counting is applied to any situation of calculation. Through analyzing the MTEs' responses, primary students used both fingers counting method and drawing sticks counting method to solve the given subtraction. They tried to use decomposition only when they were told by the teacher educator or suggested by the team members. Although students use counting methods, one of the MTEs appreciated the students' effort, as he said that even though this method "is not corresponding to the objective of using decomposition for subtraction, it can also get correct results as well"-SLK. Additionally, VVL expressed her conception about student mathematical knowledge that students didn't remember four steps of subtraction through decomposition yet. Unable to remember these four steps causes difficulty for students to solve subtraction by this method and also the ability to explain their work related to decomposition.

In the category of teaching-learning resources, the lesson plan was only the subcategory found in this 2nd lesson study practice. The MTEs perceived that the exercises could be modified as a lesson for this lesson study practice. Instead of giving exercises to students directly, the group adapted it as one lesson. Actually, these two lessons of practice 1 & 2 were adapted from the exercises because of the regular teaching schedule. When they were making the lesson plan, the lesson was exactly about the exercises. Subsequently, to be consistent with the curriculum, the group must modify the exercises to be a new lesson. However, in this lesson, the exercise contains three topics that the members want to teach all. As a result, the lesson contains too many activities even exceeded the time teaching schedule. During the lesson design, the group considers students' knowledge and language ability by appropriately adjusting the length of sentences in the word problems not to be too long or too short. Besides, what MTEs can learn from this lesson planning is that the lesson plan should be as detailed as possible, and the teacher educator should understand all details so that it would not cause any problem in the research lesson. This one-page lesson plan, however, didn't provide that much details as their demand.

Another significant point that MTEs can learn when planning a lesson is that the members should always be attentive during the planning because they would never know who would be pointed out to demonstrate the lesson. At this lesson study practice 2, the teacher educator who demonstrated the lesson was pointed out at nearly the end of the planning session. In this case, the MTE, who was usually paying much attention to typing the lesson plan into a computer, was pointed out. This kind of decision made difficulty for the participants who were not closely following the lesson plan from the beginning. Because of this issue, one of the members prefers to make a lesson plan individually so that she would be able to clearly and confidently teach that particular lesson. Or else, the lesson plan should be drafted and summarized in a paper at first under the agreement of all members before giving to one person to type into the computer. This kind of practice is required so that all members will understand the details of the lesson plan equally.

Concerning the category of instruction, teaching behavior is the subcategory of instruction describing the behavior of the teacher educator during teaching, ability to handle classroom situation, and perhaps knowledge background. The lesson study group members helped the lesson implementer as like teaching in a team. It was not general helping like distributing materials or sticking papers on the blackboard, but it was a kind of team teaching. This kind of practice would probably limit the opportunity of the lesson implementer to strengthen her instruction, as well as it might be breaking the ethic of the lesson study itself. Of this occurrence, the researcher was not quite sure if the group afraid of losing their faces when their students cannot perform well or not, or this was the nature of the lesson study practice of this group. Apart from the lesson implementer's behavior in helping students in the classroom, her instructional strategy in handling the unexpected situation in the classroom was also seriously criticized among the group members especially spending much time on reviewing previous lesson, language use, ability of lesson conclusion, decision making to handle situation, and ability to draw students to the point that they wanted. In this research lesson of lesson study practice 2, unintentionally, the lesson implementer spent almost 30 minutes reviewing the previous lesson because her students who were pointed out to solve the problems were not able to come up with solving subtraction with decomposition.

Another point was the lesson implementer's ability to conclude the lesson. This ability has been criticized in association with what the researcher used to mention in the previous section. During the lesson planning session, the group members didn't focus much on this part, rather roughly say, conclude it based on the results of the activity. As a sequence of that, as the researcher's observation, while the research lesson was ongoing, the leader of the group interfered with the conclusion part using his own idea most of the time. This implies the poor quality in the lesson planning.

Regarding the category of collaboration, it is quite straightforward to the sharing of subject matter knowledge. The group members realized the objective of the lesson regarding the subtraction because they helped or discussed each other about the existing lesson objective against the content knowledge of the selected topic if it is corresponding or not. The group members can identify that the general objective of this lesson didn't contain or corresponding to the word "decomposition," whereas the entire lesson implied the solving subtraction with decomposition. The overall objective written in the guideline is that "students will be able to understand subtraction method and able to calculate subtraction 2-digit numbers subtracted by 1-digit number in which the result equals to a 1-digit number" (MoES, 2017, p. 141). Accordingly, the group agreed to change the overall objective that "students will be able to use subtraction utilizing knowledge about calculation with decomposition." The second point of the collaboration in sharing subject matter knowledge was related to removing some traditional ways of saying subtraction. Traditionally, in the old curriculum, all teachers and teacher educators were familiar with the term borrowing. In this new textbook, MoES tried to remove or not to use the term "borrowing" but promoting to use "taking away" instead so that it will be firmly corresponding to the bottle cap manipulatives, decomposition, and based-10 number system that is used entirely in the new primary textbook.

Regarding the issues in the 2nd lesson study practice, the study found four main themes, such as knowledge, teaching-learning resources, instruction, and collaboration (see Table 37). The first issue was the lesson objective modification. There was a curiosity if the objective of the lesson can be modified, not only using decomposition to solve subtraction but also using other methods. One of the MTEs realized that other methods are also workable to find out a solution to the subtraction. Typically, the concept of the Open Approach is to allow students to find out several methods of solving mathematical problems, not just sticking on the decomposition. By limiting student's opportunity to use only a method provided in the textbook, say decomposition, it may not call the Open Approach. As a matter of fact, this 2nd research lesson was primarily depending on the curriculum by just following the regular teaching schedule. Therefore, if the researcher removed lesson planning in a team, it is hard to find the difference between everyday teaching and research lesson of this lesson study practice. Thus, lesson study practice in this TTC can probably be defined as a practice of collaborative designing mathematical tasks, student worksheets, and teaching materials by following regular lesson content of the curriculum through problem-solving approach teaching method. The 2nd issue in the knowledge domain was the difficulty of getting student mathematical thinking. MTEs perceived that it would be very difficult for the teacher educator alone to get student mathematical idea emerged in this research lesson without the help of the group members. Perhaps, because of those 2 mathematical problems are different from what students used to learn in the previous lesson topic. Therefore, each TTC2-G3 group member must help the teacher educator to stimulate student thinking by approaching individual groups during the group work activity. The leader of the group, KHL, explained that they helped by suggesting students, asking some sorts of questions, investigating some points so that it will open the points that students cannot think of or get confused, not directly telling them what to do or how to do it (see Figure 29). The 3rd issue in the knowledge domain was students' conceptions on their explanation. MTEs faced the issue of students' mathematical idea explanation. This may be because they are still in grade 1 that they have a limitation of both language ability and mathematical knowledge. As SKH pointed out this issue that "I think that students still cannot achieve the lesson objective to do subtraction by decomposition because they still cannot explain … students still cannot explain how to decompose, how to subtract, this the issue." Regarding the issue of student ability to solve subtraction, the respondent didn't mention clear on this issue. However, through the descriptions within the sections above, we can somehow imagine that students have difficulty to solve subtraction, especially using the decomposition method.

Table 37. Issues of lesson study practice 2 of TTC2-G3

Main theme	**Subcategory No. of codes**	**Coding examples**
Knowledge	Student conceptions (4)	Quality of student expressing ideas, Students still can't explain their method,
Teaching - learning resources	Lesson planning (6)	Can change objective not only using decomposition to solve subtraction? The quality of making lesson plan not intense,

Instruction	Instruction (4)	Helping teacher to stimulate student thinking, Concluding the lesson,
Collaboration	Punctuation (3)	Delay of planning due to member punctuation,

Regarding the issue in the teaching-learning resources, the details of the lesson plan were pointed out. Although the group members collaboratively worked on the lesson plan, their discussion was majorly on task design, worksheet design, and preparing materials, while the other details were missing in the discussions. For example, the flow of the lesson, how to handle students if the answer is different from the anticipation, what kind of key questions to ask, how to conclude the lesson, etc. Implicitly, those became the lesson implementer's responsibilities. As mentioned earlier, the one-page lesson plan didn't cover many details. And finally, s/he will be criticized about what should do or shouldn't, what should be aware or avoided, etc. Another issue raised in the lesson plan was the length of the mathematical tasks. The MTEs perceived that this might be directly affecting students' understanding of the questions. Here, PVL stated that "the order of the mathematical task is not firm, still in general, or still too long." A further issue was classroom management to get student attention. The MTEs claimed that it was difficult to control the class since the students were naughty. Sometimes the lesson implementer needed to use her power. However, using the power may affect discouraging the students from expressing their ideas, while becoming too kind or loose to them, then the students may be less paid attention. Therefore, TTC2-G3 group members were not only helping the lesson implementer in investigating students to elicit their mathematical ideas but also controlling the class simultaneously. Moreover, teacher educator's skill of talking to children, MTE who demonstrated the lesson claimed it as the big issue and challenge for her because she usually taught adults (pre-service teachers), she didn't have knowledge about children psychology. She claimed that she didn't know what to say to attract them to do as what she wanted. She even accepted that she lacked the confidence to teach children and didn't know what to say to make them understand the lesson well. Another important issue was the lesson conclusion. The general term "concluding the lesson based on each activity" during the lesson planning made the lesson implementer got concerned if what she would conclude would meet the group members' expectations or would be corresponding to the lesson objective. VLV, who demonstrated the lesson, shared that "before we finish lesson plan, I used to ask how to conclude, but the team members mentioned [that] conclude it in each activity, but the main points of what students will get were not yet emerged in the lesson plan."

Figure 29 TTC2-G3 members monitoring student group work

6.2.8 Summary of the MTEs' professional learning of TTC2-G3

The triangular data analysis has shown that most of the MTEs' professional learning embedded in the knowledge domain with little emergence in the teaching-learning resources and instruction. However, as the role of teacher, the highest level of the MTEs' professional learning was still regarded in level 1 with a high possibility to reach level 2 because the knowledge domain tended to emerge in all lesson study process, especially the subject matter knowledge and the students' conceptions. The subject matter knowledge and curriculum knowledge were regarded in-depths to some extent because it contained some strong points that the MTEs interpreted and modified the lesson objective to suit the selected lesson contents. They were able to not only describe the different concepts of the subtraction but also transform or contextualize the existing abstract subtraction number sentence into a word problem. However, they still had some weaknesses that the MTEs failed to capture the connection of the lesson content in the long run. There were some missing points regarding the connection how the selected lessons were connected to previous lessons or previous knowledge, other lessons in other grade levels, and the long-term goal development that are expecting students to acquire after five years in primary school. Also, of the students' conceptions, the MTEs limited their opportunity only in describing and identifying the situations of the students without analysis. They were able to identify the students' unordered processing skills, students' difficulties in solving and explaining the subtraction by the decomposition. Yet, the MTEs failed to analyze and connect students' thinking to other students' thinking. They did not pick up the details of the student thinking and discussing in a way that is more connected to the mathematical concept. They failed to analyze why the students responded or thought in such a way and how students approached the problems. They failed to reason the way of students' thinking about why the students manipulated in such a way.

Besides the knowledge, of the level 1, the emergence of the teaching-learning resources was found through the lesson content conceptualization, mathematical task design, teaching materials, and the strategy for students' engagement. In contrast, although their discussions about the observation protocols did not emerge in this lesson study group, it doesn't mean that they didn't have a focus. Implicitly, based on the evidence in the post-lesson discussions, the MTEs focused on subject matter knowledge and students' learning. Whereas the instruction domain that belongs to the level 0, the triangular analysis found out the comments on the lesson implementer's instructional sequencing, instructional strategy to handle the classroom situation, and the ability of the lesson implementer to conclude the lessons.

Regarding the role of teacher educators, the study also regarded their professional learning in the level 1 because the study found only the emergence of the curriculum knowledge in the lesson planning 2 when the MTE stimulated the members to think about lesson objective. Mostly, the role of teacher educator was emerged in the teaching-learning resources and the instruction domain especially when the MTEs stimulated the members to consider a strategy for student engagement, asked the team members to think of other methods, provided choices that students may likely to come up with, and the suggestions to improve the instruction. For example, the suggestion to make it clear about reviewing the previous lesson, suggesting alternative instruction, and suggesting a strategy to conclude the lesson.

6.3 Analysis of lesson study practice in Khangkhay TTC

6.3.1 Emergent changes in the research lessons of TTC3-G5

Of this lesson study group, the MTEs conducted a lesson study with Physics year 1 student teachers. In the first lesson, the MTE spent full time of 90 minutes to teach the lesson. The lesson implementer followed her usual traditional teaching steps. Such as presenting the formulas at first, teacher educator solved one example as a model, dividing the student teachers into the group work to solve the given problems, and finally reported their results. This class was a very mathematics lesson that concentrated on formula application to solve the exercises. The issues that occurred in this lesson were the overused time in reviewing the previous lesson. The lesson implementer spent about 40 minutes to solve the previous lesson while their initial plan was only 7 minutes. This issue has occurred because the teacher educator gave one mathematical problem to the student teachers to solve it as the task of reviewing the previous lesson, but some of the selected representatives were not able to solve it correctly. In this lesson, there were seven different mathematical problems. It meant that the student teachers needed to apply seven different formulas. Thus, this lesson focused on finding the correct answer and the right process if the student teachers would be able to apply the formulas to solve the given mathematical problems of radical inequalities. The lesson was full of a talk by the teacher educator because she repeated every work of the student teachers' group report. Because of the time overused in the reviewing part and repeating explanation in each group report, the lesson couldn't finish within 90 minutes. Of the second research lesson, there were some changes have emerged. At least, the time spent on teaching activity was reduced from 90 minutes to 60 minutes. The number of mathematical tasks was reduced from seven to four. The role of the lesson implementer was changed from active talking to listener and facilitator. The time allocation and usage in each activity were managed appropriately. The lesson was a kind of discovering because it has changed from giving formula at the beginning to giving the formula at the end as the lesson conclusion. The lesson provided the student teachers with an opportunity to encounter the problem at the beginning with providing minimum necessary exponential properties or laws. And finally, the group work activity was gone but focusing on individual student-teacher' and pairs' work instead. However, this group also shared a similar issue with other groups of lesson study, especially no curriculum analysis before designing mathematical tasks but following the regular curriculum. More importantly, in the second lesson study practice, the MTEs committed to contributing their intellectual wisdom during the lesson planning. They didn't leave all the things to the selected teacher educator, but they worked together as a team collaboratively. This change implied that they started adapting themselves and gradually changing their concept of lesson study.

6.3.2 Protocol data analysis of lesson planning 1 of TTC3-G5

The protocol data analysis found only the emergence of the MTEs' professional learning as the role of the teacher in two domains, knowledge (subject matter knowledge) and teaching-learning resources (student teachers' group setting). The study found the emergence of the subject matter knowledge when the MTEs designed and solved mathematical problems prepared for the evaluation part (i.e., ($\sqrt{x^2 + 2x + 3} < x - 2$)) and when the MTEs expressed their concern of being asked by the student teachers about the way of solving other types of radical equation formulas out of those four given formulas (i.e., how to solve a radical equation in the form of $\sqrt[3]{f(x)} > g(x)$). Regarding the emergence of student teachers' group settings, as the researcher's experience, this was a very common practice in the Lao context. Whenever they have a quest to observe the class, the first thing to consider was putting students or student teachers in group work. For them, this contained two meanings, learner-center and learner participation in the activity. Even though the students might not cooperate well in the activity, at least they sit together. For this lesson study group, they carefully selected eight well-performing student teachers to be a leader of each group to help other members in solving mathematical problems. To make it more exciting, they set the rule by using the animals as a symbol of each group. For instance, a tiger group, elephant group, pig group, etc. And before going to the group, the student teachers must do a lottery, and if they belong to which group of animals, they must make a sound like that animal.

6.3.3 Protocol data analysis of post-lesson discussion 1 of TTC3-G5

At this step of the lesson study practice, the data analysis found the emergence of two roles, teacher role, and teacher educator role. As the role of the teacher, the study revealed the teaching-learning resources expressed by the student teachers' participation and instructional task issue, while the instruction domain expressed by instructional strategy. Regarding the teacher educator role, the study found only the teaching-learning resources expressed by the suggestion of a strategy for student-teacher engagement. More details are clarified below.

As the role of the teacher, the student teachers' participation has emerged through the expression of their collaboration during the group work activity. MTE found that there was only one student teacher who actively solved the given mathematical problem, perhaps the leader of the group who was intentionally selected by the lesson study team members. While the others were not well participated in the group work. Whereas, the emergence of the instructional task issue was expressed by the statements that the task didn't promote student teachers' mathematical thinking but following the formula. As CHP commented that "… the activity doesn't develop student-teacher thinking because they solve it based on the formula, if it is wrong from the formula, then it is wrong".

Regarding the instructional strategy, there was a lot of evidence to support this claim. First, it was evidenced by the expression when the MTE expressed his appreciation that it was a good practice in writing formula in the large white paper. Second, it showed the evidence when one MTE commented that this lesson study practice tried to solve the wrong problem of different teacher educators. Third, when the MTEs commented that repeating student teachers' work wasted time instead of asking their confirmation of understanding. Fourth, when the MTEs criticized that there was a missing appreciation of student teachers' work by crapping their hands for their motivation. And fifth, when the MTEs commented on the issues of fluency of the teacher educator for evaluating student teachers' work and unclear explanation.

As the role of teacher educator, it was evidenced when the MTEs suggested a strategy for student-teacher engagement in the group report and how to handle the instruction. As PHV suggested that "for the next lesson, we should allow all groups to report their works at first, then we can explain only one time so that we will not waste time…" As well as when CHP suggested that "…how to save the time and get all group work reported, group 1 reports then we modify that point then move to the next group…" Also, PHK suggested that "… if student teachers already solve it, if it is already appropriate, we may just ask their understanding, if they are all agreed, we may modify the unclear point only…" Obviously, those suggestions were not related to mathematical knowledge or student teachers' mathematical think at all.

6.3.4 Protocol data analysis of lesson planning 2 of TTC3-G5

In this step of lesson study practice, the study only found the MTEs' professional learning as the role of the teacher in the knowledge domain, teaching-learning resources, and instruction. The knowledge domain contained curriculum knowledge and student teachers' conceptions. The teaching-learning resources domain contained an observational protocol, student teachers' group setting and selecting representatives to present their works, strategy for student-teacher engagement, and mathematical task design. The instruction domain included instructional strategy and instructional sequencing.

Of the knowledge domain, first, there was an emergence of curriculum knowledge expressed by the awareness if the taught lesson could be applied to solve the next exercises that would be given by the homeroom teacher educator and awareness if what was supposed to be teaching meets the objective of the lesson. Second, the emergence of the student teachers' conceptions that was illustrated when the MTEs put awareness about student teachers' prior mathematical background with the problem to be given and allowing some proper time for them to think. The MTEs concerned if the student teachers would come up with the idea of making the same base before further solving an exponential equation. The evidence of the student teachers' conceptions had also illustrated when the MTEs considered suitable questions to elicit students' ideas to link from exponential law to solve the exponential equation. The group members considered the word problem for the exponential equation. However, it was difficult for them to design word problems using the exponential equation; thus, using formula was considered but put it at the end of the lesson as the conclusion part.

Third, the teaching-learning resources, this domain was expressed by the discussion about the observational protocol on how student teachers would respond to each teaching process based on what they have planned. They discussed each other not to use a checklist as what they usually did, rather doing observation based on the context of the student teachers about how the lesson plan made an impact on the student teachers' learning. They explained to each other to focus if their lesson objectives were achievable using the result of the student teachers' learning as a lens. Those discussions were promising for the change in the second lesson study practice. The teaching-learning resources have also emerged through the discussion about the student teachers' group setting and selecting representatives to present their works, the strategy for student-teacher engagement, and mathematical task design. The team members agreed to use individual and pairs work for this lesson. They discussed how to select the student teachers' work to report in the front. They even planned to arrange the order of the student teachers' work from more mistakes to no mistake. Noticeably, the MTEs realized the importance of mathematical task design. Therefore, within these three hours, they spent most of the time designing mathematical problems.

Fourth, regarding the instructional domain, time management, instructional strategy, and instructional sequencing were the emerged components of this domain. Usually, 90 minutes is the period for teaching in TTC. However, since the numbers of mathematical tasks were reduced, the MTEs agreed to maximize the time by teaching 60 minutes and doing post-lesson discussions for 30 minutes. Regarding the instructional strategy, the lesson study team members discussed pretty clear about what to ask and what the student teachers were supposed to respond. They talked to each other as if they were the student teachers because they asked and answered their questions to make the flow of the lesson. For example, SKH said, "…now we ask what is the value of x, it is 2, if so, what is called this equation? If there is someone who can answer," and SLY also continued that "It is exponential equation right, now we go to our lesson, so today we will learn about exponential equation right. We will present to the student teachers like that, right …" To make the flow of teaching goes smoothly, the team members conceptualized the sequence of teaching about the teacher educator's activity. For example, "the teacher educator presents a mathematical problem on the blackboard, the teacher educator gives an example and asks some questions to the student teachers, like this, isn't it?"-PHV.

6.3.5 Protocol data analysis of post-lesson discussion 2 of TTC3-G5

At this step of the lesson study practice, the study found the role of teacher expressed in the knowledge domain, especially the student teachers' conceptions, while both the role of teacher and teacher educator was expressed in the instruction domain. More clarification of each point is demonstrated in the following. First, the emergence of the student teachers' conceptions, as the role of teacher, was expressed by the discussions about the student teachers' wrong writing and multiplication, wrong answer and wrong process, not remembering the properties of exponentials, difficulty to transform to the same base before solving the problem and their participation in pair work activity. The MTEs were able to see the student teachers' mistakes in multiplication, especially the usage of the distributive law properly. As YYG reflected that "…student teachers are not well understood … they multiply only the number close to the multiplicator; sometimes they don't put a parenthesis; it is wrong in terms of mathematical discipline …" And PHK noticed the mistake that "as I observed 3 - 4 student teachers in the front, many student teachers get solution as 8^2 … they simply take this result. They don't even care whether it will have the same base or not…" One MTE was also able to see that the student teachers remembered the law of exponents wrongly. LVN commented that "…some student teachers still cannot remember the properties of exponents. Some student teachers still see $(a^m)^n$ as the addition of its power [i.e., $(\mathrm{a}^{\mathrm{m}})^{\mathrm{n}} = \mathrm{a}^{\mathrm{m+n}}$] and transformation into the same base…"

Second, as the teacher role, there was the emergence of instructional strategy in the instruction domain. This claim was supported by the evidence when the MTEs expressed the necessity of introducing properties of exponents. The group members realized the need to introduce the properties of exponents at first before giving the main mathematical task so that the student teachers would use it to solve the tasks. As PHK reflected that "…here I think there is a need to talk about the properties [of exponents] … when reviewing the previous lesson or when making a connection between previous knowledge to new knowledge, because…we have already learned from grade 7, grade 8…" This comment on the instructional strategy was relatively relevant to the mathematical knowledge to a certain extent. Besides, several comments on the instruction were given by the lesson study team members. The MTEs commented that there was no clarification to the student teachers about making the same base of the exponential equation, no explanation where the student teachers made a mistake, no clarification regarding the solution when the teacher educator showed up the answer sheet to the class and no modification where the student teachers made a mistake. Furthermore, there was a criticism of unmatching between homework and the taught lesson and criticism on the teacher about arranging student teachers' answers in the right order. PHV commented that "…we do not make it clear that we want to reach the point of making the same base. Also, we didn't ask deeper questions…in the following teaching step [especially] of the first activity, after revealing the answer sheet …" As well as LVN commented that "… when we give homework, do we agree with each other or not about homework at numbers 1 and 2? … because as I have checked [against] the lesson content, it is not that much relevant …"

Third, as the role of teacher educator, this emergent instructional strategy was witnessed by the suggestion for clarification and modification of the mistaken points. As YYG suggested that "… teacher educator must suggest student teachers that they must put a parenthesis, and when multiplying it, they must multiply with all numbers." PHV also agreed with the YYG's suggestion and further suggested that "…if possible, next time we must clarify this again … the 3rd person, he changes from negative to positive sign … but we don't modify it; it would be better if we modify it for them…" This finding was also supported when the MTE suggested to emphasize about making the same base at the beginning to solve exponential equation, as LVN suggested the lesson implementer that "…if, in the reviewing previous lesson part, we clarify that we must try to transform [exponential equation] into the same base, then the student teachers would get better than this…so I want you to clarify the mistake point…" As well as the suggestion to the lesson implementer to suggest the student teachers solve a mathematical problem and the suggestion to explain about the reviewing related previous lesson regarding the law of exponential equation. As PKH suggested that "…there is a little need to explain about the law of exponents when reviewing previous lesson part…students don't know where they make a mistake, so it is necessary to explain it a little bit…because student teachers cannot answer the teacher educator's question." Those suggestions to improve instructional strategy were somehow related to the content of mathematics in which it was getting better than simply talking about lesson implementer's teaching behavior. However, they failed to give an alternative idea of how to make those kinds of suggestions. It was not yet related to the stimulation to the MTEs to think about the mathematical concept or student teachers' conceptions.

6.3.6 Interview data analysis after lesson study practice 1 of TTC3-G5

From the interviewed data analysis, the study found the MTEs' professional learning in the teaching-learning resources, instruction, and collaboration domain (see Table 38). First, the teaching-learning resources contained subcategories of lesson planning (19), student teachers' participation (15), and task design (4). The MTEs generally perceived that they knew about designing activity for reviewing the previous lesson, knowing the problem for planning to solve it, and knowing an objective of what to achieve. They also blamed that the lesson planning was not clear sometimes. There should be a second plan when student teachers can't do an activity. The activity design should be appropriate with the classroom environment and should be suitable to the student teachers' knowledge background. The group members suggested that the mathematical task for reviewing the previous lesson should be as what they have already learned. It “shouldn’t be different from the lesson that makes difficulty for student teachers”-YYG. They claimed that the teacher educator shouldn’t use difficult math for reviewing the previous lesson “because student teachers’ background is still low, we will not use math problems like that. We should give them exactly what they used to learn”-SKH. Also, there are too many math problems, so “it’s wasting time when the student teachers do it”-SKH.

Furthermore, the MTEs also perceived the student teachers’ participation during the research lesson. They could see student teachers’ reports of groupwork activity not achieved as expected goals. The student teachers even made a mistake in copying and solving a math problem, “for example, group 3, group 4, never correct, even copying math problem is written incorrectly”-PTL. The MTEs pointed out that the student teachers didn’t discuss each other and no collaboration during the group work activity, no enjoyment in the class, weak mathematical background, and unable to conclude the solution of the inequalities. As SLY clarified that “some student teachers in the group understood well the example solved by the teacher educator. However, when they get a solution, they don’t know which one to put at first, which solution unions which solution.”

Second, the emergence of the instruction included subcategories of teaching behavior (36), way of setting group work (6), and teacher educator’s explanation (4). The MTEs criticized the teaching behavior of how she managed the time in the research lesson, the achievement of the lesson comparing to the lesson plan and allowing student teachers for discussion. They commented on allowing student teachers to answering and concluding activity, managing materials, and way of transitioning to a new lesson. The MTEs perceived that the time management during teaching was not well-controlled because they noticed that the lesson implementer repeatedly re-explained what the student teachers have already explained. The group members suggested the lesson implementer give more time to student teachers for discussions, choosing fewer groups to report their activities in order to shorten the time or reducing numbers of the groups for timekeeping. Besides, the group members viewed that the evaluating step didn’t go smoothly as planned, especially the content of the evaluation itself didn’t cover the main lesson content. For better lesson improvement, the groups gave a further suggestion that “don’t do [activity] in 8 groups but 4 groups instead so that we don’t need to explain every group, make it as a big group 6 -7 student teachers …so that they will discuss”-YYG. While the way of setting group work, the MTEs satisfied that their method was a creative way. They divided student teachers into a group by separating well-performed student teachers to be a leader of each group for the convenience and smoothness of the group work. Doing so, they expected that the group leader would help other members in the group, while the poorly performed student teachers could also learn from the leader. Regarding the teacher educator's explanation, the MTEs responded that the lesson implementer didn't do well during the teaching, especially lack of unclear explanation. The lesson implementer didn't explain about change side change sign. As LVN explained that "when calculating the sign, when solving inequalities with a negative sign and when the sign changes … the teacher educator didn't explain to student teachers … when multiplying negative sign to both sides, the sign will be swapped …"

Table 38. Views on professional learning in lesson study practice 1 of TTC3-G5

Main theme	**Subcategory (No. of codes)**	**Coding examples**
Teaching-learning resources	Lesson planning (19)	Planning a lesson to meet an objective
	Task design (4)	Too many math problems
	Student teachers' participation (15)	Student teachers do not discuss each other
Instruction	Teaching behavior (36)	Managing materials during group report not yet good
	Teacher educator's explanation (4)	Teacher doesn't explain about change side change sign
	Way of setting group work (6)	Explanation after lucky drawing is not yet clear, creative way of setting student group
Collaboration	Sharing (8)	Sharing good and weak points of teaching

Third, the collaboration domain expressed by the subcategory of sharing (8). The group members perceived that they had an opportunity to gain the ideas of teaching steps from the others, exchanging lessons from each other, and forming consensus ideas for selecting a suitable activity to fit the formula type. The MTEs perceived that they got well collaboration among the members, sharing ideas of the problem, and sharing good and weak points of teaching. As SKH expressed that "I learn from what many teacher educators are sharing their thoughts, intertwining their ideas to form a consensus idea … supposing there are many mathematical problems, will they be corresponding to formula form or not? We share ideas about that". Although, based on the characteristic of the lesson study, sharing thoughts and working together is important, what these MTEs gained from the lesson study practice 1 was just an initial process of the lesson study practice, an outer most, edge or superficial point of the lesson study practice.

Other than professional learning, the MTEs were requested to express their thought on the issues in the lesson study practice 1. Interviewed data analysis found the issues in the teaching-learning resources, collaboration, and preconditions (see Table 39). The teaching-learning resources included subcategories of student teacher's behavior (7), lesson planning (7) materials (4), and student teacher's knowledge testing (3). The MTEs claimed that the student teachers lost their nature and acted in an unusual way when there were some observers in their class. They had low attention to study in the class. "They come to the class just to pass the day, not all of them though, but some just play, only sitting and fall sleep"-PHV. This issue of lacking attention is perhaps "they don't know how what they learn is related to daily life, as when going for shopping only receiving change 5 or 10 thousand, they don't know how it can be applied in daily living… so they lack attention"-BPG. The group also sees the issues related to the insufficient mathematical background of student teachers. As BPG responded that they "lack of math knowledge background and it is also advanced mathematics." Nonetheless, the group was unable to identify clearly in what areas of student teachers' weak points of math background were. Another subcategory of the issue was planning a lesson. They argued that the group members didn't check the planned lesson together but simply agreed to whatever the assigned teacher educator has planned. There was no consideration about student teachers' mathematical background on this lesson plan; lack of planning in advance to solve unexpected incidents; and the lesson plan wasn't trialed at first. Those implied a weak collaboration among lesson study team members. The more emerged issue was lacking concrete materials to support this abstract mathematics to interest learners. The group members wondered if they could find materials to visualize this math problem of inequalities. The second issue of materials was the lack of voice and video recording devices to support this lesson study practice. The leader of the group claimed the issue of devices. Other than the student teacher's behavior criticism and planning lesson, time factor together with lesson study understanding (preconditions) were the issues raised by MTEs of TTC3-G5. The group claimed difficulty in managing time to meet each other, not enough time in planning and time pressure in teaching because it was conducted only 1 hour where they usually teach 2 hours for 1 period. And finally, the group sees that their members' understanding of lesson study is varied. Contrarily, the researcher didn't see any different level of the group members' understanding of lesson study.

Table 39. Views of MTEs on the issues of lesson study practice 1 of TTC3-G5

Main theme	Subcategory (No. of codes)	Coding examples
Teaching-learning resources	Student teacher behavior (7)	Student teacher acted unusual way when there is an observer
	Lesson plan (7)	Reviewing the previous lesson was not planned as discussed.
	Materials (4)	Lack of concrete materials
	Student teacher's knowledge testing (3)	No testing student math prior knowledge
Collaboration	Time factor (4)	Time pressure in teaching
Preconditions	Lesson study (3)	How to analyze problem and way of solving it

6.3.7 Interview data analysis after lesson study practice 2 of TTC3-G5

Based on the analysis of the interviewed data after the lesson study practice 2, the study found the MTEs' professional learning in the knowledge domain, teaching-learning resources, and instruction (see Table 40). There were only the student teachers' conceptions (13) emerged in the knowledge domain. While the lesson plan (5) and student teacher's behavior (2) emerged in the domain of the teaching-learning resource, and teacher educator's behavior (36) emerged in the instruction domain. More details of each domain were explained below.

As the student teachers' conceptions, the MTEs increased their professional learning associated with student teachers' difficulties in solving exponential equations. They could see that student teachers multiplied the power of the exponential equations without parenthesis. For example, from $(3^3)^{5-x}$ to $3^{3.5-x}$; and $(3^2)^{x-8}$ to $3^{2.x-8}$. Student teachers multiplied only with the first term but not the second one. Many student teachers made a mistake in transforming properties of exponents and couldn't distinguish between base and exponents. For instance, they like to transform from 64 to 8^2 when they solve the activity 1 ($2^{7-3x} = 64$). As LVN responded that "when they do multiplication, some of them transform from 2^{3^2} to 2^5, they do addition"-LVN. Besides, based on their responses, the observers were able to see student teachers' weak background of properties of exponents, such as, he wrote $a^n = a$. This can be equal only if the value of $n = 1$; and the mistake on writing from negative sign to positive sign, like from $-15 - 3x = 2x - 16$ to $3x - 2x = -16 + 15$. Surprisingly, there was one MTE mentioned that she had learned a clear method of solving exponential equations about the math problem in activity 1, that was solving $2^{7-3x} = 64$.

Regarding the lesson plan under the teaching-learning resources, the MTEs perceived that, first, the numbers of mathematical problems should be reduced and not to hasten to follow the curriculum strictly. As YYG pointed out that "if we want them to get what we teach, we should do like this…don't run with the curriculum, if we run… student teachers will not learn, [we] must use a little math problem and give more time to think". Second, an easy mathematical problem should be selected in order not to cause any issue. As SKH responded that "this is what we have selected to use with lesson study, now we do and we know that only choosing an easy [math problem] is enough." Third, the introduction of properties of exponents is missing at the beginning. For better student teachers' performance, the MTEs suggested introducing some of the necessary properties of exponents at first. As LVN commented that "some learners can't solve exponential equations, I think this is a good lesson for the next teaching; we should additionally teach about the properties of exponents..." She further suggested that the teacher educator can use this as a homework for them to investigate the properties of exponents in advance before the class has been carried out so that the teacher educator can ask them to list it down on the blackboard during the research lesson and they can use those properties to solve math problems.

Table 40. Views on professional learning in lesson study practice 2 of TTC3-G5

Main theme	**Subcategory (No. of codes)**	**Coding examples**
Knowledge	Student conceptions (13)	Students multiply without parenthesis
Teaching-learning resources	Lesson plan (5)	Selecting an easy math problem for doing lesson study,
	Student teachers' behavior (2)	Student teachers lack courage, student teachers mistake in solving a problem
Instruction	Teacher educator's behavior (36)	Should point out student teacher's mistaken point with clear explanation

Teacher educator's behavior (36) emerged under the main theme of instruction is what most of MTEs perceived as their professional learning. The MTEs were still strongly commenting on teacher educator's teaching behavior in two ways, weaknesses, and good points.

Of the good points, the teacher educator who demonstrated the lesson used materials properly. For example, using a large white paper that contains a solution in it to confirm the learners' solutions if it is correct or wrong. The class learning atmosphere was pleasant to the observers because the MTEs were able to see the student teachers doing some activities and working in pairs that allow them to engage in the teaching-learning activity interactively. The MTEs received a new technique of instruction from others. As LVN responded that the lesson implementer used "multiple teaching techniques… for example, student teachers work individually on activity 1, and they work in pairs on the activity 2. This way of teaching provides various teaching techniques". In contrast, there were a lot of weak points that the MTEs commented on the teacher educator's teaching behavior. They claimed that the teacher educator made a mistake when pointing out student teachers' mistakes. The lesson implementer didn't clarify on how to re-correct the mistakes to the learners. The teacher educator didn't explain the answer sheet of the activity 1 as well, rather simply pasted on the blackboard. He didn't conclude the main lesson content to solve these exponential equations. For instance, the learners should "…try to make it [the exponential equations] the same base. If they can form it to that format [$a^x = a^y$], the next step would be fine"-SKH. Furthermore, there were some weak points of giving student teachers homework, arranging student teachers' mistakes on the group report, and teacher educator's understanding of the properties of exponents. For example, the homework number 1 & 2 "seem not to be corresponding to what has been taught, because it contains not only division, factoring and other methods, but also logarithm on the 2nd problem…so this gives us a lesson for the next time homework provision"-LVN.

Regarding the MTEs' perceptions on the issues that emerged through the lesson study practice 2 (see Table 41), there was the emergence of subcategories, such as student teacher's behavior, time and workload issues, a weak point of curriculum and participation of the group members. One of MTEs, PKH, the leader of the group, thought that the learners didn't try to solve math problems because they just wait to copy from others or just don't want to be asked to solve on the blackboard. He didn't think that it is because they don't have enough math knowledge background or the difficulties of the math problem itself. He further claimed that the student teachers didn't discuss each other during pairs work, being shameful if other learners know his or her ability to solve math problems, and their courage to ask or answer teacher educator's questions. Another important issue was that student teachers have a low math knowledge background. LVN criticized that "their knowledge background [about the foundations of algebra subject] in any topic is rather weak, simply say even about exponential equations are not proficient." Other issues are finding time to meet each other, workload issue, full participation of the members in all lesson study process and curriculum. One of the MTEs stated that some of their members didn't participate in all processes. As a result, they don't understand the concept of the lesson. This might lead to misunderstanding in observation points and reflection content. Regarding the curriculum, the distribution of each topic may not be well consistent with each other because the MoES has a policy allowing the teacher educators who are supposed to teach that subject to write the textbook themselves. While the MoES only provides topic lists or chapter lists without content. So, the teacher educators have to find or collect content themselves. Therefore, of this subject, when she collects the content to make a textbook, she found inconsistency among the topics.

Table 41. Issues of lesson study practice 2 of TTC3-G5

Main theme	Subcategory (No. of codes)	Coding examples
Knowledge	A weak point of the curriculum (1)	Some math topic distribution is not corresponding to each other
Teaching-learning resources	Student behavior (7)	Students don't solve the math problem but wait for others
Instruction	Full participation (1)	Planning and observing should be the same members
Collaboration	Time and workload issues (3)	Consensus time to meet each other

6.3.8 Summary of the MTEs' professional learning of TTC3-G5

Triangulation data analysis illustrated that there were emergences of the MTEs' professional learning in both the role of teacher and teacher educator. However, the depths of their professional learning of these two roles have remained in level 1 because the MTEs concentrated too much on the teaching-learning resources and the instruction. While the subject matter knowledge, curriculum knowledge, and student teachers' conceptions were emerged only by chance. The MTEs just focused on today's lesson with superficial awareness if the taught lesson could be applied to solve the next exercises, awareness if what was supposed to be teaching meets the objective of the lesson, and awareness of student teachers' prior mathematical background. This issue was probably hindered by the checklists that limited their views only on looking if some components of the lesson plans have existed and if it was clear in general (i.e., is the objective clear? is the management of materials smooth?). Furthermore, it was mainly affected by the lack of curriculum analysis and lack of analysis of student teachers' mathematical thinking in relation to the mathematical concepts. Those missing points made the failure to capture the connection of the lesson content for long-term development how the selected lessons would be connected to the future lessons and mathematical concepts that the student teachers would develop at last.

6.4 Discussions about MTEs' professional learning and issues

The discussions took place within the four domains, including knowledge, teaching-learning resources, instruction, and collaboration, respectively. These four domains are also explaining the levels of MTEs' professional learning and issues where instruction and collaboration are in level 0, teaching-learning resources are in level 1, knowledge is in level 1 if it is associated with a description or level 2 if it is related to analysis, and building a teaching theory is in level 3 (see also Sec.3.5 & Sec.4.3). Additionally, each domain discussed both MTEs' professional learning from the perspective of teachers and MTEs' professional learning from the perspective of teacher educators.

6.4.1 Knowledge

This section discussed the emergent knowledge domain based on the MTEs' perspective as the teacher and as the teacher educators.

Through the MTEs' perspective as the teachers, this research finding demonstrated the emergence of MTEs' professional learning in the three sub-domains of knowledge, including curriculum knowledge, subject matter knowledge, and students' conceptions. Each sub-domain was drawn on evidence from MTEs' discussions and their perceptions. Lesson study enhances three areas of intensive professional development (professional learning), such as instructional practices, subject matter knowledge, and understanding students' thinking (Sithamparam, 2015, pp. 171-172). Thus, it is a flatform of knowledge creation to externalize tacit to explicit knowledge (Cheng, 2019, p. 32). Engagement in lesson study provided benefits in enhancing professional knowledge of how students make sense of mathematics, mathematics subject knowledge, and methods for teaching mathematics (Hunter & Back, 2011). Teachers developed their knowledge of personal dispositions and qualities, knowledge of mutual interpersonal relationships, and subject matter knowledge (Cheng, 2019, p. 9). They built a knowledge base about student mathematical thinking, instructional strategies, and lesson design (Lewis & Hurd, 2011, p. 14). Furthermore, they deepened subject matter knowledge, as well as their knowledge of students and student thinking, improving their abilities to "examine, build, and share knowledge about teaching and see their own teaching through the eyes of students and colleagues" (Lewis & Hurd, 2011, p. 66). Teacher professional learning is developed through an opportunity to carefully examine and analyze students' learning, the factors influence their learning difficulties, sharing various perspectives about students' misconceptions and difficulties, and engaging in deep discussions (Cheng & Yee, 2012). When conducting lesson study, teachers have primarily used pedagogical content knowledge in every cycle, especially knowledge of content and students, which is "demonstrated in teacher notices student thinking and interpretation of mathematical meaning associated with student's responses…teachers saw mathematics through the eyes of their students" (Clivaz & Ni Shuilleabhain, 2019, pp. 429-432). The knowledge of content and students was also emerged through identifying students' prior knowledge, anticipating students' thinking, and strategies, highlighting common conceptions, and noticing students' mathematical strategies and expressions (Ni Shúillebháin, 2015. p, 370). It also expanded individual knowledge of content and students by the collective knowledge of the group (Meyer & Wilkerson, 2011, p. 22). However, as far as the knowledge concern in the present study, the findings showed a fundamental stage of knowledge base construction regarding the depth of the discussions. Lao MTEs' professional learning was still in an early stage against the aforementioned previous studies. They were still in the transition from level 1 or in the early stage of level 2, because—as for the students' conceptions—the MTEs put a major focus on consideration and awareness about students' mathematical ability and difficulties rather than analyzing, interpreting, and connecting the students' work to the meaning of mathematics in a broader sense of mathematics education. For example, based on MTEs' perceptions, MTEs were able to identify that students did not understand the meaning of subtraction but were rather memorizing its position. Students counted rather than decomposed subtraction, acquired results ahead of performing decomposition, multiplied without using parentheses, made mistakes in writing from negative sign to positive sign. Moreover, in order to solve $2^{7-3x} = 64$, many students transformed 64 into $8^2$and 6^2, MTEs could identify the issues related to students' language ability, obtaining correct answers before doing decomposition, and the ability to explain their method when solving mathematical tasks. Those statements illustrated that MTEs were able to see students' situations but unable to analyze or interpret students' mathematical ideas to gain a strong knowledge understanding about students' mathematical thinking in order to formulate their own local theory of teaching in that particular topic with particular students' situations. Therefore, the issues hindered MTEs' professional learning regarding students' conceptions are MTEs' ability to analyze and interpret mathematical meaning behind students' thinking, possible factors influencing students' issues and valuing students' idea to see mathematical concept through the eyes of their students (Clivaz & Ni Shuilleabhain, 2019). This could convey theoretical knowledge to the field of research in lesson study that, initially, lesson study practitioners—either or both teachers and teacher educators—should concentrate on the students, anticipating students' questions and responses to increase an opportunity of mathematical knowledge for teaching (Meyer & Wilkerson, 2011, pp. 19-22). Then, they should be able to identify students' mathematical knowledge background, abilities, difficulties, and misconceptions before being able to analyze and interpret mathematical meaning from the lens of the students and correlate this lens among the students to the meaning of mathematical concepts.

The emergence of curriculum knowledge is crucial for MTEs who played a role as schoolteachers to be able to see and become aware of (a) the connection between the lesson objective and the content, (b) how the content is connected to the later parts of the lesson, and (c) how the main lesson content could be applied to solve the exercises or relation from topic to topic within the same lesson. Nonetheless, constructing a lesson plan in lesson study is not restricted to the connection within that particular lesson but also broader sense that incudes connection across the lessons, units, and grade levels. Research lesson plan for lesson study should be a unit plan that contains several lessons or a series of lessons rather than one single lesson plan (Lewis, 2002, p. 65). For example, in a unit of subtraction of Grade 1 mathematics, it could be divided into 12 lessons to achieve the goals of the unit (Fernandez & Yoshida, 2004, pp. 37-38), because the teachers or teacher educators considered "long-term goals for student learning and development, study curriculum standards, and identifying a topic of interest." A single lesson might not be able to achieve such long-term goals previously set. Yet, the present findings revealed the issues that MTEs were not considering or able to see the broader view regarding how the selected topics relate to the other topics in other lesson units and grade levels. Rather, they only concentrated within those particular topics without deep analysis of the content as a whole. These indicated some missing points about considering how much the mathematical concepts related to the selected topics the students have already been introduced to. They were unable to determine how much previous knowledge or mathematical background should be provided to solve the current mathematical problems. They also could not see how the subsequent mathematical concepts related to the selected future lessons or how much mathematical knowledge should be provided in the current lesson to build a foundation for the next topic in other lesson units or grade levels. This is important because lesson study creates the "opportunity to develop teachers' knowledge through the discussion of topics taught at each grade level"; and "teachers' mathematical knowledge is deepened when they see new and deeper connections regarding a topic in relation to the rest of the content" (Meyer & Wilkerson, 2011, pp. 19-22). Because of those missing points, for example, as the case of TTC2-G3, the activity of reviewing previous knowledge became a model or an example that MTEs expected students to follow to solve the main mathematical tasks because they were greatly concerned about the correct solving procedure and answer. In addition, it might be because the teachers or teacher educators perceived lesson study as a "strategy to increase the academic achievement of students in low-performing schools" or in a class (Lim et al., 2018, pp. 54-57). Moreover, they hypothesized that students with insufficient mathematics knowledge and skills at the beginning would increase their abilities by the end of the lesson study practice (Bruce et al., 2016). By following the readymade procedure, it would satisfy lesson study group members and would be perceived as the success of lesson study practice or the lesson objective. This lack of considerations was perhaps influenced by three reasons. First, they may see their lesson plan as standalone, disconnected from previous or subsequent lesson concepts; alternatively, they might be able to see it, but they could not find the connection of previous or later mathematical concepts because of the selected topic was only a small part of the whole lesson. Second, the influence of their traditional way of constructing a lesson plan that they usually focused only on the immediate lesson of the day and ignored those that were not yet in an urgent need to tackle. Third, they were simply following the curriculum without analyzing what the main concept of this lesson was and creating a lesson plan based on that main lesson concept. As the author's observation in these three TTCs, they were all strictly following the regular curriculum without fail. This argument was strongly supported by the following discussions during the second lesson planning meeting when the researcher (RSC) proposed an idea to them:

RSC: When we conduct lesson study, it is not necessarily to only follow the regular curriculum. We can also select another lesson topic with the reasons we have to select that particular lesson or topic.

DSM: I understand that we can choose any lesson, but we do not want to leave [the order of] the curriculum…as today's lesson, we have no intention to select this lesson, but you come this time and our curriculum is also taught up to this lesson. Thus, we have to select it to follow the order [of the curriculum] because we are still depending on the District Education and Sport Bureaus…

The emergence of subject matter knowledge or mathematical knowledge that is defined by Ball et al. (2008) as common content knowledge and specific content knowledge is necessary for all MTEs to be able to facilitate schoolteachers and identify students' mathematical errors or misunderstanding. All teachers and MTEs should possess this fundamental knowledge background. For example, teachers or MTEs must be able to use mathematical terms and notation correctly; determine where students made a mistake, wrong definition, or answer; and solve mathematical problems given to the students. They should be ready and aware that nonstandard solving approach might be working in some cases, as well as "whether an unusual method proposed by students would work in general" (Ball et al., 2008). Teachers and teacher educators must be able to talk explicitly about how mathematical language is used; how to choose, make, and use representation effectively; how to explain and justify one's mathematical idea; and "how to represent quantities using diagrams, how to provide a careful explanation of divisibility rules mathematically, or how to appraise the mathematical validity of alternative solution methods" (Hill, Rowan, & Ball, 2005). Moreover, those are the special mathematical content knowledge necessary for both teachers and MTEs. This study discovered that an explanation of the mathematical concept to each other among lesson study group members is essential to share a common understanding about the mathematical knowledge they are dealing with. The discussions about several possible solutions of the proposed mathematical problems are needed in lesson study because it will subsequently be used to detect students' mathematical representation, thinking, errors, or misconceptions. Simultaneously, it will be used to evaluate if the designed mathematical problem is appropriate to the students in the grade level. Another important finding was the discussions about the length and clear language used in the mathematical tasks to reduce its complication and make most understandable for the students. Moreover, emphasizing the necessity of the decomposition in subtraction and drawing lines for pairing numbers for operation, designing and solving mathematical task by MTEs themselves before giving to the students, and being anxious to be asked to solve other types of radical inequalities are extremely important to get themselves ready in the mathematical knowledge domain. Consistently, through the interview analysis, there was an emergence of professional learning regarding subject matter knowledge when the MTEs mentioned the different meanings of subtraction: completely taking the subtrahend away and through comparing two different things. These emergences of subject matter knowledge implied that MTEs needed to understand the main mathematical concept of the selected topics. Furthermore, several alternative solutions should be explored or predetermined by the group members, clear and precise mathematical problems should be designed, and accuracy in solving process and solutions for the unexpected questions that might be raised from the students should be mathematically tested and certified by the team members. Nonetheless, although Grade 1 mathematics regarding subtraction and quantity comparison might be simple mathematics lessons for the MTEs, as the case of TTC1-G1, they were still having difficulties linking the playful activity to the main mathematical concept. TTC3-G5, especially during the first lesson study practice, was still having difficulties regarding how to solve radical inequalities in other forms, for example, $\sqrt[3]{f(x)} > g(x)$ or $\sqrt[3]{f(x)} \leq g(x)$, which it was undesignated in the textbook. Therefore, the issues underlying MTEs' professional learning in mathematical knowledge was the lesson content analysis to determine the main concept and be free from the daily routine curriculum.

Through the perspective of teacher educators, the study revealed only the curriculum knowledge specifically when the MTE stimulated lesson study team members to consider designing the lesson objective to suit the main lesson content of today's lesson during the lesson design in the second lesson study practice. This emergent curriculum knowledge was illustrated when the MTE encouraged team members to think of another possible objective to suit the main lesson content, when providing a hint to the members to think further and when offering an alternative idea of the objective. This little emergent finding implied that the MTEs had limitation performing in this role. Their sense of being knowledgeable other was still weak. It might be because they have weaknesses the focus. Amador and Weiland (2015) claimed interesting finding that classroom teachers and university facilitators that acted as knowledgeable others focused only on superficial thing in general event (i.e., class attendance, behavior, and teacher pedagogy) while pre-service teachers focus on students' mathematical thinking in higher level than those knowledgeable others. Therefore, as the role of teacher educators, improving this sense is extremely needed. Lesson study knowledgeable other (facilitators, moderators and outside advisors) should not only deepen content knowledge and how students learn the content, but also "think in broader issues what the study lessons might inform our on-going efforts to improve teaching." (Watanabe, 2005). They should bring new knowledge from research and curriculum (i.e., providing pedagogical ideas, concepts behind the textbooks, and understanding content in-depth), show the connection between the theory and practice (i.e., "suggest possible directions for pursuing the school's research theme, and offer a professional viewpoint and opinions about the school's research and the research lessons") and help others learn how to reflect on teaching and learning (i.e., "raising important issues that were not addressed during the post-lesson discussion" rather than simply a summary of the discussion) (Takahashi, 2014).

6.4.2 Teaching-learning resources

Playing the role of the teachers, MTEs' professional learning in this domain included strategy for students' engagement that was expressed through MTEs' discussions about students' group setting, students working in pairs or individual work, selecting representatives to present their works and their collaboration in the group work. It was further illustrated by mathematical task design and awareness of promoting student thinking, teaching material discourse, main lesson content conceptualization, and observation protocol focusing on how students respond to each teaching process. Additionally, the interviewed data revealed three aspects of MTEs' professional learning in this domain. The first involved the following aspects: (1) how to plan a lesson, especially creating a one-page lesson; (2) planning and creating task questions, (3) appropriate sentence length in mathematical task, (4) modifying exercise as a lesson for teaching, (5) reducing the number of mathematical problems to increase time for students' thinking, and (6) selecting easy mathematical problems for lesson study. The second aspect comprises how to make teaching materials and the third regards students' learning behavior. For instance, students did not solve the mathematical problem but waited to acquire the answer from others. There was also a lack of discussion among students during the group work, lack of courage to express their ideas, feelings of shame when expressing an idea in front of others, and having a weak mathematical background. Ni Shuillebhain (2015, p. 372) found that the teachers' knowledge of content and teaching emerges through developing contextualized questions, evaluating mathematical activities, and sequencing learning trajectories including a series of lessons and sequencing content within a research lesson. Furthermore, Clivaz and Ni Shuilleabhain (2019, pp. 429-432) found that the knowledge of content and teaching was demonstrated as an "opportunity to select appropriate models, representations and examples to support students' mathematical understanding." Gonzalez and Deal (2017) found the change of knowledge of content and teaching through the task examination by creating criteria and selecting best tasks for the students to determine specific properties of perpendicular bisector. Apparently, these findings from the literature were specifically associated with the present findings regarding the mathematical task design to elicit student thinking and engagement. For example, the subtraction expression, 15 - 7, in the exercise was modified into the word problem. In contrast, the present findings revealed much basic concern about student engagement in the activity, their collaboration in the group works, and teaching materials. At the same time, there were some missing points regarding a series of lessons and task examination for best selection of examples or representations to design mathematical problems. Instead, the focus was in following the curriculum lesson by lesson taking whatever it had in the textbook as a top priority. Through these findings, it could be said that a good lesson might consist of teacher, students, mathematical tasks, and teaching materials, while the quality of the research lesson might depend on the quality of the mathematical tasks and interaction among those components. Lao teachers already bear a student-centered teaching concept in their mind. However, constructing a method is another challenge that they must overcome. Honestly, they were still at a risk because of the misunderstanding surrounding this concept. In traditional Lao teaching culture, whenever they have visitors to observe their classes, the first thing they were likely to consider was how to make students busy with many activities in the group work to gain observers' impression that the class has effective teaching. Subsequently, the team members needed to prepare numerous teaching materials, closely focusing on how to divide a group of students, deciding who would be selected to present their work, who had the better performance to lead the group, assigning a duty for each group member, etc. These were common scenarios that Lao teachers considered as a method to increase student participation and collaboration during teaching. The discussions about mathematical problems seemed to be less of a concern for them because it was already in the textbook; thus, the focus on students' mathematical thinking may have emerged superficially. Another phenomenon was making use of the term "student thinking." Lao teachers were likely to use the term incorrectly. They continued asking several questions during the teaching without knowing what the main problem was. As demonstrated with TTC1-G1, several questions were given to the students. Of course, it is undeniable that to encourage students to think we must ask some questions. However, it is dangerous to think that simply asking a series of questions is the goal as this may cause confusion for both the teacher and students. Typically, one or two main questions are suitable for a single lesson that encourages students to think. Later, during the group report or individual work report, the teacher may investigate several questions for clarification around the content.

The interviewed data also revealed some issues concerning the mathematical task design, such as how to design the introductory part of the lesson and not understanding the objective of the activity, as well as the lesson planning issues. For instance, the lesson plan was not sufficiently clear yet. Furthermore, it had not been determined how students would solve mathematical problem and if the expected way of solving subtraction could be changed aside from using decomposition. To understand these issues, it is necessary to understand the steps of how Lao teachers create a lesson plan or teach mathematics. As previously mentioned, Lao teachers followed five steps of lesson planning or teaching including reviewing the previous lesson, teaching the new lesson, conclusion, evaluation, and homework. In the first step, reviewing the previous lesson, most teachers interpreted incorrectly. They tend to be teaching the previous lesson entirely, solving a previous problem, or providing an example showing the solution process and formula in order for students to follow the guide to solve the main mathematical problem. This has been a common problem in Laos. Subsequently, the teachers would spend extensive time on this part. For example, with the second research lesson of TTC2-G3, the teacher spent more than 20 minutes reviewing the previous lesson. Another example is the first research lesson of TTC3-G5, in which the teacher educator spent approximately 40 minutes to review the previous lesson. Therefore, the issue that emerged in this research implied that MTEs still had difficulty designing this introductory part appropriately.

MTEs in the role of teacher educator also found some major points of their professional learning including the suggestion of strategies for (a) student engagement, (b) improving instructional tasks by removing the equal sign, (c) increase student decomposing skills through frequent exercises, and (d) for pedagogical strategy. The strategy for student engagement was expressed when the MTEs suggested that the lesson implementer divide students' duties in the group work and allow them to manipulate the teaching materials; when asking team members to consider the strategy to engage students in solving mathematical tasks; when offering an alternative strategy to interact with the students about the subtraction using decomposition method; when the MTEs suggested a strategy for student engagement in the group report; and when the MTE suggested the group members retain the method of providing formula material for the next lesson. The pedagogical strategy was evidenced by the suggestions of (1) introducing a clear solving method for the mathematical task during the previous lesson review, (2) establishing it as a model for the students to follow; the alternative strategy to manage students when they obtain unexpected solving methods during the review portion, and (3) increasing flexibility in decision making during the live lesson.

6.4.3 Instruction

Previous studies revealed some positive changes through lesson study practice. These were that the teachers have instructional improvement about vocabulary, differentiated instruction, manipulative mathematical instruction, knowledge of mathematical learning stages, and establishment of high student expectations (Rock & Wilson, 2005). Warwick, Vrikki, Vermunt, Mercer, and van Halem (2016) found that the teachers have altered the lesson structure by allowing students a more appropriate amount of time to articulate their reasoning and thinking, providing a clear point for group discussion, changes in proper mathematical language, and presenting the challenge of mathematical tasks. Instead of "identifying what was or was not implemented well," it is better to search for improved approaches or alternatives instead of merely evaluating failure and success (Pang, 2016). Hung et al. (2014) also found that "the teachers made significant improvements to their respective lessons including setting appropriate instructional objectives, optimizing instructional procedures, and selecting and sequencing mathematical tasks." The instructional objective changed "from mathematical knowledge and skills to mathematical knowledge, mathematical thinking, and mathematical activity experience," while the instructional procedure improvement was demonstrated by using several strategies to connect students' prior knowledge to the new topics, by "introducing, exploring new topics, exploring new knowledge and skills, practicing with variation, and summarizing." Coenders and Verhoef (2019) also discovered that professional learning in lesson study for beginning and experienced teachers motivated teachers to prepare the lesson to capture meaningful student learning activities. They designed instructional strategies for student engagement in the discussion with the group, expressing their ideas and consensus answers. They observed how students perform an activity, the difficulties they face, how students solve the difficulties, and different forms of student understanding.

In contrast to this research, acting in the role of teacher, this study determined five important points. The first concerned the assessment of the teacher's explanation that was illustrated by criticizing the use of questions; providing no explanation or modification to the points where students made mistakes to correct them to the right answer; lack of connection between homework and the lesson; and criticism regarding no clarification for the student about making the same base for solving an exponential equation. The second point involved instructional sequencing, expressed by discussion about the coherence of the questions and dialogues to interact with the students; three ways of presenting plastic water bag; discussing the scripts for how the teacher was supposed to instruct and how students would likely respond to the teacher's talks; and criticism on disorderly instructional sequence (demonstration of indirect comparison before comparison). The third point regarded criticism of time management demonstrated by the complains of wasted time in the previous lesson review, and wasting time in repeating students' work from beginning to end. The fourth point involved the suggestion that the teacher must frequently emphasize decomposition method; clear elaboration of two methods of decomposition (i.e., method 1, 12 becomes 10 and 2; method 2, 12 becomes 2 and 10); finding additional time for exercise drill; and appreciation of effective teaching based on preparing formula materials. The final point concerned the teacher's hesitation to make decisions when they noticed students could not effectively perform the activity.

The data from the MTEs' perceptions about their professional learning were also unpacked in a domain that would be classified into negative and positive points. First, positive points included learning about how to use concrete teaching materials, appropriate classroom management, and proper class controlling as well as learning techniques for pleasant classroom atmosphere and attracting students' attention. However, there were numerous negative points; questions were overly difficult for students, so the teacher should include additional, deeper questions. The teacher was not successful in following the lesson as planned, did not allow students much discussion time, and was unable to identify student responses. The teacher was overly talkative, no key question was written on the blackboard, and information students already understood was constantly repeated. The conclusion of the main content was unclear; the teacher could not maintain patience to instruct students on how to solve problems, and decision making for solving in-class issues was weak. The teacher educator was not fluent in teaching steps, provided a weak explanation regarding "change side change sign," and offered no arrangement for student teacher's work to present their work on the blackboard. The teacher educator should be able to point out student teachers' mistakes with a clear explanation of where the student teachers went wrong and why.

Obviously, instructional concern was evident in each step of the lesson study practices in each TTC. MTEs greatly emphasized the superficial feature of instruction because they might have preconceptions about practicing lesson study for refining the teacher's teaching behavior over enhancing students' learning comprehension and the actual teaching. This implied the weakness of collaboration in lesson planning and individual professional learning judgement, as well as, perhaps, their understanding about the concept of lesson study. Also, the scope in the checklist might urge them to focus on these superficial things. As a result, during lesson planning, they had limitations when discussing the content but heavily discussed "the needed materials, the role of students and who would teach the lesson" (Meyer & Wilkerson, 2011, p. 21). These findings also implied that motivation for doing lesson study was to increase student performance, inciting students to come up with the right solving procedure and correct answer. For instance, as with the case of TTC2-G3, there was an emergence of strategies for student engagement, but it was weak. It seemed that they facilitated everything to help students simply obtain the right solution method with the correct answer. First, the homeroom teacher gave her students some exercises related to the main problem that would be taught in order for the students to practice at home a day before the actual research lesson. Second, during lesson planning, MTEs emphasized to the homeroom teacher that she provides a clear explanation during the previous lesson review to explicitly introduce the two ways of decomposition. Perhaps, this was so the students could copy its method or be provided with a direction. Third, as a result, there was a risk; before moving to the main task—even while students were solving the main problem—the homeroom teacher "emphasized that students will be using these two methods to solve next mathematical problem" and "please students do it in two methods as we did a moment ago in the previous lesson review" (see Sec.5.2.2). Fourth, the worksheet was already designed, clearly drawing the blocks for the students to fill numbers in while these blocks already represented the mathematical ideas of subtraction by decomposition. Finally, while the students were working in groups, each observer moved around trying to stimulate each group by asking some questions, even giving some suggestions to make sure they understood. Those were critical, and it needed to be changed. Lewis, Friedkin, Emerson, Henn, and Goldsmith (2019, pp. 23-24) found and listed many challenges in each step of lesson study, as follows:

> [The problems involve] jumping into lesson planning without first considering the unit design and long-term content trajectory and clearly identifying the lesson's role within the larger unit and trajectory. [Another issue involves] failing to identify the new learning that will occur during the lesson…rather than identifying what students will learn from the activity, [as well as] planning the lesson around what the teacher will do, rather than around what the students will think, do, feel, and learn. [Additionally, many neglect] to incorporate learning from the Study Phase into the Teaching-Learning Plan – for example, neglecting to incorporate what is known about building agency or about learning fractions multiplication; failing to grasp students' current knowledge and to design the lesson based on that knowledge; anticipating student thinking in enough depth, accuracy, and breadth to write a plan that is likely to promote learning. Lopsided planning focused on one element of the lesson (often the launch). [There is a tendency to] focus on logistical elements of the lesson, rather than on the key student experiences that will produce tension or contradiction and drama of breakthrough. Team members divide responsibility for writing the Teaching-Learning Plan in a way that fails to build all team members' learning. The data collection plan is not well connected to the lesson goals. Gaps in the model of teaching-learning underlying the plan—for example, the plan may anticipate certain important student responses but not plan the teacher questions and moves that will allow other students to grasp these ideas.

The challenges during the research lesson were that student thinking may not be made visible, observers may interfere with student learning and did not collect data on student learning, and the teaching deviated greatly from what was planned. In the reflection, the discussion may not enable the learning because of poor data collection, lack of focus in observation, or focusing only on obtaining the correct answer but not strategies that students use. Furthermore, there is no motivation to take what they gain during lesson study practice and apply it into their daily teaching practice at their school—or to continue lesson study (Lewis et al., 2019, pp. 27-32).

Regarding the MTEs' professional learning as the role of teacher educators in the domain of instruction, the study revealed some key findings. This included the emergence of suggestions regarding (1) the strategy for improving instruction about the quantity comparison, (2) to demonstrate the three different ways of showing the water bag before asking questions, and (3) to ask deeper questions to clarify the lesson concept for the students. Suggestions were also made for the homeroom teacher to (a) improve her questions to stimulate students to think, as well as asking the students to demonstrate the comparison themselves in the conclusion part; and (b) to directly tell the students about the decomposition method instead of counting fingers. She was also provided with a strategy to conclude the lesson. Moreover, there were the suggestions for clarification and modification of the student teachers' mistaken points, to emphasize the lesson concept about making the same base at the beginning of the lesson, and to explain the related previous lesson review regarding the law of exponential equation. Interestingly, there was also the illustration of alternative instructional strategy provided to the group during the planning.

6.4.4 Collaboration

Collaboration can be discussed in several aspects of collaboration, such as among team members, between TTC directors with team members, between TTCs with primary or secondary schools, between a TTC with other TTCs, and between TTC with MoES. For this research, however, only two aspects of collaboration were discussed. First, data from the interview revealed MTEs' collaboration through sharing ideas, receiving others' views, and exchanging teaching experience with one another. For example, sharing an idea about avoiding the "borrowing" term but instead, using the term, "taking away." They perceived what they could learn as forming a consensus idea for a better lesson plan, sharing good points, and sharing teaching weaknesses. Nonetheless, workload issues, consensus times to meet each other, insufficient time in planning, and punctuation of the members is regarded as the issues of collaboration in the lesson study practice. Second, the collaboration among lesson study team members was also expressed by the number of participants in each step of lesson study practice, their attention for sharing ideas, and the collaboration between TTC directors with the team members, which was expressed by document support and whether they knew what the lesson study team members were doing. The other aspects of collaboration were the limitation of this research because still lacks information. Lesson study practice 1 and 2 of the TTC1-G1 still had some issues in the collaboration domain regarding attendance and sharing ideas because of the decrease in the number of observers. For example, there were 10 observers in research lesson 1 and post-lesson discussion 1. However, there were only two observers in research lesson 2 and post-lesson discussion 2, while the others were absent because of their personal work. There was between five and seven participants during the lesson planning, but they lacked a sense of sharing their ideas. Only two MTEs actively and dominantly expressed their ideas often, with the lesson flow going based on their direction. These two MTEs were some of the key individuals to lead lesson study practice in mathematics within this TTC. Perhaps, it was because both were once JICA participants in Hiroshima, Japan in 2010 and 2018 and was regarded as reliable facilitators. The other MTEs and the homeroom teacher were good listeners and rarely shared their ideas. Interestingly, during the lesson planning discussions, no one took notes or added anything to their notebooks except the person who wrote the lesson planning on the computer. While SPC, who demonstrated the lesson, was not fully participated in either lesson planning as the sessions occurred during school hours, and her students often disturbed her. Significantly, lesson plan 1, which was collaboratively planned, was not used in research lesson 1 due to a technical problem. This implied the weakness of collaboration and their group responsibility. This situation of less attention is usually happening in Lao context. Their motivation and active participation seemed to decrease when the intervention was less incentive, and they could not determine its benefits. In contrast to the case of TTC2-G3, their collaboration was impressive. The group members worked collaboratively and engaged in all steps of the lesson study practice with many instances of sharing their thoughts. They were a step ahead than the other TTCs. A possible reason why they have internal motivation or eagerness to practice lesson study relates to the work of the master's student, who graduated from a Thai university. Some of the key individuals were sent to observe some lesson study practices in Thailand, visiting some primary schools and even inviting some lesson study experts to their TTC. This kind of arrangement indirectly encouraged the MTEs in the TTC to internalize their motivation.

Previous studies determined that teachers work in a collegial manner through lesson study engagement especially while developing a lesson plan, during lesson observation, and through deep discussion in post-lesson reflection (Hunter & Black, 2011). They strengthen their professional community, first, through a shared framework for instructional analysis and sharing language, such as when the teachers used the language of "out-of-school mathematics," "school mathematics," and "context of the problem." These sharing of features were expressed when the teachers studied their instructional materials to identify students' previous knowledge before choosing a task in the lesson plan. It was also expressed through a sense of mutual accountability, because "all the teachers had to implement the research lesson in their own classroom…they critically evaluated the task presented…they showed a commitment to crafting a problem that would be engaging for their students" (Gonzalez & Deal, 2017). Lesson study is as collaborative work because the teachers teach each other about teaching, share a language in describing and analyzing teaching, and "provide a benchmarking process that [they] can use to gauge their own skills, continuing interactions about effective teaching method and observations of one another's classrooms, to help teachers reflect their own practice and identify things that can be improved." (Stigler & Hiebert, 1999, pp. 123-124) Through collaboration, teachers could see their own teaching through the eyes of colleagues and students and discover how their teaching relates to what other teachers are doing (Lewis, 2002, p. 34-37). Their in-depth discussion helps each other modify group's suggestions "by going into [the] role themselves and offering an alternative suggested question, instruction, or phrase." (Dudley, 2015, p. 17-18)

CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

This chapter consists of the conclusions about the MTEs' professional learning and issues of both teacher and teacher educator roles, recommendations, and limitations. The conclusions are based on those three research questions that guide the study to find out the emergence of the MTEs' professional learning, the depths of the professional learning, and the issues that occurred through actual lesson study practice.

7.1 Conclusions of the MTEs' professional learning and issues

a) What does MTEs' professional learning emerge during the actual process of lesson study practices among Lao MTEs?

As the role of teacher, MTEs' professional learning has emerged in the knowledge, teaching-learning resources, instruction, and collaboration. The knowledge included curriculum knowledge, subject matter knowledge, and students' and student teachers' conceptions. The curriculum knowledge was evidenced by the interpretation and modification of the lesson objective, awareness of the connection between teaching content and the objective of the lesson, consideration of the mathematical word problems in the subsequent lessons, and awareness of the content application to solve the exercises. Whereas the explanation of the lesson concept to each other was the evidence of the subject matter knowledge, including the emphasis of the necessity of the decomposition in subtraction, designing and solving mathematical tasks, and mathematical anxiety that would be asked by the learners to solve other types of radical inequalities. While the repeating students' words concerning the main lesson concept illustrated the students' conceptions, including discussions about students' mathematical ability and prior mathematical knowledge background, and identification of students' unordered processing skills when solving the given mathematical problems. Also, the student teachers' conceptions were demonstrated by the concern if student teachers would come up with the exponential laws, and consideration of suitable questions to elicit student teachers' idea to link from exponential laws to solve the exponential equations.

Regarding the teaching-learning resources, the study found out the emergence of the strategy for students' engagement, mathematical task design, and discussion about teaching materials. Furthermore, it found out main lesson content conceptualization, observation protocol that focuses on how students respond to each teaching process, and student participation in the teaching-learning activity. Whereas, the emergence of the MTEs' professional learning about the instruction included the comments on the lesson implementer's explanation, using questions, and instructional sequencing. Moreover, this finding was supported by the evidence of designing the coherence of the questions, criticism on the unordered instructional sequence, the complaining about time management in reviewing the previous lesson, and the criticism on the lesson implementer's hesitation of decision making during the live lesson. Regarding the MTEs' professional learning about the collaboration, it was expressed by sharing and receiving others' ideas, workload issues, time management and punctuation of the members; the decrease of the group members in the second lesson study practice, dominant in lesson design, attention to take note during planning or reflection, participation in lesson planning, and technical problem about utilizing the first lesson plan.

As the role of teacher educator, the MTEs' professional learning has also emerged in the curriculum knowledge, teaching-learning resources, and the instruction. The emergence of the curriculum knowledge was illustrated by the encouragement to think of possible lesson objectives of the chosen mathematical tasks. The emergence of the teaching-learning resources was evidenced by the suggestion about some strategies for student engagement and the suggestion of improving mathematical task design. Whereas the emergence of the instruction was evidenced by the suggestion of the strategy for improving instruction.

b) How deep is the emergence of the MTEs' professional learning in actual lesson study practices among Lao MTEs?

This study found out two levels (level 0 and level 1) of the depths of the emergent professional learning in both teacher and teacher educator roles. Level 0 contained the emergence of instruction and collaboration, the comments on the lesson implementer's explanation, using questions, and instructional sequencing. This level also included criticism on the lesson implementer's unordered instructional sequence, the complaining about time management, and the criticism on hesitation of decision making during the live lesson; workload issues, the decrease of the group members, dominant in lesson design, participation in lesson planning, and technical problem about utilizing the first lesson plan. Whereas the level 1 contained the teaching-learning resources and the knowledge domain that included a strategy for students' engagement, mathematical task design, discussion about teaching materials, main lesson content conceptualization, observation protocols, and student participation in the teaching-learning activity. This level 1 also included the interpretation and modification of the lesson objective, awareness of the connection between teaching content and the objective of the lesson, and awareness of the content application to solve the exercises. Furthermore, level 1 included the explanation of the lesson concept to each other, the emphasis of the necessity of the decomposition in subtraction, designing and solving mathematical tasks, and mathematical anxiety to be asked to solve other types of radical inequalities. Moreover, the level 1 included the discussions about students' mathematical ability and prior mathematical knowledge background, identification of students' unordered processing skills when solving the given mathematical problems, awareness if student teachers would come up with the exponential laws, and consideration of suitable questions to elicit student teachers' idea to link from exponential laws to solve the exponential equations.

c) What are the issues occurring in the actual lesson study practices in Lao TTCs?

Based on the MTEs' perceptions on the issues of lesson study practices, the study found the issues embedded in the knowledge, teaching-learning resources, instruction, and collaboration. Consistently, through the protocols data analysis, this research revealed some issues that hindered the progress of lesson study from reaching a high level. These issues included the status of relying on the checklists that superficially emphasize on the lesson implementers' teaching behavior, the lack of analysis of the main mathematical content, the lack of analysis of students' and student teachers' mathematical thinking, the lack of analysis of the connection of the curriculum, and the lack of connection of student mathematical thinking with the mathematical concept in a broader aspect. The content of the checklists and the lack of those analyses would affect how much previous knowledge or mathematical background should be provided to solve the current mathematical problems; what the subsequent mathematical concepts related to the selected lessons would be later presented in other lesson units or grade levels; weakness of understanding main mathematical content and the ultimate goal of the lesson that expects students to reach in the long-term development. And the lack of analyzing student mathematical thinking would limit the MTEs' opportunity to see mathematics from the views of the students, theory building, or the theory behind the mathematical concept.

7.2 Recommendations

Based on the findings, the study has some recommendations to the MTEs, administrators of TTCs, the MoES, and future study.

This study has revealed that the highest level of the MTEs' professional learning in those three cases remained in level 1 because of insufficient curriculum knowledge, insufficient knowledge of student conceptions, and weakness of understanding the main mathematical concept. To scale up to the higher level 2 or level 3, for the MTEs, analysis of those three issues and making a connection of the mathematical concept is the key. First, the study recommended refraining from using checklists but using some questions to guide the focal points when conducting lesson study. Second, the study recommended analyzing the whole curriculum of that chosen particular lesson. The analysis should not just remain only today's lesson but critically looking at previous and future mathematical concept that expected primary students or student teachers to achieve at the end within five years of primary education (as the case of primary students) or within four years (as the case of student teachers) or even further grade levels. For example, as the case of Savannakhet TTC, they should analyze how the quantity concept is developed in grade 1 across the lessons; how the quantity concept is connected to other grade levels; and finally, what mathematical concept of quantity that students will be acquired in the grade 5 or even further. Analyzing those connections will allow the teachers and/or teacher educators to understand where they are, what exactly mathematical concept of the quantity they are dealing with, and what the final goal they need to achieve is. Therefore, what they are doing of today's lesson is the foundation of mathematical concepts that students need to accumulate to acquire the other quantity concepts in other grade levels. Third, the MTEs or teachers should develop and accumulate the knowledge of students or student teachers by seriously putting a focus on the learners' mathematical thinking not just describing or identifying WHAT they are doing or difficulty they have, as found out in this study, but also analyzing HOW or reasoning WHY they manipulate or process in such a way. For example, as the case of Pakse TTC, the MTEs need to analyze why the students have difficulty to solve 15-7 using the decomposition method while they can solve it easily when the teacher reads the question for them or when they use counting method or simple calculation. Analyzing students' mathematical thinking shouldn't solely practice only during the lesson planning per se, but also during the research lesson and in the post-lesson discussion. Fourth, in relation to the curriculum analysis, the MTEs should clearly understand what the main focus of the chosen lesson topic is and how it is connected to other topics so that they will be able to exactly design the main mathematical task and correlate the mathematical concept to the theory behind such idea. Fifth, the MTEs have mathematical knowledge, but it seems to be disconnected to each other. So, reorganizing at their own pace is highly recommended. Sixth, the MTEs are expected to be knowledgeable others; therefore, they should play the role model of lesson study practice to others and be able to stimulate group members, colleagues, and teachers to think of those points mentioned above. At the same time, they must be able to provide an alternative suggestion for them to consider. Simultaneously, the MTEs must be able to supervise their group members constructively and professionally. To do so, they must be knowledgeable in lesson study concepts, be knowledgeable about effective instruction (i.e., problem-solving approach), and strong background of PCK and SMK of both school education and teacher education context.

The administrators of the TTCs should seriously take into account to support their staff to conduct lesson study in their practice. To implement that, in addition to those five points of recommendations, internal motivation is important. This study recommended collaborating with other TTCs and universities in domestic or international partners to exchange lesson study practices with them so that it would implicitly internalize their motivation.

The study also recommended the MoES considers revising the lesson study guidelines and including lesson study as a subject in teacher education. By putting lesson study in the system, it implies a huge progression and a good starting point of improving teaching and student learning through the lesson study approach. Further research would consider how MTEs or schoolteachers can improve their professional learning to the highest level by theorizing or creating their teaching theory based on the practice of the lesson study approach. Or identifying more why the MTEs or teachers failed to analyze and interpret the students' mathematical thinking during lesson study practice.

7.3 Limitations of the research

First, although the questionnaires about the MTEs' perceptions of their professional learning were collected, it was excluded in this study. This exclusion is to minimize the bias of the study. Based on individual reviewing some of their responses in the questionnaires, it was far from the reality comparing to the interviewed data and discussions protocol data analysis. Second, the intervention was minimum; as a result, the change has not outstandingly occurred. Also, some of the MTEs in some TTCs did not cooperate well, especially in the second lesson study practice. Third, the way of the lesson study practice was quite different from the literature. There was no modification of the lesson plans but teaching a new lesson instead. Fourth, the study faced difficulty in eliciting the MTEs' professional learning in terms of the role of teacher educators through the interviewed data because of the interview question design.

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APPENDIXES

Appendix A: Lesson plan 1 of TTC1-G1

(Original lesson plan 1 of TTC1-G1)

Subject: Mathematics

Lesson 13: Quantity comparison

I. Objective: to get students interested on the size of the object and understood the principle of quantity measurement.

II. Content: Quantity comparison

III. Teaching-learning materials: color water; glass or different size of bottles and transparent plastic bag

IV. Time: 45 minutes

V. Teaching-learning activity

Teacher activity	Time	Students' activity
1. Introduction - Teacher respects students - Teacher checks attendance - Introduce guesses, - Check homework - Conclude students' solutions of their homework	5 mins	 - Students respect teacher - Representative report absentees - Students applause - Give homework to the teacher - Students listen to teacher's conclusion
2. Teaching - Teacher write lesson title on the board Lesson 13: Quantity comparison - Teacher asks students to notice plastic bag that contains color water - Teacher asks students about the change of the quantity inside the plastic bag how it is changed?	20 mins	- Students notice as what teacher said - Students say about the quantity of water in the plastic bag based on what they see - Students answer as what they have seen - Students answer based on their understanding

- Teacher asks for the reason why it is increasing or decreasing? - Teacher additionally asks that if we change water from plastic bag to a glass, the amount of water will increase or decrease? - Teacher selects 1-2 students to the front and demonstrate to others - Teacher asks students again whether it is increasing or decreasing? - Teacher concludes the activity that students did		- Students answer both increasing and decreasing - 1-2 students come to the front to demonstrate to others - Students answer - Students answer based on what they have seen - Students listen to teacher
3. Conclusions - Teacher re-concludes about the measurement about the amount of water inside the plastic bag with students - Teacher suggests students to take notes the correct lesson to their notebook	5 mins	- Students join conclude the lesson with teacher - Students jot down the lesson to their notebooks
4. Evaluation - Teacher selects 1-2 students come to the front to explain about the amount of water inside the plastic bag whether how it is changing? - Teacher concludes what students explain then applause	10 mins	- 1-2 students explain about the amount of water as the teacher's suggestion - Students listen to the teacher's conclusions and applause
5. Homework - Teacher suggests students to study next topic	5 mins	- Students take the next topic to work at home

Appendix B: Lesson plan 2 of TTC1-G1
(Modified lesson plan 1 of TTC1-G1)

Subject: Mathematics

Lesson 13: Quantity comparison

I. Objective: to get students interested on the size of the object and understood the principle of quantity measurement

II. Content: Quantity comparison

III. Teaching-learning materials: color water; glass or different size of bottles and transparent plastic bag

IV. Time: 45 minutes

V. Teaching-learning activity:

Teacher activity	Time	Students' activity
1. Introduction - Teacher respects students - Teacher checks attendance - Introduce guesses, - Check homework -Transition to new lesson by asking Q1. After having breakfast, do you drink water? how much did you drink? - We see that each student drink water different amount isn't it So, today let's we learn quantity comparison together	5 mins	- Students respect teacher - Representative report absentees - Students applause - Give homework to the teacher - Drink, eat, no - A haft of glass, one glass, little
2. Teaching - Teacher write lesson title on the board Lesson 13: Quantity comparison	20 mins	

Q2. Teacher shows up plastic bag with colored water inside and ask students to notice Q3. Teacher asks students, what can you see? (suggesting students to freely talk about the water inside the bag based on what they have seen) Q4. Teacher presses up the bottom of the plastic bag and ask students how is the water? (increase, decrease or unchanged? why?) Q5. Do you think why it is increased, decreased, no change? Q6. Teacher put the plastic bag on the palm and ask how is the water? (increased, decreased or unchanged? why?) Q7. Do you think why it is increased, decreased, no change? Q8. Teacher put the plastic bag on a tray and ask how is the water? (increase, decrease or unchanged? why?) Q9. Do you think why it is increased, decreased, no change? - Arrange students into 7 groups - Teacher explains each material for activity (a half-cut bottle, plastic cup) - Distribute materials to each group - Teacher explains each step how to do it and discuss what the questions		- Students notice as what teacher said - Students notice - Students say about the quantity of water in the plastic bag based on what they see - Students answer based on what they have seen, increase because the water is nearly full in the bag -Decreased because… - No change because… - Students answer based on what they have seen, increase because the water is nearly full in the bag -Decreased because… - No change because… - Students answer based on what they have seen, increase because the water is nearly full in the bag -Decreased because… - No change because… -Students group together -Students listen to teacher's explanation - Students discuss with teacher

Q10. If we change the water from the plastic bag into the half-cut plastic bottle, plastic cup, how is the water changed? (increase, decrease or unchanged? Why?) Q11. Teacher additionally asks that if I (the teacher) put the same amount of water into a different size of containers, how is the water in each container? (increase, decrease or unchanged?) - Teacher concludes about students' activity that although the shape of water containers is different, the amount of water will not be changed.		- Students answer, increase, decrease, unchanged - No change because the amount of water is the same - Change because of different container - Students listen to teacher's conclusion
3. Conclusions - Teacher concludes the activity by asking what did we do in this lesson? Water from the plastic bag put into another container, is the amount of water changed? - Teacher emphasizes that although the shape of water containers is different, the amount of water will not be changed.	5 mins	- Students join concluding the lesson with teacher
4. Evaluation - Teacher selects 1-2 volunteers to the front to explain about the amount of water inside the plastic bag whether how is it changed?	10 mins	- 1-2 students come to the front to explain about the amount of water as the teacher's suggestion
5. Homework - Teacher suggests students to study next topic	5 mins	- Students take the next topic to work at home

Appendix C: Views of professional learning

C.1 MTEs' views on professional learning in lesson study practice 1 (TTC1-G2)

Similar to the TTC1-G1, Professional learning of the TTC1-G2 in the lesson study cycle 1 is classified into 3 main themes, collaboration, instruction, and a little touching teaching-learning resources. Why the researcher mentioned it as a little touching teaching-learning resources, it is because of the details of each code. The MTEs just simply say these terms in short phrases without providing content related to mathematics. For example, SLT said "I learn many things, I did lesson planning, right". BPN also stated that "…[got] sharing idea so that when we teach, we will know what to add in teaching, it helps us to know what to adapt in this lesson plan and take which things as teaching materials".

The main theme collaboration contains subcategories about opportunity to discuss with others, collaborative work with others and receiving ideas from others. MTEs generally stated that participating this Lesson study allows them to have got some ideas from many people in which it is different from individual thoughts especially the one that is related to the selected topic for teaching, as STV clearly stated that "we share comments related to what is going to be teaching, it means that not only my ideas but also others'". As well as, "I see many ideas not only mine", "for example, teaching materials, some [of MTEs] take their own ideas about terrestrial - aquatic animals, to me I am not quite agreed with that because we still don't know well the details of these animals". Similar to his responses, one of group members, SLT, expressed ideas about her Professional learning through this Lesson study practice, it helps her with the experience of consulting "about how to use teaching materials related to the prepared topic that is Sets and its elements" with other MTEs. This characteristic is quite common for those who lack of understanding about Lesson study. She also pointed out that there is an agreement about what "will be teaching this way [or that way] and use this one as teaching material…with students, whether how to use it so that students will understand about Sets and elements". Those general comments are described because, as from the interview, it is their first time of conducting Lesson study of this group. Thus, during the lesson planning activity, most of the MTEs stay not active and passively get information. As, BPN, the leader of the group, even himself also perceived that he got a lesson about "gathering together to decide about grouping (Sets), one more thing, we seldom have meeting to make a lesson plan like this, this is a new problem since I got training". This is pretty much convincing that a first hand in

Lesson study practice would have more focus on the properties of collaboration in which it is very much correlated with the process of instruction.

While the instructional theme contains instruction itself and teacher behavior as the subcategories. They perceived that they gained a better way of improving teaching from this practice, even though, from the researcher's perspective, it was not different from their own diary way of teaching. This might be, perhaps, because of all MTEs in this group are teacher educators who have experience only on training pre-and in-service teachers. For this reason, they thought as they got a new way of teaching especially how to teach children. As DML clarified that

> our way of teaching is different, I used to teach adults only, teaching adult is this way but teaching children is another way, new way of teaching that is the difference of teaching adult and children…. for adults when teaching, I comfortably and freely say [what want to say], for example, we teach about Sets, I generally explain, because they have already known what the Sets is, they have already had some background. For children, in contrast, before teaching about Sets, we have to give an example outside the lesson [that is related to daily life]".

Other than the way of teaching, MTEs also criticized how the teacher asks some questions during research lesson 1 as well as how he approaches the students during group activity. For example, the teacher should not ask direct questions or shouldn't only ask closed questions. Whereas during students doing groupwork, the teacher should spread attention to the whole class equally. Those kinds of occurrence made observers criticizing that it was not a good way of teaching. Following is the statement that one of the members, STV, pointed out

> Some words the teacher gives too much time pressure [during student doing groupwork], the question is direct question. I think, [he] should use indirect question, for example, the given problem, we think together, how we can find the solution, we say like this in order to get all students involved; this is the technique of asking a question. For example, supposing the math problem is to find the area of rectangle, instead of asking what the area of the rectangle is, it can be asked like let's find the area together whether by which method we can find out, we ask indirect way as such.

Through this criticism, it reflects to the group about how seriously they collaborate planning the lesson together; how depth they design the lesson plan. Through the researcher's observation, they take it gently and very dependent. It could be said, from the researcher's interpretation, that it is not lesson design or lesson planning, rather a meeting to share the schedule of what is going to be doing and when to do that because the lesson plan is already predetermined or designed by the homeroom teacher and they are all agreed without any critical looking at it. As a result, many negative attitudes go to the teacher's teaching behavior.

Table 43. Professional learning in Lesson study practice 1 of TTC1-G2

Main theme	Subcategory (No. of codes)	Coding examples
Collaboration	Discussing each other (12)	Discussion of using materials, discussion of way of teaching, consulting each other regarding a topic for teaching
	Collaborative work (2)	making lesson plan together to solve problem, improve teacher and lesson plan together
	Getting idea from others (3)	getting suggestion from others
Instruction	Instruction (8)	A better way to improve teaching, new different way of teaching adult and children
	Teacher behavior (2)	Teacher should ask more open-ended questions, Teacher paid attention only on some specific groups
Teaching-learning resources	Lesson planning (3)	Choosing teaching materials, making lesson plan, improving lesson plan
Preconditions	Lesson study (3)	Understanding about lesson study, set objective of doing lesson study

The last theme of Professional learning in Lesson study practice 1 is preconditions that will be used for further development of other components like instruction, teaching-learning resources professional knowledge and finally theory building. Typically, it is assumed that, prior Lesson study practice 1, MTEs already have preconception about what Lesson study is and how to implement it. Surprisingly, one of the group members mentioned what he got from other observers in the post-lesson discussion is about setting up the objective before conducting Lesson study. Through the researcher's investigation, this is their first hand of conducting Lesson study. So far, they only got intensive training about theory of Lesson study from their colleagues within the TTC. Given these facts, they are learning to learn how to do Lesson study. At this point, STV stated that "I understand more deeply about the word Lesson study". It means that "study about lesson before teaching, it is teacher gather to talk about teaching a lesson". Furthermore, he can even figure out the advantage and disadvantage point of it. The advantage is "seeing a short coming of the lesson". While the disadvantage is

> it seems to be too much of meeting, based on our situation, oh, it is not, it is 2 or 3 cycles, before conducting has a meeting, after conducting has a meeting. In term of the content is good, but in the real practice it has too much meeting. Based on our country situation, based on current economic, that is a weak point.

C.2 MTEs' views on issues in lesson study practice 1 (TTC1-G2)

The issues, based on interviewed data, have 3 points such as collaboration, time issues and preconceptions. This Lesson study practice 1 has collaboration issue especially in preparation of lesson plan and teaching materials. The prepared lesson plan and teaching materials cannot support each other because during the planning session, the group did not discuss about the lesson planning at first; they only put more emphasis on designing teaching materials while the lesson plan itself just simply following what the homeroom teacher made last year. So, both of it cannot be harmonized and finally the teacher didn't use that materials in this lesson. More seriously, on the day of research lesson, there was a mistake, the group members who are responsible for preparing teaching materials were late to bring the materials to the homeroom teacher. To solve this mistake, immediately, the homeroom teacher spent around 15 minutes to create students' worksheet. As DML stated that

> It is like lesson planner is this person but preparing teaching materials is another one, it is prepared separately. I don't know what to say, it is not consistent. As such, it has a mistake, the teacher is only wait, there is misunderstanding…. the teacher waits teaching materials from others. I want that, on that day [teaching day], I want everything get ready, when the time for teaching is come then just take it to the class, no need to wait like that.

Another issue is about the lesson plan. Some of MTEs perceived this as the issue in which it is reflecting their collaboration. These MTEs shared the traditional ideas that the person who makes the lesson plan should be the person who teaches the lesson. Doing this it will secure the teacher's quality of teaching. As this MTEs, DML, mentioned that "sometimes this teacher makes a lesson plan, but that teacher teaches the lesson; how this can go to the right track. Supposing that I make a lesson plan myself and prepare myself, I think doing this way I will get more ready". It is probably because of this belief, researcher commonly noticed that all most all of lesson planning in the Lesson study practice 1 of TTC1-G1, TTC1-G2, TTC3-G4 & TTC3-G5 pointed out one teacher to make a lesson plan his/her self and demonstrate the lesson his/her self. However, doing so is conflicting the concept of Lesson study.

Time issue is typically raised in every Lesson study practice of each TTC especially for the first experience in Lesson study like TTC1-G2. They generally pointed out insufficient time for preparing, perhaps, bot lesson plan and teaching materials. Also, the issue in finding appropriate time to meet each other. As BNP claimed that "sacrificing time for each other is difficult, some people have their private time, so they are rushed".

And the last theme is the issue of understanding Lesson study (preconceptions). As stated in some sections earlier, this group has no experience of conducting Lesson study before; they only knew its theory a couple of years ago. As a matter of fact, they confess that they don't understand it well. As these 2 MTEs pointed out "as I told you there is only me who understood about the Lesson study [in this group], STV also doesn't know, the other younger teachers they graduate from this TTC, so they know nothing about Lesson study". Additionally, SLT added that "the issue is the readiness because I am still don't understanding well about Lesson study, I have never practiced Lesson study before. So, we encounter difficulties, our team doesn't work well. Also, during this time it is a workload period".

Table 44. Issues of Lesson study practice 1 of TTC1-G2

Main theme	**Subcategory (No. of codes**	**Coding examples**
Collaboration	Preparation (3)	Unmatching lesson plan and materials, mistake in preparing materials
	Lesson plan criticism (3)	One plans the lesson but other teaches it, a person who makes lesson plan should teach
	Miscommunication (3)	Coordinating with director only not teacher, asking director only not teacher himself, my mistake that I didn't ask him
	-	One teacher influences lesson planning idea
	-	Afraid of giving comments
Time issue	Time (3)	Not enough time for preparation, finding time to meet each other

Preconceptions	Lesson study (2)	Don’t understand lesson study, group members don’t know Lesson study

C.3 MTEs’ views on professional learning in lesson study practice 2 (TTC1-G2)

Although Lesson study practice 2 is not really discussing about mathematics in the whole process, Professional learning in this practice has emerged 4 important themes, such as, knowledge, initial teaching-learning resources, collaboration and instruction. Comparing this with the Lesson study practice 1, although it is not yet deep enough, knowledge and initial teaching-learning resources are the new emerged themes.

The key theme *knowledge* contains 2 important subcategories, student conceptions and student learning. This Lesson study practice 2 has expanded MTEs’ attentions on student conceptions especially in anticipating student answer in several ways when designing the lesson plan so that the teacher can handle unexpected responses from students while the research lesson is ongoing. STV frankly say that:

> we should anticipate several students’ answers and roughly think the way out how to respond to those anticipated answers. As for today teaching, the teacher did a good job, students answer that it is an animal that has wings. He, then, tries to narrow down to the expected group [sets] that is the animal with 2 legs.

The 2nd point that is related to student conceptions is student misunderstanding. MTEs can identify student misunderstanding regarding the group. Probably they regarded the term “group” in this Lesson study practice 2 as the “Sets” in mathematics. Students have misunderstanding among terrestrial, aquatic animals, and amphibians. As SLT explained about students’ misunderstanding that

> some students in some groups misunderstood about group. For example, duck and goose, students still don’t understand that they are terrestrial animals. Rather they understood that when it goes into the water it will become aquatic animals and when it goes up to the land it will become terrestrial animals. They don’t know how and where amphibians live.

MTEs of TTC1-G2 also regarded student behavior as their Professional learning. For example, students have enthusiasm and well participated in the group work, understanding the meaning of the group (Sets) after doing activity. However, some students lack of will or courage to answer teacher’s questions even if they know well the answers. It seems that MTEs have impression in this lesson because they see the dynamic of the classroom that students interactively work together even if the content is not well associated with the Sets and elements.

While the 2nd new emerged theme, initial teaching - learning resources contains subcategory lesson planning, instructional strategy, lesson connection and use of materials. Why the researcher uses initial teaching-learning resources as the key theme not stand-alone teaching - learning resources is because of the content of each subcategory. MTEs simply imply those key terms without providing much details. For example, in lesson planning, MTEs perceived that the steps of making lesson planning is their Professional learning, as DML simply pointed out that "I learn about the step of making lesson plan…the 5 steps of lesson plan like we used to do starting from introduction up to conclusion and evaluation. Such as, introduction, teaching, conclusion, evaluation and warning". As well as instructional strategy in which the MTE describing about the teacher's characteristic of how the teacher asks a question or answer students' questions. As SLT said that I gain about "finding a way out to answer students' questions while we were teaching, if we don't know how to answer, if we hesitate how we will answer". For instance, "is the goose aquatic animal when it goes into the water, or when it goes up to the land, is it terrestrial animal? in order to stimulate students to think". Whereas the 3rd subcategory, lesson connection or transitioning activity in which it is usually not used in daily teaching rather straightforwardly to the main lesson content. Here, MDL honestly mentioned the point of her Professional learning that "it is the step of transitioning activity, in daily practice, mostly I don't use transitioning activity because I teach adult, I accepted that I don't teach all step…from now on I will improve my teaching, I will follow this step". She means 5 steps of Lao teaching style, but she will put more emphasis on activity of connecting previous lesson to a new lesson.

Table 45. Professional learning in lesson study practice 2 of TTC1-G2

Main theme	**Subcategory (No. of codes)**	**Coding examples**
Knowledge	Student conceptions (4)	Should anticipate student answer in several ways, student not courage to answer questions
	Student learning (3)	Student learning about sets and elements, got knowledge about that topic

Initial teaching - learning resources	Lesson planning (7)	Steps of making lesson plan, considering appropriate questions to ask students
	Instructional strategy (4)	Professional in teaching, questioning technique to stimulate student thinking
	Lesson connection (2)	Transitioning activity to a new lesson, transitioning to a new lesson
	Use of material (1)	How to use materials to stimulate students understanding sets
Collaboration	Collaboration (10)	Exchanging idea regarding activity about sets, respecting others' ideas
Instruction	Teacher's behavior (6)	Teacher's hesitation about student's answer, teacher knowledge about animals is rather weak
	-	Change from less to more preparation

Although the new themes are emerged relatively, MTEs still stick with collaboration pretty much. The practice of Lesson study 2 gives them a chance to exchange an idea regarding activity about group (Sets), planning the lesson together, respecting others' ideas, working in team and discussing about both teachers' and students' answers as well as the point that the teacher didn't conclude the lesson. At those points, STV pointed out that "we work in team like BNP & LNP working on teaching materials and sharing their ideas, DML is typing content into PC, and I, DTV & SLT also share the ideas to the group…". BNP also added to the point of respecting other ideas that

> something we should accept it for them and for us, just following our idea or their idea alone is impossible. We are not always right, we should consider cause and effect as well. For the past time we make a lesson plan alone, it is not 100% sure because it is our own idea, we don't know what other people think, this is a little bit difficult.

Again, Professional learning associated with instruction by describing teacher's behavior. The group members viewed that the teacher has hesitation on student's answer because the teacher himself is also not quite sure with the answer. This is happening because the teacher's knowledge about animals is rather weak. Actually, the main concept of this lesson is about Sets and Elements in mathematics. But the group tries to link from daily life (real world) to the mathematics using types of animals to interest students. As a result, when students spotted out several names of animals, teacher himself is also not a specialist about this area, it makes difficulty for him to judge if students' answer is valid or not. The other criticism is that the teacher didn't conclude the lesson and forgot to write the Elements of the Sets. These are regarded as the teacher's weak points that he needs to overcome in the next lesson. Nonetheless, one of the members, STV, expressed his opinion, a kind of understanding situation well that

> at this point I think it is based on the situation, a chance, and time. The teacher is not ready to conclude yet because it is on the way of students doing activity. It might be because of our anticipations, we thought that students can do it. When the real research lesson has come, however, it doesn't go smooth that way; so, the time [of doing activity] is extended. If we have more time than this or if we cut something out, then it may be matched as what we expected.

His comments implied that he's getting started to have critical lens in research lesson not just simply criticizing only the teacher's behavior.

C.4 MTEs' views on issues in lesson study practice 2 (TTC1-G2)

There is no difference between the issues in the practice 1 and 2 of Lesson study. As usual, they can only see the issues about time and instruction (see **Error! Reference source not found.**). The teacher who demonstrated the lesson claimed that the time for teaching is not enough, time for planning a lesson is not enough and doing Lesson study spends much time. These are chronical issues and simply criticized by most of participants because it conflicts their traditional way of teaching the lessons. Typically, the teaching hour system in Laos, say, one hour means 45 minutes, is prescribed to take a beak every hour. In actual practice, however, Lao teachers are relatively teaching 2 hours continuously before a short break. This is commonly and world widely practicing from grade 1 up to grade 12. Consequently, when conducting Lesson study, spending 45 minutes for one lesson is not enough for them.

The second theme of issues is instruction in which it is related to the content that the group selected to teach. They accepted that the group didn't chose a lesson that they understood well in term of content so that they can fully support students. The group also excused that they are not specialist in secondary mathematics. Responding to this, researcher likes to have an argument that, actually, all of the group members know well about Sets and Elements. It is a matter of how they design learning activity. In this case they use animals to classify into 3 types of animals, such as, terrestrial, aquatic and amphibians' animals in which it may not be related to mathematics at all or partially related, perhaps. Another claim that MTEs in this group excused is that they are not teaching secondary mathematics. Actually, all of them are teaching abstract mathematics in the TTC like Calculus, Analysis, Algebra and applied mathematics in which it is already covering secondary mathematics and secondary mathematics is the foundation of those abstraction.

Table 46. Issues of lesson study practice 2 of TTC1-G2

Main theme	Coding examples
Time (6)	Insufficient time for teaching, Time to meet group members, Time in planning is not enough
Instruction (3)	We should teach what he knows well, limit content and worry if away from textbook, not all group members teach secondary math
-	Don't know what the issue is

Based on MTEs' views, this study illustrated that MTEs' Professional learning through the actual Lesson study practice 1 & 2 has a little progress. Even though there appeared to be a strong criticism on the collaboration, instruction and teacher's teaching behavior at the first practice, at least they pointed out student awareness after the 2^{nd} research lesson. For all that, referring to the lens of this research, they are in level 0 in the first practice and there is a possible transition from level 0 to level 1 after the actual Lesson study practice 2. Nevertheless, they haven't realized that they have a lot of issues related to Lesson study practices. This research expected their Professional learning and issues related to the new knowledge that students created through solving mathematics problems. For example, how they come up with this solution or ideas, what kind of prior knowledge students use that lead them got such results, how to interpret these results, what does it mean by students, and as high as abstract to forming a theory of teaching or student learning in the specific topic, etc.

C.5 MTEs' views on professional learning in lesson study practice 1 (TTC3-G4)

Lesson planning in the Lesson study practice 1 is the MTEs' Professional learning of the TTC3-G4 emerging under the main theme of teaching - learning resources (see Table 54). MTEs of this group, but not many though, generally and superficially expressed their Professional learning about how to plan a lesson, giving an appropriate time for the objective of the lesson, and setting the objective of the lesson to suit the lesson content. VLX simply stated that "mainly I learn about planning a lesson, planning a lesson in Sathith primary school is what I learn the most", "giving an appropriate time with the objective", and "setting up the objective to meet the lesson we want to achieve". These expressions are lacking in-depth and details how the group make the lesson plan, their thoughts about what they learn in lesson planning is rather weak in comparison with the TTC2-G3. For example, MTEs of TTC2-G3 mentioned that "the exercises can be modified as a lesson for this Lesson study practice… the group considers students' knowledge and language ability by appropriately adjusting the length of sentences in the word problems not to be too long or too short" (see sec.5.4.10). Hence, even it is under the teaching - learning resources, what MTEs perceived in this subcategory is still shallow.

The 2nd main theme is subject matter knowledge about subtraction and how to calculate it. However, their responses are also lacking deep discussion rather simply stated that "mainly learn about subtraction because there is only subtraction in the lesson plan"-PLP. This MTE knows what he is doing about, but he doesn't know how to explain in further details.
As well as MTH stated that

> I learn ones place value can subtract with ones place value…because it was not mentioned in the textbook from the beginning…based on scientific principle we must, if it can be subtracted, subtract ones place value with ones place value, we don't need to subtract with tens place value"

This MTE sees the basic principle that if the minuend is larger than the subtrahend then we don't probably need to decompose before calculating the subtraction but subtracts them directly.

Instruction is the Professional learning that TTC3-G4 perceived in the Lesson study practice 1. They have pretty deep responses in this subcategory related to the mathematical content knowledge. The group realized that teaching subtraction using decomposition is a new method of teaching primary mathematics because the old textbook of primary mathematics didn't suggest them this way but direct number calculation. As the comments from PLP, it is a "new way of teaching, if we can't subtract then we use decomposition, decomposing into ones place and tens place". The view of PLP means that in case the minuend is smaller than the subtrahend in the ones place then we cannot do direct subtraction but using decomposition instead. However, the researcher was not quite sure if he is really aware about this because during lesson planning or post-lesson discussion, he didn't share any of his thoughts. He also, PLP, viewed this way of teaching is "student-centered approach because the teacher didn't explain that much but let students explain more [than the teacher's] …for example, 11-3, mostly the teacher didn't do it but allow students to do it, later the teacher re-explain and conclude it". Considering the number of codes, however, it is undoubtable if the MTEs' Professional learning in the Lesson study practice 1 is really emerging in these 2 main themes teaching-learning resources and subject matter knowledge or it is just randomly stated by chance.

Teacher behavior, the subcategory of instruction, is highly stated as MTEs' Professional learning in the Lesson study practice 1. MTEs appreciated that the teacher provided full set of teaching materials with clear voice of explanation during the research lesson. This might be, based on the researcher's observation, because of the teacher was not only talkatively explaining how to subtract using decomposition but also helping students to memorize useful expressions, and demonstrating how to use bottle caps before getting students practiced for the group work activity. MTEs of this group also expressed negative attitude and criticized some points related to the teacher behavior that the teacher likes to erase the blackboard pretty often, not well-organized dividing students for the group work, worrying about the results of student activity too much, and not following the lesson plan well. This maybe because of, based on the researcher's observation during the teaching, the teacher was holding the textbook most of the time, while the lesson plan she made didn't appear in the class. Furthermore, MTEs of TTC3-G4 perceived that this Lesson study practice 1 made them an opportunity to receive some comments from vice director and some teachers, while a few of them didn't have courage though. In contrast, through the researcher' observation in lesson planning and post-lesson discussion 1, there were only 2 MTEs, MTH & VLX, were actively commenting or sharing some ideas, whereas the others just listening.

Collaboration, MTEs also expressed that Lesson study practice 1 provided an opportunity for them to experience working with primary teachers, exchanging and accepting others' comments and working in team. As following conversation among 2 active MTEs

VLX: [primary teachers] don't want to accept [comments from others]

MTH: through doing Lesson study we see that

VLX: their acceptance

MTH: they accept it, they're courageous to talk to each other, they're courageous to comment each other this and that…

VLX: I also used to hear that we cannot criticize some teachers, if we do, they will turn out to another way, but when doing this, they understand and accept it,

MTH: it makes primary teachers, if we can do like this every subject, it will be getting better.

Apparently, MTEs' Professional learning emerging in the theme of collaboration is not clearly described in term of the details of collaboration other than simply statements of working in team and exchanging ideas. While the last component is preconceptions that is learning about

Lesson study. Two (2) MTEs mentioned that their understanding about Lesson study is increasing because, as their comments, for the past time, they just do it without understanding how and from what source to analyze it. However, this time they know how to analyze from the video using S-T program-the one that was designed by JICA, to analyze teacher's and students' behavior in 5 items. Nonetheless, these 5 items are specifically associated with teachers' and students' behavior in which it is categorized under the instructional theme.

Table 47. Professional learning in Lesson study practice 1 of TTC3-G4

Main theme	**Subcategory No. of codes**	**Coding examples**
Teaching-learning resources	Lesson planning (3)	Lesson planning, giving appropriate time for the objective, setting objective to suit the lesson
Subject matter knowledge	Mathematics knowledge (2)	Subtraction, ones' place can subtract ones' place
Instruction	Instruction (5)	Teaching decomposition, new way of teaching subtraction
	Teacher's behavior (15)	Well explanation with clear voice, setting a group of students is not well organized, erasing blackboard is too quickly
Collaboration	Collaboration (4)	Experience in working with primary teachers, accepting others' comments
Preconceptions	Lesson study (2)	Lesson study process
	Time	Time management
	Observation	Points to observe base on checklist

C.6 MTEs' views on issues in lesson study practice 1 (TTC3-G4)

The issues of Lesson study practice 1 is not much different from what MTEs have mentioned on their Professional learning. Referring to the number of codes of the subcategory, firstly, MTEs mentioned about the teacher teaching's behavior like the teacher is not proper preparing and organizing materials for students, understanding how to set up student group work is not high, and blackboard use is not well organized. For instance, MTH commented that "we have already said to prepare it. Actually, before group work activity we should prepare materials in package for them”. Practically, “the teacher just gives to students, if it is not enough then students can take more, if it is too much students can give it back, this makes students confusing”-MTH. This MTE meant how the teacher distributed bottle caps to students during the group work activity. The teacher didn’t prepare each set for each group in advance. She randomly gives some bottle caps to each group without counting how many. Regarding blackboard use, MTEs criticized that the teacher is extravagant and not well-organized where to write lesson topic or where to paste student worksheet, etc. Secondly, even though they planned this lesson together, the MTEs complained that this lesson contains too much activities and content. Thirdly, student conceptions, the MTEs generally pointed out the issues that some students cannot do decomposition. While manipulating materials, mainly the students didn’t apply decomposition rather remove it directly. As PLP responded that “for bottle caps use, mainly, students didn’t decompose at first, they just count, for example 13 - 9, they count up to 9 then take it out. They didn’t decompose 13 into 10 and 3” before removing 9 from 10 and put 1 with 3 together become 4. This MTE noticed the issues that students didn’t use theory in manipulating the real teaching materials. The other issues are about not all participants join the group, time management and budget to support the practice.

Table 48. Issues of lesson study practice 2 of TTC3-G4

Main theme	**Subcategory (No. of codes)**	**Coding examples**
Instruction	Teacher behavior (7)	Preparing and organizing materials for students, setting up student group work, blackboard use
Teaching-learning resources	Lesson plan (2)	Too many activities, too much lesson content
Knowledge	Student conceptions (2)	Some students cannot do decomposition, student manipulating materials not applying decomposition
Collaboration	Collaboration (1)	Group members not all come
Time and budget	Schedule (1)	Leaving students when planning or reflection
	Budget (1)	Lack of budget

C.7 MTEs' views on professional learning and issues in lesson study practice 2 (TTC3-G4)

As mentioned earlier this study lacks interview data of Lesson study practice 2 because the group conducted it after the fieldwork schedule is already over. Therefore, literally, following information is the data from online communication. The members of TTC3-G4 simply replied what they could learning from the Lesson study practice 2 is about making materials, planning a lesson, working in team, how to teach math in merged class, and how to manage time in merged class. These are the short keywords exactly as what they responded to the researcher through the online communication without further information or clarification provided. Whereas the issues of the Lesson study practice 2 are the difficulty in teaching merged class and time management of the merged class.

Appendix D Semi-Structured Interview guide

1. What did you learn when you plan the lesson with your colleagues? (Give specific examples)
2. What did you learn when you observe/implement research lessons? (Give specific examples)
3. What did you learn through the post-lesson discussion? (Give some examples?)
4. What do you think about the issues of this lesson study practice? (Please explain)
5. What do you want to understand more about lesson study?

Appendix E: coding of MTEs' views

5.4.1 Professional learning in Lesson study practice 1 of TTC1-G1

Main theme	Subcategory	Coding
Collaboration	Sharing ideas (8)	Valuing group members' ideas, exchanging idea, sharing several ideas in planning, sharing common understanding on lesson plan,
	Getting from others' views (7)	each one observes based on their own views, seeing what couldn't see from others' views, some points that couldn't see on students' answer, learning from other suggestion, getting several ideas from others
	Collaboration (2)	helping each other finding materials, well participation of members
Instruction	Understanding lesson plan (1)	Teacher doesn't understand lesson plan well
	Teaching materials (6)	Appropriateness activity and materials for children, Using concrete teaching materials
	Classroom management (5)	Well classroom management, how teacher controls the class
	Instruction (4)	What to consider when teaching children, Way of teaching children, Blackboard use with concluding lesson on it, instructional strategy for unexpected incident
	Language (2)	Appropriate language for children
	Questions (4)	Questions are too difficult for students, Teacher asking simple questions related to daily life
Student participation	Student participation (4)	Students do activity well, seeing student doing activity, students' interest in activity

5.4.2 Issues in Lesson study practice 1 of TTC1-G1

Main theme	Subcategory	Coding
Collaboration	Preparation (6)	Preparation, no trial lesson causes change way of teaching, no lesson plan is given to teacher (4),
	Collaboration (2)	Collaboration in planning lesson
		we make lesson plan, but she teaches

Instruction	Teacher behavior (6)	Teacher speaks too much, missing important point in the question, no demonstration before student doing, no key question written on the blackboard, not followed as planned
Teaching-learning resources	Task design (3)	Difficulty in designing introductory part of the lesson, don't understand objective of activity
Points for observation	Points for observation (1)	don't know focal point to observe lesson
Time and work	Time and workload issue (1)	Time consensus and busy issue

5.4.3 Professional learning and issues in Lesson study practice 2 of TTC1-G1

Main theme	Subcategory	Coding
Instruction	Instructional technique (2)	Instructional technique for pleasant classroom atmosphere
		Increase understanding instructional technique to attract students' attention
	Teacher's behavior (7)	Not well followed as planned, strategy of managing student distraction works just a while, teacher not allowed students to discuss much, using the word "containing" instead of "quantity" may confuse students, teacher unable to identify student responses
	Question (3)	Technique of asking question, teacher should ask more deeper questions, change the way of asking question based on lesson learned
	-	Students pretty well participated
	-	Exchange experience for best lesson

5.4.4 Professional learning in Lesson study practice 1 of TTC1-G2

Main theme	Subcategory	Coding
Collaboration	Discussing each other (12)	Exchanging a lot of ideas, discussion of using materials, discussion of way of teaching, consulting each other regarding topic to teach, sharing idea regarding lesson plan (2),
	Collaborative work (2)	making lesson plan together to solve problem, improve teacher and lesson plan together
	Getting idea from others (3)	getting suggestion from others (3)
Instruction	Instruction (8)	A better way to improve teaching, way of teaching, new way of teaching (teaching adult is different teaching children), new way of teaching that is the difference of teaching adult and children, Weak point of today teaching is materials, Seeing comparison between low and well performance groups
	Teacher behavior (2)	Teacher should ask more open-ended questions, teacher paid attention only on some specific groups
Teaching-learning resources	Lesson planning (3)	Choosing teaching materials
		Making lesson plan
		Improving lesson plan
Preconditions	Lesson study (3)	Understanding about lesson study (2), Set objective of doing lesson study,

5.4.5 Issues of Lesson study practice 1 of TTC1-G2

Main theme	Subcategory	Coding
Collaboration	Preparation (3)	Unmatching lesson plan and materials (2), mistake in preparing materials
	Lesson plan criticism (3)	One plans a lesson but other teaches the lesson, a person who makes lesson plan should teach
	Miscommunication (3)	Coordinating with director only not teacher, asking director only not teacher himself, my mistake that I didn’t ask him

	-	One teacher influences lesson planning idea
	-	Afraid of giving comments
Time issue	Time (3)	Not enough time for preparation, finding time to meet each other
Preconceptions	Lesson study (2)	Don't understand lesson study, group members don't know Lesson study

5.4.6 Professional learning in Lesson study practice 2 of TTC1-G2

Main theme	Subcategory	Coding
Knowledge	Student conceptions (4)	Should anticipate student answer in several ways, student's enthusiasm and participation in group work, student misunderstanding regarding group (sets), student not courage to answer questions
	Student learning (3)	Learning about sets and elements, got knowledge about that topic (but not mentioned clearly)
Collaboration	Collaboration (10)	Exchanging idea regarding activity about sets, planning together, respecting others' ideas, working in team and group idea, discussing both teachers' and students' answers, Expressing idea regarding unconcluded lesson,
Initial teaching - learning resources	Lesson planning (7)	Steps of making lesson plan
		Considering appropriate questions to ask students
	Use of material (1)	How to use materials to stimulate students understanding sets
	Instructional strategy (4)	Professional in teaching, questioning technique to stimulate student thinking, technique to answer student question
	Lesson connection (2)	Transitioning activity to a new lesson, transitioning to a new lesson

Instruction	Teacher's behavior (6)	Teacher's hesitation about student's answer, teacher knowledge about animals is rather weak, teacher didn't conclude the lesson, teachers have more courage to give comments, expressing idea that teacher forgot to write elements of sets
	-	Change from less to more preparation

5.4.7 Issues of Lesson study practice 2 of TTC1-G2

Main theme	Coding
Time (6)	Insufficient time for teaching, Time to meet group members, Time in planning is not enough, flexibility of time of each teaching step, doing this spending much time
Instruction (3)	Teacher should teach what he knows well, limit content and worry if away from textbook, not all group members teach secondary math
-	Don't know what the issue is

5.4.8 Professional learning in Lesson study practice 1 of TTC2-G3

Main theme	Subcategory	Coding
Knowledge	Student conceptions (7)	Student learning by memorizing, Student understanding subtraction, Ability to solve subtraction problem, don't understand meaning of subtraction but remembering position, Student learning by memorizing, Student memorizing rather than understanding
Teaching - learning materials	Lesson planning (8)	Making one-page lesson planning, creating task questions, sequencing instruction, instructional design
	Making teaching materials (3)	Making materials, Learning task and materials
Collaboration	Collaboration (9)	Collaborative study textbook, Sharing and comparing one's idea with others', sharing idea on instruction promoting student's own thinking. Getting members'

		variation ideas, Forming consensus ideas for better lesson plan
Instruction	Instruction (12)	Teacher repeating what students already understood, Teaching in team, Difficulty in controlling students, Blackboard use, Communication between teacher and students, Unclear conclusion of the main content, Instructional strategy. Lesson conclusion not matching the objective, not well categorizing student math idea to present on board, shouldn't blame teacher who taught lesson
Preconditions	Lesson study (1)	Lesson study process like Plan-Do-See steps

5.4.9 Issues of Lesson study practice 1 of TTC2-G3

Main theme	Subcategory	Coding
Teaching-learning resources	Lesson planning (5)	Lesson plan is not well clear yet, Lesson plan not yet clear how students will solve math, Planning issues (details of lesson plan)
Instruction	Teacher teaching (3)	Teacher sometimes not well absorbed main teaching content, Not well followed as planned, Not fluency in teaching steps
Student conceptions	Student conceptions (2)	Inconsideration student language ability, Student get results first before decomposition
Time and work issue	Time and workload issue (2)	Have to call every time through social media apps, Workload issues
Sustainability	Lesson study sustainability	Worrying of its sustainability

5.4.10 Professional learning in Lesson study practice 2 of TTC2-G3

Main theme	Subcategory	Coding
Teaching-learning resources	Lesson plan (11)	Appropriateness of sentence length in math task, modifying exercise as a lesson for teaching, understanding details of lesson plan, be attentive during planning, preferring to make lesson planning

		individually, too many activities, Lesson plan should be as detailed as possible, summarizing and drafting total ideas before typing
Knowledge	Subject matter knowledge (1)	Different meaning of subtraction
	Student conceptions (17)	Concerning student ability of solving math problem, anticipating student math thinking, awareness if student can use manipulatives, attention to teacher explanation, Difficulty in explaining their work, Difficulty to relate previous knowledge to new situation, Difficulty of using materials to demonstrate the difference, Students like doing rather than listening teacher explanation, Students don't understand what they learn today, Math subtraction thinking using drawing sticks, counting rather than decomposing in subtraction, Different ways of student thinking, Student ideas about decomposing not yet shown, Students don't know 4 steps of subtraction
Collaboration	Sharing ideas (9)	Working in team, together realizing objective of lesson regarding subtraction, sharing that not to use borrowing but taking away, sharing ideas from members regarding unseen problems, discussing teaching-learning problem
Instruction	Teaching behavior (11)	Should strengthening individual instruction, Teacher couldn't be patient enough to tell students, spending so much time on reviewing previous lesson, Teacher language confuses students, not well concluding the lesson. Teacher decision making to solve occurring situation, Time management in each teaching step, Main point that teacher should be able to conclude from lesson, Instructional strategy in reviewing previous lesson to connect to a new lesson

Preconceptions	Lesson study (1)	Better understanding open-approach

5.4.11 Issues of Lesson study practice 2 of TTC2-G3

Main theme	Subcategory	Coding
Teaching-learning resources	Lesson planning (6)	Can change objective not only using decomposition to solve subtraction? The quality of making lesson plan not intense, Math task is long, more details of lesson plan, Selecting a teacher at first
	Teacher teaching (4)	Helping teacher to stimulate student thinking, Concluding the lesson, Classroom management to get student attention, Talking skills with children
Knowledge	Student conceptions (4)	Quality of student expressing ideas, Students still can't explain their method, Student ability of solving subtraction, Student readiness to study (concentration)
Punctuation	Time (3)	Delay of planning due to member punctuation
		Punctuation of members
		Spending much time on planning

5.4.12 Professional learning in Lesson study practice 1 of TTC3-G4

Main theme	Subcategory	Coding
Instruction	Instruction (5)	Teaching decomposition, new way of teaching subtraction, process of teaching and learning
Collaboration	Collaboration (4)	Experience in working with primary teachers, accepting others' comments, exchanging ideas with others, working in team
	-	Courage to express idea
Teaching-learning resources	Lesson planning (3)	Lesson planning, giving appropriate time for the objective, setting objective to suit the lesson
Subject matter knowledge	Mathematics knowledge (2)	Subtraction, ones' place can subtract ones' place
	Teacher teaching behavior (11)	Teacher has full set of teaching materials, well explanation with clear voice, setting a group of

		students is not well organized, erasing blackboard is too quickly, Teacher's explaining technique with clear voice, Teacher worries about the results of students' doing activity, well preparation with clear voice, Teacher should look at or follow lesson plan, Teacher should well understood teaching step, Not well blackboard use and often erase, student group setting not well organized
	Comment expression (3)	Got comments from vice director, pleasant that many teachers express their comments, some teachers don't express comments
Preconceptions	Lesson study	Lesson study process
	Time	Time management
	Observation	Points to observe base on checklist

5.4.13 issues of Lesson study practice 1 of TTC3-G4

Main theme	Subcategory	Coding
Instruction	Teacher teaching behavior (7)	Preparing and organizing materials for students, setting up student group work, blackboard use
Teaching-learning resources	Lesson plan (2)	Too many activities, too much lesson content
Knowledge	Student conceptions (2)	Some students cannot do decomposition, student manipulating materials not applying decomposition
Collaboration	Collaboration (1)	Group members not all come
Time and budget	Schedule (1)	Leaving students when planning or reflection
	Budget (1)	Lack of budget

5.4.14 Professional learning and issues in Lesson study practice 2 of TTC3-G4

Making materials, planning a lesson, working in team, how to teach math in merged class, how to manage time in merged class. And the issues are difficulty in teaching merged class and time management (insufficient data).

5.4.15 Professional learning in Lesson study practice 1 of TTC3-G5

Main theme	Subcategory (No. of codes)	Coding
Instruction	Teaching behavior (21)	Managing materials during group report not yet good, Teacher worries and tries to control the class, Teacher should choose fewer groups to report to keep time, not well time management in teaching, well followed as planned, evaluation math problem doesn't cover main content, should change the way of selecting student to answer reviewing previous lesson, Instructional strategy to keep time, reducing number of student group to increase their discussion, good teaching, give more time to students for discussions, spending much time reviewing previous lesson, Evaluation is not smooth as planned, Repeating student explanation wasting time, Teacher should allow students conclude activity, reduce numbers of math problem for next teaching
	Instruction (15)	Instructional technique, Way of teaching, Technique of transitioning to a new lesson, different teaching technique of each teacher, Lesson not well achievable, not achievable as planned
	Teacher explanation (4)	Teacher doesn't explain about change side change sign, Teacher explanation should be clear, wasting time of explanation, Will explain clearer for next teaching

	Student group setting (6)	Explanation after lucky drawing is not yet clear, dividing student into groups, Creative way of setting student group, Selecting well performed students as group leaders, expecting that well performed students help others in the group
Teaching-learning resources	Lesson planning (19)	Designing activity for reviewing previous lesson, objective of what to achieve, planning a lesson to meet objective, lesson planning was not clear sometimes, Lesson plan not well planned, knowing problem for planning to solve it, Lesson not well planned, should have a second plan when students can't do, Activity design should be appropriate with classroom environment, Activity should be suitable to the student knowledge background, Task design should conform to curriculum
	Task design (4)	Should use simpler math for reviewing previous lesson, don't use difficult math for reviewing previous lesson, Too many math problems
Student's behavior	Description about student (15)	How student report their workgroup, Students not discuss each other, Students not well explained, Students can't do, Student not well enjoy the class, Students don't know to conclude the solution of inequalities, Student mistake in copying and solving math problem, Student math background, Student math background, Student lack of collaboration, Student groupwork reporting,

Collaboration	Collaboration and sharing (8)	Team consolidation, teaching steps from team ideas, exchanging lesson from each other, consensus idea to select suitable activity to fit the formula type, well collaboration, sharing ideas of the problem, Sharing good and weak points of teaching

5.4.16 Issues of Lesson study practice 1 of TTC3-G5

Main theme	Subcategory	Coding
Student's behavior	Student descriptions (7)	Acting unusual way when there is an observer, students' low attention, lack of math background
Planning lesson	Lesson plan (7)	Group members didn't check the planned lesson. Reviewing previous lesson was not planned as discussed. Our lesson plan didn't consider student math background. Lack of planning in advance to solve unexpected incident. Our members didn't pay attention to what teacher has planned. Lesson wasn't trialed at first,
	Materials (4)	Lack of concrete materials (3), lack of voice and video recording tools (1)
Time	Time factor (4)	Time to meet each other, Time pressure in teaching, Not enough time in planning
Preconditions	Lesson study (2)	Different level of understanding Lesson study, Teachers understand that Lesson study is to criticize teacher
		How to analyze problem and way of solving it (1)
	Student knowledge testing	No testing student math prior knowledge (3)

5.4.17 Professional learning in Lesson study practice 2 of TTC3-G5

Main theme	Subcategory	Coding
Instruction	Teacher teaching behavior (23)	Teacher should point out student mistake point with clear explanation, Teacher mistakes in pointing out student mistake, Instructional technique, Teacher explanation, Variety of materials use, Arranging student mistake in group report, Well teaching-learning atmosphere, Teacher should understand more about exponents, Well followed teaching steps, Teacher gains confidence, Weak point of giving homework, Weak point to mention main point of the lesson, time management in teaching
	Teaching behavior in general (10)	Teacher should have strong knowledge background and curriculum, sharing idea about instruction, designing learning-teaching activity, well classroom atmosphere, multiple ways of planning and teaching, Ways of improving teaching, Good and weak points
	Student group setting (3)	Technique in group setting, student group setting
Knowledge	Student math difficulty (7)	Students multiply without parenthesis; many students transform to $8^2$and 6^2, Student mistake in transforming properties of exponents, Students can't distinguish between base and exponents, weak background of properties of exponents
	Subject matter knowledge (5)	It's okay to transform to 8^2 at first then transform again, multiply only first term (x) but not the second one (8), Mistake writing from negative sign to positive sign, Clear method of solving exponential equations (i.e., $2^{7-3x} = 64$)
	Subject content (1)	Can't go as details as this lesson because too much content in the curriculum

Teaching-learning resources	Task design (5)	Reducing math problem for more student thinking, selecting easy math problem for doing Lesson study, properties of exponents should be introduced at first, choosing math problem to meet student math knowledge
Student behavior	Student behavior (2)	Students lack courage, Student mistake in solving problem

5.4.18 Issues of Lesson study practice 2 of TTC3-G5

Main theme	Coding
Student matter (7)	Students don't solve math problem but wait for others, lack of discussion among students, student lack of courage, student psychology of being shameful, student math background is weak
Time and workload issues (3)	Consensus time to meet each other, workload issue
Weak point of curriculum (1)	Some math topic distribution is not corresponding each other
Full participation (1)	Planning and observing should be the same members

Appendix F: discussion in lesson planning

(Discussion in lesson planning 2 of TTC1-G1)

DSM: Because Ajan Sommay will not be here next day, because Friday is exercise.

SPC: Tomorrow is doing activity, because Friday is the doing exercise.

DSM: Because tomorrow is Mathematics 2 hours, isn’t it?

Res: When doing Lesson study, it is not necessarily only following the regular curriculum. We can also select another lesson topic with the reason why we have to select that lesson particular lesson or topic

DSM: I understood that [we] can choose any lesson, but we don’t want to leave (skip) the curriculum, on Lao side unlike Japanese side that can teach any lesson. Actually, this lesson is not our intention to choose but you come at this time and our curriculum just right up to this lesson. So, [we] choose this lesson to follow daily teaching schedule because [we] depend on District Education and Sports Bureau. For example, supposing that we plan to do [lesson study] next Monday, we check next Monday schedule what lesson it will be, check if that lesson is suitable, check if it is not suitable for student group work then we will choose another day, we check these things, we also check the time, Friday is solving exercise day. So, if you want to see [the lesson] it should be tomorrow [Thursday], if tomorrow then I will not be available.

VNK: I also won’t be available.

Res: Can we not doing exercise but teaching instead on Friday?

VNK: No, the exercise in this book, of course we teach it.

SPC: The exercise [we] should pause for a while in order to link to the lesson 14.

Res: The exercise, do we teach, or we just let them solve themselves?

SPC: Yes, we teach, [we] teach them, suggest them how to solve, it is also in teaching process as well.

VNK: It is in the process of teaching as well.

SPC; Because we cannot leave our children solve alone, we need to explain, we need to lead them how to do it, solve it.

Res: If so, then it is up to [the group], it is also in the process of teaching. I thought that it would be just only giving them the exercise.

VNK: In this new textbook, it is also in the teaching process in the exercise part. In this book, there is no homework, they are only let students do in the class.

SPC: With the suggestion of the teacher.

VNK: If we do on this Friday then we can move the schedule to the morning. Tomorrow we only teach about comparison, for indirect comparison, Soun (JOCV) already suggested, for the direct comparison we just put it close to each other, exercise also teach from addition, subtraction.

SPC: Smaller than, bigger than, and equal (she reads the exercise in the textbook). Or let me teach this exercise tomorrow (Thursday) then students can do this block activity in their home.

DSM: The exercise is not related to that [quantity comparison] isn’t it?

SPC: No, no, it is related to previous lesson, it is related to addition-subtraction

VNK: So, what lesson then, lesson 13?

SPC: That day we taught about this. If we want to make it connected to the previous Lesson study practice, then we can keep this and teach that one first.

VNK: but this is just revision.

SPC: After revision then we will move to this lesson just for one hour, because it is also related.

VNK: Okay, let check it, SPC on that day Mr. Soun (JOCV) brought some materials, do you still keep it? we will use, that day he brought bottles of milk, big ones and small ones.

JIN: This size of bottle, is it okay?

VNK: No, it is too big.

JIN: Eh! let students pour into this.

VNK: Yes, pouring into it, Mr. Soun gave us a bottle.

JIN: It is not enough for each group.

VNK: Here, our bottles are not enough right?

SPC: Here, here, here, we have bottle A & bottle B and this bottle has water.

VNK: No, for the cup we can use the one we cut, this one we can compare directly, and this is indirect comparison, but this one we have not enough [bottles].

SPC: Taller, shorter, the cup is different.

VNK: But don’t forget our objective, but in this activity, it is talking about comparison isn’t it. So, it must be [comparing].

JNL: No, it is not, this one belongs to this one, it is in the same with activity 1, this direct comparison.

VNK: Direct comparison, right. This one is not direct [comparison], this is indirect, this is indirect, there is only one direct comparison (they mean that the direct comparison is only the one that they have just taught).

KON: Maybe there is something wrong.

SDV: Which one?

KON: It’s wrong here.

DSM: It is wrong all direct and indirect one?

KON: When we train the primary teachers, we told them that the objective of this lesson is wrong.

** Then SPC shows all materials that Mr. Soun (JOCV) gave the group last week

KON: The question is how many small cups of this bottle, the question asking that if the bottle of 700 ml how many small cups

KON: 7 cups, it is 700 ml.

** Then JIN put 2 bottles of 700 ml on the table, each bottle contains water.

KON: Will we let students do groupwork gain?

JNL: No emphasis on groupwork any more

VNK: [We] will modify the objective to emphasize on student thinking

KON: Why do we need to change?

VNK: We will focus on student thinking

DSM: Because our activity [in this lesson] not emphasize on students' groupwork. As like this, how can students do in groupwork.

VNK: It means that we remove student groupwork out, but we put emphasis on student thinking process as usual, just remove groupwork out.

KON: The objective is to use a unit to express the quantity by number.

DSM: Next time, let's plan the lesson at the TTC, so that there will be no children [interrupting]. As you can see like this, the teacher come in and go out [very often].

VNK: Because the half one [glass of water] we cannot see

SPC: Right, which one we can add to get 100 ml.

VNK: No, we are not focusing on this one [comparison using small cup as a unit to measure], we only focus on which one has more or less water.

SPC: How many bottles?

VNK: Direct comparison.

SPC: How many bottles can it get, they will say 4 bottles with a little more.

KON: Which one has more volume between these 2 things.

SPC: Get 4 bottles with a little more, but this one is full, we only want them to know which one can contain more or less [amount of water].

DSM: Separate into groups.

KON: Dividing [students] into groups is also good

DSM: But our materials will not be enough.

VNK: Our materials are not enough. If we don't have enough materials then what to do when demonstrating in the middle of the class, what should we do? Let students see this one at first, how much it has.

DSM: No, demonstrating in front of the class would be fine then let each group comes and see.

SDV: Will it be noisy?

SPC: It will be noisy.

KON: [We] should have enough equipment so that they can practice at the same time, they able to manipulate it, they enjoy, then buy more package

JNL: One pack has 6 bottles.

KON: How many?

SPC: Almost 22 bottles.

VNK: Now, one bottle [700 ml], how many cups is it? 4 cups?

JNL: 7 groups

VNK: The same as usual

JNL: 2, 4, 6 here, each group use 2 packs.

KON: Or should we cut the small bottle, we give assignment to our group members who will cut it, who will buy it.

JNL: These small bottles, I have it because there was a wedding party behind my house

SDV: Right, please collect it then

SPC: About 100 bottles

JNL: One group need 15 small bottles.

SPC: 7 x 15 = 105, one hundred [bottles], 7 groups, it is enough isn't it.

VNK: Now, this bottle [700ml] or bigger bottle? If bigger one, then we must use many small bottles.

DSM: The bigger bottles, only 3 big bottles are enough, we only want to know comparison.

JNL: It mean that we must follow textbook?

SPC: We divide students into 3 groups.

JNL: Too much, SPC teacher

DSM: They will not pay attention at all.

VNK: If so, let just the teacher demonstrating the activity would be fine. Let students watch [the teacher's demonstration] together, but we need a table.

KON: This one, the teacher will say, do experiment instead of students, it will be more efficient than students do.

JNL: Only guessing, allow students to guess at the beginning.

VNK: If allowing students to guess, [we] must buy Betagen one bottle for each student. Have we already read all what it wants us to do?

** Now the teacher KON read teacher guidebook to all members.

VNK: Mostly, the overall process [of this lesson] put emphasis on asking questions. Just only conversation with students. If we use this, it will be similar to that day. Students will know, understand nothing at the end as like what we did on last Tuesday.

KON: Students, because the water is overflowed, it means that the bottle A has more amount of water than bottle B. If students can answer, then we move on. If students can't answer then [we] have to ask more why they respond that way, why it comes out this way, why.

VNK: So, here, we don't use student groupwork, right? the main process is the question isn't it? now we will do in group.

KON: Working in group is allowing students to have a real test and what students can get then?

SPC: They will get about conversation with each other.

VNK: Because we saw the result from last Monday [the first research lesson].

KON: If showing up the bottle, [we] must show it as high enough, don't show it at low level for students to see it.

VNK: If the teacher starting to discuss [with students], the teacher will start with these 2 bottles, right? whether which one has more or less volume than each other, isn't it? let students guess, who think this bottle has more volume, raise your hand up.

KON: Why [students think so]?

VNK: Now, how can we know which one has more or less [volume]. Mostly, it is the conceptual process that we want students get. After that, what should we do to elicit students' idea? Fill [the water in] it then comparing direct-indirect way. This one, I think, the teacher demonstrates then asking a question [to students] would be better. Students do, we do, while they are doing, they will listen to our questions.

JNL: If we are going to do that way, firstly [we should] explain them then let students do it. While they are doing, [we] don't need to say anything much, let them pay attention on doing activity. If they do activity and listen to the teacher's explanation, their concentration will be lost. After they completed the activity then the teacher can ask a question. It shouldn't be like the teacher keeps talking while the students are doing activity.

VNK: Here it means that it starts from these 2 bottles, it starts from students' thinking

DSM: I got it, let not to talk about this one because we want to prove which bottle contains more or less [amount of water], after that we look at this, let not to talk about this one, for sure, the teacher must ask this.

SDV: Starting from asking about what is this bottle? is it the same? Which one is bigger or smaller?

KON: Ah!

Appendix G: Post-lesson discussion

(Post-lesson discussion 1 of TTC2-G3)

SMN: For my teaching I will point out only the complicated points. Based on my thoughts and experience of previous teaching, I think they understand pretty well. However, there are some parts and some students don’t understand previous lesson about the first method. For the 2nd method, as we just practice them as the first lesson, it is still complicated. They maybe don’t understand yet, as I see 2-3 groups. Some groups are done correctly for the first method but mostly not the second method. Regarding the reviewing previous lesson part, I think it is pretty detailed, however, there are high numbers of the students who cannot solve. I have only that, please others suggest more for further improvement.

SLK: First of all, I agree with SMN’ comments…when you use the command, we want you to integrate with the reviewing previous lesson part because the command and the question is the same. We want to use question, please everyone agrees with this. Also, as the leader said, we don’t want others to criticize the teacher when we do post-lesson discussion. If we want to criticize then criticize our planning instead. What I can see, firstly, about reviewing part, about communication with students. Because the teacher mention that do as the reviewing previous lesson part does. So, the students understand that to decompose into 10 and 2, even 15 they also decompose into 10 and 2 [they copy exactly from the reviewing previous lesson part], then the students decompose 15 and 7 in the second one [second block format]. When they draw the diagram then they draw the same. I think this is because the communication is not well clear yet. I have only that.

PVL: Our objective is to get 2 methods [of decomposition]. We set the goal that decomposing 15 into 10 and 5 [as the first method] and decomposing 15 into 5 and 10 [as the second method]. Regarding the decomposition they [the students] can do it, but they stuck in the new method that we bring them today. Our objective is to see the students circle 10 and 7 (drawing diagram), still they hold the old method that is they cycle the first term again. Nonetheless, although they circle the first term, for example, there are some groups, they circle 5 and 7 but when they write it they write 10-7. It means that their remaining difficulty is not where they make a circle but what number they take for the subtraction. Here, I observe that they circle 5, but when they write the subtraction expression still, they write 10-7 equal to 3, the answer is correct. So, they don’t understand the circle (drawing diagram to connect which one operates with which one). Still, they don’t understand which number to subtract at first. They only draw a line [to connect the first number, as the minuend, with the second number, as the subtrahend]. Most of the students draw like that almost all pairs... if we don’t walk around, if we don’t investigate them more [they will not come up as what we want]. However, they can also get an answer…we decompose 10 and 5; 5 and 10; regarding 10 and 5 they remember they draw a line [from

10 to 7], but for 5 and 10 still they draw the same line [from 5 to 7]. Some students, even they draw that way, when they write subtraction expression, they write 10-7. This is learning by remembering.

KHL: Let’s see our main objective, students are able to subtract by decomposing 10 with a number. Here, it is about subtraction with borrowing because the ones place value of the minuend is less than [the subtrahend]. [We] let the students see its importance that in the case 12-3 that is we cannot take 3 away from 2 because 2 is less than 3. Therefore, the simple way to subtract is to directly suggest them the decomposition. We don’t want the students to count their fingers, don’t want them to count, it is slow, it is wasting time because this number 12 if you (students) use your all fingers you still need your friends’ fingers. Therefore, if they cannot use this method, the simplest way, other than counting fingers, is the decomposition. So, if decompose 13 into 2 numbers, how can we decompose? This is 10 and 3. Can it be decomposed in other numbers? Yes, it can, but it should not less than number 9. So, the simple way is decomposing into 10 and 3; or if decompose 12 then it will be 10 and 2 or 2 and 10. This one we should talk with students back and forth so that the students will apply this suggestion. When we first introduce this decomposition, we emphasize only decomposing into 10 with any number but when we say decomposing into any number with 10 then it becomes a new thing for them because we don’t [explain this to them]. Regarding the drawing diagram, I want to suggest the teacher because you do it very complicated way. The drawing line in the previous lesson, they (curriculum maker) didn’t want it to be taught in drawing the line like this. They just want us to see its meaning which number operates with which number. They draw the dash lines just to be a guide for the teacher to teach the students. For example, 12-3, the students make a circle and then they rewrite 10-3 here, it is wasting time. Actually they (curriculum maker) just want to let us know which position operates with which position only. Here, 10, because we cannot subtract 3 from 2, after decomposition then we subtract this [10-3] equals to 7, then the remaining number will become addition automatically because the losing 3 is already gone. The students will immediately know that, when the students write it, they will write this right away…this one we should not let students remember in the class. Furthermore, now other than making a circle of these numbers, for example, 12-3, as we review the previous lesson part, if we decompose into 2 and 10, if we draw a line [to connect from a number to a number] for the students they will see it clear, not complicated, the line is not intersecting each other. This is also an answer. However, it has also 2 ways of drawing the lines, because when we emphasize like this, when we conclude like this, the students will take a note like this and they will remember like this. Other than memorizing like this they will remember the positions, as you can see [from today’s lesson], they decompose into 5 and 10, when they draw the line, they draw from 5 to subtract with 7 as usual. This is called the students learning from remembering not from understanding. Because if they understand it, they will always draw the line from the larger number to the smaller number, but this remembering the position. So, we must re-train them about this. Give them a lot of exercises, after that recheck them in an additional time, it shouldn't be skipped. Actually, the previous lesson about decomposition from 11-8 and so on, you see, when they suggest [from the textbook], they draw dash lines, they didn't draw a circle line, that method is just an explanation in which it needn't the students to rewrite it…This is just to let us understand where it is coming from. It is not necessary to draw the circle line, it is kind of wasting time, just to know which position with which position only.

SMN: Don't we need to write subtraction number sentence?

KHL: Yes, we can write but when you write you have to write below here. Here, notice this, as I observe, we like to do putting equal sign here, put at the above here [it is not recommended]. If you write subtraction number sentence, you may write below here 12-3=9, here, in this place is where to write number sentence.

SLK: Here, the students write here as well.

KHL: I have already said, we must not put [equal sign here] because when the children see the equal sign [they will solve it at first before decomposition].

VVL: We anticipated like this.

SLK: No, what we have anticipated is what we don't want it to be happened.

VVL: The anticipation has both right and correct one, right.

KHL: Here, here, when you put the equal sign in the subtraction expression, then the students will not concern about the decomposition at the first place, but they will pay attention about finding an answer. Therefore, don't put it, if we want to put then let put it here [in the number sentence below] 12-3 equals to what, if the students look at the answer then they can count as like when you distribute the oranges [on the chalkboard], they immediately answer it, 8 oranges, 9 oranges, they subtract it, they take it away, they count their fingers here, they also count from the chalkboard.

SLK: Exactly, the students are very concerned, if we put only this subtraction expression 15-7, they will not much pay attention [to solve it] but they are concerned about the equal sign at first.

KHL: Don't put the equal sign.

SLK: When our students see this, they really want to write [the answer] here, teacher it is equal to 8, before they continue doing here.

SMN: However, when I teach, I sometimes put equal sign here below, I sometimes put equal sign above here.

KHL: Alright, alright, let's summarize. At the conclusion, we ask the students to do in 2 methods, when conclude the lesson [you] must say who can do in 2 methods, please recheck, then check this one that one. That is the first method, this is the second method. What is the difference between the method 1 and 2? This question must be given to the students so that they will see how it is different from the first method in which it has only 2 positions. The second thing is to practice the students to explain, when they say or explain, we want them to point out the point [that he/she's talking about], as Boss case (the name of the student) he only keeps saying without looking at the chalkboard. Maybe he has already remembered or understood that’s why he keeps saying, but the important thing is to allow the students to express [their idea]. Their expression or discussion is for others to listen in order to know the decomposition from which one to get this one and this one, next take this one to operate with this one equals to which one, finally from this one to this one. We practice the students to talk. If possible, if our microphone device is still working fine, we can use so that they will say out loud. And the third one is, if you have time, I want you to practice the students gain [regarding this topic], this is important topic, we should not just leave it, review it often because we see our students’ situation that they still cannot do as what we want. Make a revision for one or more hours, don’t just be in haste. However, of course, we can still finish the curriculum. Don’t just go fast, we review for them gain the important topic, just use the exercises to review with them. That’s all.

Appendix H: numbers of pre-service teachers

Statistics of student teacher distributed each year ("Savannakhet TTC," n.d.).

No	Subject	System	Year 2017			Year 2018			Year 2019		
			Total	F	M	Total	F	M	Total	F	M
1	Kindergarten	12+4	66	66	0	95	95	0	95	95	0
2	Primary	9+3	236	165	71	194	134	60	65	47	18
3	Kindergarten	9+3	186	186	0	-	-	-	-	-	-
4	Primary	12+2	30	15	15	-	-	-	29	25	4
5	Kindergarten	12+2	279	279	0	201	201	0	96	96	0
6	Mathematics	12+2+2	-	-	-	-	-	-	15	4	11
7	Vietnamese language	12+3	33	21	12	-	-	-	-	-	-
8	Primary	12+2+2	25	15	10	25	15	10	20	7	13
9	English	12+2+2	-	-	-	-	-	-	20	7	13
10	Chemistry	12+2+2	-	-	-	-	-	-	20	8	12
11	Mathematics	12+4	388	258	130	217	151	66	148	104	44
12	Primary	12+4	116	84	32	145	107	38	88	66	22
13	Lao language	12+4	196	144	52	54	41	13	28	20	8
14	English	12+4	243	147	96	133	81	52	75	42	33
15	ICT	12+4	171	102	69	201	119	82	182	103	79
16	History	12+4	97	61	36	97	61	36	-	-	-
17	Physics	12+4	46	30	16	74	49	25	28	19	9
18	Chemistry	12+4	257	169	88	210	149	61	190	137	53
19	Science	12+4	99	67	32	-	-	-	-	-	-
20	Social science	12+4	151	111	40	-	-	-	-	-	-
Total			***2,619***	***1,920***	***699***	***1,646***	***1,203***	***443***	***1,099***	***780***	***319***

Statistics of staffs distributed in each office. Source ("Savannakhet TTC," n.d.).

No	Office	2017		2018		2019	
		Total	Female	Total	Female	Total	Female
1	Evaluation office	12	3	12	3	12	3
2	Foreign language office	12	6	12	6	12	6
3	Student affairs office	16	9	17	9	17	9
4	Academic promotion office	22	12	24	12	25	13
5	Administrative office	18	6	19	6	19	6
6	Teacher promotion office	0	0	1	0	1	0

7	Personnel office	16	5	16	5	16	5
8	Natural Science office	19	11	19	11	19	11
9	Social Science office	26	15	26	15	26	15
10	Pre-and Primary Office	24	22	24	22	24	22
Total		***165***	***89***	***170***	***89***	***171***	***90***

Statistics of student teacher distributed each year. Source ("Pakse TTC," 2019).

No	**Subject**	**System**	**Year 2017**			**Year 2018**			**Year 2019**		
			Total	**F**	**M**	**Total**	**F**	**M**	**Total**	**F**	**M**
1	Kindergarten	12+4	47	47	0	74	74	0	70	70	0
2	Primary	9+3	28	16	12	-	-	-	-	-	-
3	Kindergarten	9+3	73	73	0	43	43	0	-	-	-
4	Primary	12+2	60	35	25	-	-	-	27	21	6
5	Kindergarten	12+2	190	190	0	127	127	0	59	59	0
6	Mathematics	12+4	94	54	40	82	55	27	75	49	26
7	Primary	12+4	112	70	42	140	93	47	93	70	23
8	Lao language	12+4	90	59	31	57	39	18	26	19	7
9	English	12+4	60	40	20	45	31	14	53	29	24
10	ICT	12+4	46	30	16	42	28	14	42	28	14
11	History	12+4	71	49	22	70	48	22	43	27	16
12	Physics	12+4	156	87	69	108	65	43	104	64	40
13	Chemistry	12+4	43	30	13	73	49	24	72	48	24
14	Social science	12+4	33	21	12	-	-	-	-	-	-
15	Biology	12+4	30	24	6	29	23	6	-	-	-
16	Physical education	12+4	30	5	25	30	5	25	26	5	21
17	French	12+4	93	65	28	68	49	19	88	62	26
18	Geography	12+4	28	21	7	86	61	25	81	61	20
Total			***1,284***	***916***	***368***	***1,074***	***790***	***284***	***859***	***612***	***247***

Statistics of staffs distributed in each office. Source ("Pakse TTC," 2019).

No	**Office**	**2017**		**2018**		**2019**	
		Total	**Female**	**Total**	**Female**	**Total**	**Female**
1	Evaluation office	8	2	8	1	8	1
2	Foreign language office	13	8	13	8	13	8
3	Student affairs office	10	2	10	2	10	2
4	Academic promotion office	15	5	14	5	14	5
5	Administrative office	24	10	23	10	23	10

6	Teacher promotion office	7	6	7	6	7	6
7	Personnel office	9	3	9	3	9	3
8	Natural Science office	20	14	20	14	20	14
9	Social Science office	24	15	24	15	24	15
10	Pre-and Primary Office	37	27	37	27	37	27
Total		***167***	***92***	***165***	***91***	***165***	***91***

Student teacher each year of Khangkhay TTC. Source ("Khangkhay TTC," n.d.)

No	**Subject**	**System**	**Year 2017**			**Year 2018**			**Year 2019**		
			Total	**F**	**M**	**Total**	**F**	**M**	**Total**	**F**	**M**
1	Primary	9+3	27	13	14	-	-	-	-	-	-
2	Kindergarten	9+3	28	28	0	-	-	-	-	-	-
3	Primary	12+2	31	16	15	-	-	-	30	11	19
4	Kindergarten	12+2	193	193	0	184	184	0	120	120	0
5	Primary	12+2+2	21	6	15	21	6	15	-	-	-
6	Mathematics	12+4	162	54	108	94	33	61	61	17	44
7	Primary	12+4	68	35	33	96	47	49	62	26	36
8	Lao language	12+4	231	121	110	191	101	90	187	98	89
9	English	12+4	54	20	34	48	18	30	24	10	14
10	ICT	12+4	32	11	21	60	25	35	62	27	35
11	History	12+4	-	-	-	-	-	-	29	22	7
12	Physics	12+4	57	19	38	87	32	55	80	23	57
13	Chemistry	12+4	55	22	33	82	34	48	81	34	47
14	Science	12+4	66	34	32	-	-	-	-	-	-
15	Social science	12+4	68	39	29	-	-	-	-	-	-
16	Biology	12+4	90	33	57	88	33	55	62	23	39
17	Physical education	12+2	-	-	-	-	-	-	27	5	22
18	Geography	12+4	-	-	-	-	-	-	30	14	16
Total			***1,183***	***644***	***539***	***951***	***513***	***438***	***855***	***430***	***425***

Staffs in Khangkhay TTC

No	**Office**	**2017**		**2018**		**2019**	
		Total	**Female**	**Total**	**Female**	**Total**	**Female**
1	Evaluation office	11	3	11	3	11	3
2	Foreign language office	11	4	11	4	11	4
3	Student affairs office	14	4	14	4	14	4
4	Academic promotion office	21	9	21	9	21	9

5	Administrative office	23	8	23	8	25	8
6	Teacher promotion office	9	6	9	6	9	6
7	Personnel office	13	8	13	8	13	8
8	Natural Science office	21	5	21	5	21	5
9	Social Science office	17	9	17	9	17	9
10	Pre-and Primary Office	22	17	22	17	24	19
11	Attached primary school	19	18	19	18	19	18
Total		***181***	***91***	***181***	***91***	***183***	***93***

Lesson plan Mathematics subject grade 1

Teacher: Seomany Sihavong

Shool: Sathid primary school, Pakse TTC

Date: March 19th, 2019
Time: 45 minutes

Lesson 14: Subtraction

Objective of the lesson: students are able to understand subtraction and able to calculate subtraction between 2 digits numbers with 1-digit number which the result is 1-digit

Objective of today's topic:
-Students are able to subtract by decomposing into 10 with any number;
- Students are able to discover simple diagram

Main content: Subtraction by borrowing is able to subtract by decomposing into 10 with any number

Sequence of activity:
1. Review previous lesson
2. Introduce real world situation
3. Students solve problem individually
4. Students present idea about making word problem about addition

Teaching materials:
1. Orange figure
2. Activity sheet
3. Command sheet
4. Magnet
5. Magic ball pen

Students' anticipation:

15 - 7 = 8
10 5
10-7 =3

15 - 7 = 8
5 10
10-7 =3

Planning team: Khamla, Seomany, Vanvilay, Vilaivan, Silikone

Teaching activity

- **Reviewing previous lesson**

Teacher lets students calculate 12-3 together

12-3 12-3

- **Teaching step follows 4 steps of Open approach**

1. Introduce problem or problem situation
- Teacher pastes the figures
- Teacher tells a story about the figures
- Teacher tells problem situation: Thao Itim has 15 oranges, he gives it to his friends 7 oranges, how many are left over?

15-7 15-7

2. Students solve problem individually
- Teacher observes and records students' idea when they're solving the problem
- Uses questions to stimulate students to think
- Teacher arranges students in order to report
3. Presentation and discussions of the idea together
- Teacher selects students to present by selecting least correct idea as the first presenter.
- Students discuss their ideas and works in order to exchange the ideas together.
4. Summary of the emerged ideas together
- Teacher and students conclude the ideas together in order to connect to the main lesson content
- Students record what they gain from this lesson

- **Warning:** Teacher instructs students to have good manner, discipline, and love learning. Then teacher gives homework