Chapter 28
Rethinking Lesson Study in Japan: A Case Study Analysis

Tetsuo Isozaki and Takako Isozaki

Abstract Teachers in Japan have traditionally engaged in lesson study (*jyugyou-kenkyuu*) to systematically improve their teaching and enhance students' learning since the late nineteenth century. Lesson study, a part of teachers' culture in Japan, is an art of investigation for teaching and learning through which teachers observe, analyse, and review each other's lessons. Lesson study is based on traditional understanding and expertise rather than on educational theories. Understanding and analysing teachers' methods for developing lessons may help bridge the gap between research and practice for both teachers and researchers. The authors reviewed the literature on lesson study and teacher knowledge then focussed primarily on the preparation phase of lesson study conducted at schools attached to one national university, as case studies. This phase, through researching and developing teaching materials (*kyouzai-kenkyuu*) and making and revising lesson plans (*gakushuushidouan-sakusei*), requires teachers to identify a lesson's implicit and explicit values, such as academic, pedagogical, and teacher's values, clarify their teacher knowledge, and regularly apply in lessons. Therefore, teachers spend much time and energy on this phase. There are some problems in lesson study; however, we argued that the success or failure of lesson study is related to the school culture and collegiality of the professional learning community.

Keywords Teacher knowledge · Continuing professional development · Lesson study · Japan · Case study

T. Isozaki (✉)
Hiroshima University, Higashi-Hiroshima, Japan
e-mail: isozaki@hiroshima-u.ac.jp

T. Isozaki
The University of Toyama, Toyama, Japan

M. S. Khine and Y. Liu (eds.), *Handbook of Research on Teacher Education*,
https://doi.org/10.1007/978-981-16-9785-2_28

Introduction-Background and Research Questions

Background of This Study

Teaching practices in classrooms and other special rooms, such as laboratories and kitchens, are partly based on the professional knowledge and expertise of teachers. Teachers in Japan have traditionally engaged in "Lesson Study (lesson study)", a practice that has become deeply embedded in teachers' professional culture (e.g. Isozaki, 2015, 2020; Isozaki & Isozaki, 2011; Isozaki et al., 2019). Through their experience with this practice, teachers have realized that lesson study enhances teacher knowledge base and teaching competencies, which are a part of continuing professional development (CPD). However, it is difficult for them to recognize the implicit contribution of lesson study to their CPD, especially in improving teacher knowledge, as stated by Shulman (1986, 1987).

Relatively few attempts have been made to theorize lesson study in terms of teaching and learning (e.g. Fujii, 2014, 2017; Lewis, 2002; Lewis & Hurd, 2011; Lewis et al. 2009; Winsløw et al., 2017).Despite its long history of application, neither teachers nor researchers seemed interested in investigating lesson study in Japan until the publication of Stigler and Hiebert's *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom* in 1999. Bartalo (2012) pointed out that a key point of the report entitled *Strong Performance and Successful Reformers in Education*, published by the Organisation for Economic Co-operation and Development (OECD, 2011), was to "mirror and reinforce" (p. 9) Stigler and Hiebert's ideas. This strengthens the belief that cultural factors, such as school culture and teacher culture, shape teaching and learning in every country. For supporting teachers' CPD, a theoretical understanding of lesson study as a teacher culture would contribute to students' learning in the classroom, which Black and William (1998) called the "black box", as the primary focus of lesson study is on students' learning.

Meanwhile, Winsløw et al. (2017) argued that "a theoretical framework (with explicitly defined categories and terms) is needed to move the analysis of mechanisms and principles of lesson study …toward a more international and explicit stance" (p. 126). Clivaz and Takahashi (2017) asserted that it is still unclear whether or not "lesson study projects outside Japan can properly support schools and teachers" (p. 162). Lewis (2002) and Lewis and Hurd (2011) identified lesson study as having four processes. Borrowing from these two studies, Fujii (2017) divided the cycle of lesson study into five processes. However, the findings of previous studies could not explain why Japanese teachers devote so much time and energy to preparing their lessons (OECD, 2014, 2019), or how teachers improve their knowledge and skills. Based on the experience of designing the lesson study processes with teachers, Isozaki and Isozaki (2011) and Isozaki (2015, 2020) identified the lesson study process as comprising the following phases: preparation, research lesson, and reflective meeting/conference. Isozaki et al. (2019) illustrated these three phases of lesson study in both pre-and in-service teacher education. In the present study, we

adopt these three phases of lesson study for analysis of case studies. Primarily, the preparation phase of lesson study is a dynamic process where teacher knowledge and values are represented implicitly and explicitly (Isozaki, 2020).

In this study, first, we consider theories on teacher knowledge proposed by Shulman (1986, 1987) and other researchers, as well as the nature of lesson study in the cultural context of Japan. We then investigate the nature of lesson study and associated problems from teacher knowledge perspective by analysing two case studies. Finally, we make several suggestions for conducting lesson study effectively for teachers and researchers.

Research Questions

Based on the theoretical analysis of lesson study and teacher knowledge, this study aims to rethink lesson study in Japan through an analysis of case studies to which one of the authors have directly contributed and focussed on open-house lesson study or open-house school based CPD (Isozaki & Isozaki, 2011) conducted at two schools on the same campus, one elementary and another secondary, attached to "A" national university. To achieve this purpose, we ask two research questions: first, what is the nature of lesson study in Japan and why do teachers engage in it? Second, what kind of teacher knowledge do teachers use in lesson study and how do they improve teacher knowledge, primarily pedagogical content knowledge (PCK). A careful description of the lesson study process can explain why Japanese teachers tend to devote much time and energy to prepare lesson study and develop their regular classroom lessons.

Theories on Lesson Study and Teacher Knowledge

As Lewis et al. (2009) have argued, "Lesson study makes various types of knowledge more visible…thereby enabling teachers to encounter new or different ideas, and to refine their knowledge" (p. 286). For this reason, we focus on teacher knowledge, primarily PCK, applied in the lesson study process. Analysing lesson study using the theoretical framework of teacher knowledge will be significant for not only teachers but also researchers in Japan and beyond.

Characteristics and Nature of Lesson Study in Japan

The term lesson study is the English translation of the Japanese term "*jyugyou-kenkyuu*" (or *kenkyū*), where *jyugyou* means "lesson" and *kenkyuu* means "study" or "research". Thus, lesson study is a comprehensive and well-articulated approach to examine and investigate teacher's practices. Lesson study is strongly embedded in the

professional culture of teaching in Japan as pre-and in-service training. Prospective teachers experience the nuance of lesson study during teaching practice under the guidance of mentors in their alma maters, schools attached to universities, or other partnership schools, while teachers periodically engage in lesson study within their professional learning communities (Isozaki, 2015, 2020; Isozaki & Isozaki, 2011).

The first phase of lesson study process is preparation, which includes setting the goals of a particular lesson, researching and developing teaching materials (*kyouzai-kenkyuu*), and making and revising lesson plans (*gakushuushidouan-sakusei*). Educators in Japan sometimes use the two Japanese terms, *kyhouzai-kenkyuu* and *kyouzai-kaihatsu*, separately. *Kyouzai* means "teaching materials" while *Kaihatsu* refers to "development". Therefore, *kyhouzai-kenkyuu* and *kyouzai-kaihatsu* mean researching teaching materials and developing teaching materials, respectively. However, as *kyouzai-kaihatsu* follows *kyhouzai-kenkyuu*, in this study, we regard the two terms as representing one process and use the term *kyouzai-kenkyuu*. While educators in Japan recognize *kyouzai-kenkyuu* as an essential part of the preparation phase of lesson study and regular lessons, non-Japanese lesson study adapters have ignored it, as the effort spent on this process may almost be imperceptible (Doig et al., 2011).Moreover, as Japanese researchers Fujii (2014, 2017) and Takahashi and McDougal (2016, 2019) argue, some aspects of Japan's lesson study are left out in other countries. As lesson study in Japan is deeply embedded in the school and teacher culture of Japan, for non-Japanese researchers, it may be not easy to recontextualize lesson study from its original cutural context. Elliott (2019) warned that lesson study would be "'cherry picked' and forged to fit an organisational culture that is driven by test data" (p. 187).

Researching and developing teaching materials, and making and revising lesson plans are the central activities for teachers in lesson study, as well as in everyday practice. These activities are the main part of the preparation phase, and teachers must identify the lesson's implicit and explicit values, such as academic as well as pedagogical values (Isozaki, 2020). It is expected from teachers who deliver a research lesson to carefully engage in researching and developing teaching materials, and making and revising their lesson plans based on advice and reflective discussion/conversation with colleagues and external advisors (e.g. professors and consultant teachers on the local board of education) who are "knowledgeable others" (Takahashi & McDougal, 2016, p. 515).

Through experiencing these processes, not only teachers but also student teachers can gain and improve teacher knowledge, especially PCK, values, and insight into their own subjects. Thus, lesson study helps teachers "internalize productive mindsets" (Fernandez, 2002, p. 404), and can provide them the opportunity to be a reflective practitioner (Schön, 1983).

Figure 28.1 shows a typical lesson plan and its components (Isozaki, 2015, 2020).

It is worth noting that lesson plan in Japan consists of a unit perspective, and teachers try to anticipate students' behaviour and response in a lesson as far as possible. To do this, teachers need to understand the scope and sequence of the subject curriculum in its entirety, linking lessons both within and across related units in previous and later grades, and know what students learned and understood in

(1) Name of the unit.

(2) The unit objectives, which comprise knowledge and understanding, skills, and attitudes relating to the Course of Study.

(3) A section about the unit which includes the following three perspectives:

(a) Unit perspective: The focus is on the unit's targets in terms of the subject content and its scientific and educational values, the nature of the unit, and important scientific concepts.

(b) Learner perspective: This includes students' perspectives, such as their characteristics, previous knowledge, and naïve concepts.

(c) Instruction perspective: This describes teacher's instruction policy based on unit (a) and learner (b) perspective.

(4) Scheme of work, which includes the sequence of lessons in the unit, as well as the task and objectives for each lesson.

(5) Assessment criteria and methods for every lesson in the unit.

(6) A one-hour lesson structure, as follows:

(a) Today's topic.

(b) The objectives of today's lesson (In general, these describe what students do or can do…)

(c) Today's lesson process as follows:

Time (estimated time)	Students' learning	Instruction and assessment
【Introduction】5–10 mins 【Development】30–40 mins 【Conclusion】5–10 mins	What students do or can do	What a teacher makes students do [Assessment criteria and methods]

Fig. 28.1 A typical lesson plan

previous grades (Isozaki, 2020). Consequently, several types of teacher knowledge and values are reflected in the lesson plans. Therefore, a lesson plan can be considered as reflection-on-action (Schön, 1983) for teachers and participants of lesson study. Along with the lesson plan, many teachers and student teachers create a worksheet, which engages students in practical work, and a board plan *(bansho-keikaku* in Japanese),which presents a proposed layout of the lesson. These are also important components for discussion at the reflective meeting. Finally, a teacher designs the research lesson.

The second phase involves research lessons. While the teacher conducts a lesson in the classroom based on the revised lesson plan, participants and colleagues observe and collect data on students' learning as well as teachers' teaching. Students' behaviour, informal conversation or mutter (*tsubuyaki* in Japanese), and notebooks

and worksheets are observed, and a teacher's management of the research lesson is examined. Often, colleagues of teachers record the research lesson using photos and videos, which are used for reflection and future reference. This implies that the lesson plan should be created for not only teachers and students, but others too. During the research lesson, students are taught according to the revised lesson plan; however, it may not be perfect. Even though teachers think deeply about and carefully anticipate students' behaviour and response at the preparation phase, revising the lesson plan several times, complex and unpredictable events can always occur. In such a case, teachers are required to use their professional judgement and make impromptu corrections to the lesson plan in their minds. The primary purpose of the lesson is to improve students' learning, not to deliver a lesson according to the revised lesson plan. This behaviour of teachers is referred to as refection-in-action (Schön, 1983).

The third phase is a reflective meeting/conference held after the completion of the research lesson. At the beginning of the reflective meeting, the teacher who delivered the research lesson explains his/her ideas behind teaching. Next follows a discussion based on the lesson plan, teacher's explanation, and data collected during the research lesson. Advisors, as knowledgeable others, comment on the lesson study, and at the end of the reflective meeting sometimes deliver a lecture relating to the main or subtheme of lesson study. Thus, participants can exchange and share their views and ideas on the lesson study.

This shows that lesson study is an evidence-based approach to improve learning and teaching in the professional learning community (e.g. Isozaki, 2015, 2020). Thus, starting from their student teacher term until their retirement, teachers can learn a lot of things related to teaching and learning, and implicit and explicit professional norms through lesson study.

Two Theories on Teacher Knowledge

This study focusses on teacher knowledge applied in the lesson study processes. For example, a science teacher's scientific knowledge should be organized from the teaching perspective and delivered as the foundation for the teaching of scientific concepts and ideas. According to Bosch and Gascón (2006) and Chevallard(1989, 1999), a teacher is not a scholar; therefore, teachers sometimes face difficulties when directly transforming the scholarly knowledge produced by scholars into a form that can be learned by students, which can be identified as knowledge-to-be-taught, as described in the official documents, such as the national curriculum and the textbook. In the classroom context, teachers also transform knowledge-to-be-taught into taught knowledge because the knowledge described in curricula and textbooks is standardized and not necessarily suitable for all students. The transformation of knowledge into a teachable form occurs during the preparation phase of the lesson study and regular lessons. Teachers are responsible for this transformative process because they determine the teaching methods best suited to their students and tend to focus on and take part in "internal didactic transposition" (Winsløw, 2007, p. 528), in

which knowledge is transformed from knowledge-to-be-taught to taught knowledge, and then to learned knowledge. As mentioned above, these transformations primarily take place during the preparation phase of lesson study.

Shulman (1987, p. 8) categorized teacher knowledge into seven types: (1) content knowledge, (2) general pedagogical knowledge, (3) curriculum knowledge, (4) PCK, (5) knowledge of learners and their characteristics, (6) knowledge of educational contexts, and (7) knowledge of educational ends. Additionally, Shulman (1987, pp. 12–19) proposed a model of pedagogical reasoning and action comprising: (1) comprehension, (2) transformation (preparation, representation, selection, and adaptation and tailoring to student characteristics), (3) instruction, (4) evaluation, (5) reflection, and (6) new comprehension. According to this model (Shulman, 1987, p. 16), the transformation of teacher knowledge into teachable and learnable forms suitable for students entails the following processes: (a) *preparation*, including critical interpretation; (b) *representation* of ideas as analogies, metaphors, and so on; (c) instructional *selection* of teaching methods and models; (d) *adaptation* to the general characteristics of students; and (e) *tailoring* these adaptations to specific students. This transformation can be observed in the process of lesson study, primarily during the preparation phase.

Although Shulman (1987) did not define PCK clearly, several researchers, including Magnusson et al. (1999); Loughran et al., (2006, 2012); and Bishop and Paul (2007), have tried to identify PCK in science teaching. Magnusson et al. (1999, pp. 96–97) conceptualized a PCK model to analyse teacher knowledge, which comprises the following five components: (a) orientations towards science teaching, (b) knowledge and beliefs about science curriculum, (c) knowledge and beliefs about students' understanding of specific topics in science, (d) knowledge and beliefs about assessment in science, and (e) knowledge and beliefs about instructional strategies for teaching science. Although van Driel and Berry (2012) argued that PCK can be developed both individually and in the professional collegiate community, the latter being the same as lesson study, in the present study, we use Magnusson, Krajcik, and Borko's PCK model (1999) as a tool for analysing PCK represented in the preparation phase of lesson study and regular lessons.

Research Design: Two Case Studies on Special School Culture in Japan

We conducted two case studies for one academic year within a special school context, focussing on an elementary and a secondary school attached to "A" national university. Schools attached to national universities in Japan (called (higher) normal schools before WWII) have played important roles since their establishment. With students' education, they have functioned as (1) a teaching practice school for student teachers, (2) an experimental school, and (3) a model school in the region. However, their role as a model school has largely become limited since the second World War.

While teachers in attached schools engage in open- and in-house lesson study, they also act as mentors for student teachers and conduct lesson study during teaching practice. Moreover, students in attached schools are generally selected through an entrance examination at the elementary and the secondary school levels, and therefore, academically, may perform better than their municipal school counterparts. Thus, while attached schools to national universities have had a long history of lesson study and have established their own school culture, Elliott (2019) argues that school culture shapes and distorts the implementation of lesson study. This is why we conducted case studies at attached schools and not municipal schools.

In addition, it is worth noting that in Japan, every teacher in a secondary school, regardless of school type, belongs to a grade group that spans across subjects performing several functions, such as coaching school clubs, and guiding students. Furthermore, some secondary school teachers also are homeroom teachers. As a result, as Isozaki and Isozaki (2011) asserted, similar to elementary teachers, secondary school teachers have a deeper understanding of each student's characteristics from multiple perspectives, not only their own teaching subject.

Two Case Studies

Both the elementary and secondary schools under consideration were established as attached schools to the Higher Normal School (one of the former institutes of "A" university), which was founded in 1905. The elementary school started open-house lesson study in 1915, and the secondary school in 1920. While the two attached schools under consideration have been conducting both open- and in-house lesson study with support of the "A" university for over one hundred years, both schools have become more connected to the local board of education in recent years. The elementary school has been publishing a monthly journal every year since 1914, including reviews of lesson study. The secondary school provides its lesson plans, worksheets, and other teaching materials on the school website after open-house lesson study.

Case study 1

The research lesson of open-house lesson study at the elementary school was conducted on 7 February 2020. The school's department of science had two teachers. However, though they were science majors, similar to municipal elementary school teachers in Japan, they were also homeroom teachers and taught several subjects similar to other municipal school teachers.

A male teacher with a bachelor's degree in education and 14 years of teaching experience delivered the research lesson. Before moving to this school, he worked at municipal elementary schools and was involved for a year with an elementary school attached to another national university.

He started preparing a lesson study from the beginning of the academic year in April 2019, just after coming to this school. During his stay at the school, he experienced in-house lesson study. As part of the open-house lesson study, he delivered two lessons, one on "how to warm things" for Grade 4 and the other on "the nature of electromagnets by programming a robot" for Grade 5. After the open-house lesson study, he published a report on the nature of electromagnets by programming a robot in the school's monthly journal. As Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) encourages programming education in schools, by conducting a lesson on the nature of electromagnets for Grade 5, he wanted to present his ideas on programming education in science teaching.

From April 2019 to February 2020, he consulted his advisor, who was a professor of "A" university, 11 times and held discussion on the pedagogical values of the main and sub-themes, contents of lesson plans, how to engage in researching and developing teaching materials involving worksheets, and also other educational issues. Of these 11 meetings, four were conducted face-to-face at the university or his school with another female teacher, and seven were conducted through email. The two science teachers often engaged in reflective conversation regarding the pedagogical value of teaching materials. They, fortunately, could obtain suggestions from the attached secondary school science teachers on the scientific value of the proposed teaching materials.

The male teacher focussed on how to improve students' learning using his previously created worksheet, and how to organize problem-solving activity in science lessons using a robot with a competitive game function to stimulate students' interest at Grade 5. The purpose of the lesson was not only to program a robot but also to develop a tool to understand the nature of electromagnets.

However, unfortunately, after the lesson study, there were few instances of reflective discussion on his research lesson with the advisor, except for writing a report to the school journal.

Case study 2

The research lesson of open-house lesson study at the secondary school was conducted on 13 October 2018. The school's department of science had nine teachers (three majored in physics, three in chemistry, two in biology, and one in earth science), and normally held a meeting every week. A male teacher who was a chemistry major with a master's degree in education and nine years of teaching experience conducted the lesson study. He had carried out lesson study several times at this and another secondary school attached to "A" university. At the beginning of April 2018, he started preparing the lesson study.

Considering the school's research theme and science department's sub-theme related to "deep learning" which MEXT enhances, he targeted the unit "the properties of matter and its changes" at Grade 7, which comprised seven lessons, and selected the fifth one for the research lesson. From April to October 13, he revised the lesson plan six times based on discussions in department meetings, reflective conversation with two other chemistry teachers on the teaching materials and the approaches from perspectives of scientific and pedagogical values, comments

from a university professor as the advisor, and the results of preliminary experiments. He conducted several preliminary experiments for the following purposes: for researching and developing teaching materials suitable for student engagement, for safe practical activity due to many participants observing the research lesson, and for observing students' acquired practical skills, such as measuring temperature and drawing graphs. He also focussed on how each group of students can effectively think and represent its particle model to explain the results of the experiment, and how to share their ideas in the class. The reason why he insisted on using the particle model is that the science curricula from elementary to upper secondary school include four key concepts as part of a spiral curriculum designed by MEXT: energy, particle, life, and earth. He conducted trial lessons in two other classes based on the revised lesson plan, and following students' responses, made minor corrections to the lesson plan before the actual research lesson.

However, after the lesson study, there was no time for reflective discussion on the research lesson with the advisor, except for revising the lesson plan in a department meeting before sharing it on the school website.

Discussion

How Do Japanese Teachers Gain and Improve Their Teacher Knowledge Through Engaging in Lesson Study?

During the preparation and representation phases of Shulman's (1987) model, teachers in Japan tend to critically reflect on teaching materials they had previously produced, and reference previous lessons. They read official documents, such as the Course of Study, other guidelines, and textbooks, and consider the specific key concepts and skills to be taught in the unit based on their academic and pedagogical values. They consider the topics of the unit from different perspectives so that the relevant ideas and skills provided are accessible to the students during the lesson. In the process of selecting materials, teachers apply their knowledge developed from previous teaching experiences and personal self-improvement activities, such as reading books and participating in in-service programs involving lesson study, to develop teaching materials. In the adaptation process, teachers customize their teaching materials (involving worksheets) according to their students' characteristics and understanding by considering their abilities, prior knowledge, or naïve concepts, and carefully anticipate students' behaviour and responses in and to the lesson. During the tailoring process, teachers consider within-class variation and differentiate the teaching material accordingly. Thus, pedagogical reasoning and action occur during the preparation phase of lesson study. These processes could be observed in the two case studies, and the internal didactic transposition was carefully and effectively executed by the two teachers. This exemplifies why teachers in Japan spend much energy and time preparing lessons, as shown by OECD (2014, 2019).

Furthermore, referring to Magnusson, Krajcik, and Borko's PCK model (1999), we analysed teacher knowledge represented in the lesson plan. The first and second components, orientations towards science teaching and knowledge and beliefs about science curriculum, are represented in the lesson plan described in Fig. 28.1 as "The unit objectives" and "A section about the unit which includes the following three perspectives: (a) Unit perspective". The third component, knowledge and beliefs about students' understanding of a *particular* topic in science, is similar to "(b) Learner perspective: This includes students' perspectives, such as their characteristics, previous knowledge, and naïve concepts" part of the lesson plan. Knowledge and beliefs about assessment in science can be identified as "(5) Assessment criteria and methods for every lesson in the unit". The fifth component, knowledge, and beliefs about instructional strategies for teaching science, can be observed as "(c) Instruction perspective". Thus, all the components of PCK identified by Magnusson et al. (1999) are implicitly and explicitly included in Japan's lesson plan.

Thus, from the theoretical analysis of lesson study and case studies, we can identify teacher knowledge, and pedagogical reasoning and action during the preparation phase of lesson study, as well as regular lessons in Japan.

Next, we identified the following characteristics of lesson study conducted in two schools attached to "A" national university in Japan, especially at the preparation phase.

(1) Teachers in both schools focussed on students' learning when being engaged in researching and developing teaching materials (*kyouzai-kenkyuu*), and making and revising a lesson plan (*gakushuushidouan-sakusei*), in parallel and provided feedback to each other. We identified that both Shulman's model of pedagogical reasoning and action, and internal didactic transposition, were carefully implemented during this phase.
(2) They spent more than half a year preparing the lesson study with colleagues.
(3) They revised the lesson plan several times based on discussion and reflective conversation with colleagues, comments from the advisor, and the results of preliminary experiments.
(4) They performed several preliminary experiments as part of researching and developing teaching materials from both learning and teaching perspectives.
(5) They conducted trial lessons in other classes based on the revised lesson plan to confirm and grasp students' understanding and behaviour.

Additionally, the themes of both schools for lesson study were related to the recent MEXT policies.

These case studies reflect the traditional attached school culture in Japan, with an established professional learning community based on collegiality in schools, and its academic links with universities and its connection with the local board of education. Not surprisingly, both the teachers were aware that teachers of schools attached to "A" national university should engage in lesson study positively. Furthermore, they recognize that both open- and in-house lesson study can improve their teacher knowledge base and teaching competencies and that they learn from participants, colleagues, and advisors even though they have to spend much energy and time on it.

This realization keeps teachers of attached schools up to date with the latest research trends. Of course, teachers in other municipal schools take engaging in lesson study for their CPD for granted (e.g. Fujii, 2014; Isozaki, 2020; Isozaki & Isozaki, 2011).

The standardization of lesson study can easily be achieved in other schools. According to an OECD (2019) report on the Teaching and Learning International Survey, 91% of the teachers in Japan were satisfied with the training they received involving lesson study, against the average of 82% in OECD countries. On the other hand, standardization of lesson study can lead to stylization, rigidity, and trivialization (e.g. Isozaki, 2015). For example, in general, while the reflective meeting provides opportunities to exchange ideas and learn from others about creating teaching materials, developing teaching approaches, and how to manage the class, participants tend to hesitate to criticize the research lesson, and sometimes it becomes difficult to ask questions. In addition, teachers in both schools did not get the opportunity for reflective discussion on their practices after the open-house lesson study and engaged in less informal reflective conversation with colleagues. As Sato (2009) argued, a new favourite trend in lesson study is its transformation from a program-based approach that involves researching and developing teaching materials and making and revising lesson plans in the preparation phase to a project-oriented approach that focusses on its designing processes and reflections. In this sense, the case studies under consideration are regarded as having a program-based approach, though a university professor joined the design process of lesson study as an advisor for the elementary school's case study rather than for the secondary school.

Japanese Teachers Spend Much Effort at the Preparation Phase of Lesson Study from Teacher Knowledge Perspective

The case studies showed that the two teachers spent much time and energy at the preparation phase. They revised the lesson plan and conducted preliminary practical work several times. We analyse the reason behind their spending this much effort from teacher knowledge perspective.

After the PCK summit in 2012 (Carlson et al., 2015), Gess-Newsome (2015) redefined the PCK model proposed by Shulman (1987) and developed a model of teacher professional knowledge and skill (PCK & S) that includes PCK as follows:

- Personal PCK is the *knowledge* of, *reasoning* behind, and *planning* for teaching a particular *topic* in a particular *way* for a particular *purpose* to particular *students* for enhanced *student outcomes* (Reflection *on* Action, Explicit).
- Personal PCK & S is the *act of teaching* a particular *topic* in a particular *way* for a particular *purpose* to particular *students* for enhanced *student outcomes* (Reflection *in* Action, Tacit or Explicit) (Gess-Newsome, 2015, p. 36: *italics* in original)

Gess-Newsome(2015) argued the importance of PCK & S in the classroom context. A typical lesson plan in Japan (see Fig. 28.1) and the process of conducting researching and developing teaching materials, and making and revising lesson plans include all the components (knowledge and skills) mentioned in the first definition given by Gess-Newsome (2015). As Fig. 28.1 shows, a lesson plan includes the unit objectives and scheme of works, including the objectives of each lesson and main activities and the assessment criteria and methods in each lesson. This unit perspective allows teachers to recognize why it is important for *particular* students to know the ideas presented in the unit, critically think about what is important for improving students' learning in the classroom context, and carefully reflect on what should be done for appropriate learning. The process of making and revising lesson plans is not observed by other teachers. The revised lesson plan, representing teacher knowledge and several values, serves as a guide to the research lesson and a platform for discussion at the reflective meeting. This is one of the reasons why the two teachers revised their lesson plan several times. Consequently, participants of the lesson study can understand the reasoning behind a lesson plan, and recognize and confirm it at the reflective meeting where a teacher explains his/her own ideas on students' understanding and behaviour, teaching materials, teaching approaches, and other ideas about the lesson. Therefore, a careful analysis of the lesson plan is important not only to understand how teachers plan the lesson and create the teaching material using their teacher knowledge base and skills, but also why teachers make and often revise the lesson plan for enhancing students' understanding in lesson study..

As mentioned above, teachers normally conduct research lessons and regular lessons according to a lesson plan. Although the final version of the revised lesson plan may not necessarily be perfect, it is more important for teachers to carefully observe students' behaviour during a lesson, even though they anticipate students' responses before a lesson, and need to make an instantaneous modification to the lesson plan in their minds in accordance with students' unpredicted responses during a lesson. This improvising behaviour of teachers can be identified as reflection-in-action (Schön, 1983).To effectively engage in such behaviour, teachers must have opportunities to reflect on their practices. Thus, the latter definition proposed by Gess-Newsome (2015) regarding PCK & S concerns classroom practice in lesson study.

While teachers focus on improving students' learning and enhancing outcomes in research lessons as well as regular lessons, as argued the importance of reflection by Sato (2009) and exemplified by the two case studies, teachers do not tend to reflect on their lesson study with researchers. This implies that teachers miss the opportunities to deeply reflect on what students experienced in the research lesson and discuss students' outcomes, such as learned knowledge and acquired skills represented in their notes, worksheets, and other collected data in lesson study. As Gess-Newsome (2015) argues, PCK & S can be inferred by participants and researchers through careful observation in lesson study. The two case studies also exemplify that it is important to conduct lesson study effectively for the teachers themselves as well as for the participants and that teachers need to design the lesson study process in

association with researchers to investigate students' authentic learning in a classroom context.

Implications and Conclusion

As Isozaki (2015, 2020) has argued, while lesson study has potential value for CPD and is *one* of the important vehicles for developing teacher knowledge and skill, it is important for teachers and researchers to recognize that the standardization of lesson study may lead to stylization and rigidity. Clivaz and Takahashi (2017) argued that theorizing a lesson study could help researchers and teachers outside Japan understand its specific cultural norms. As lesson study is embedded in the teaching culture of Japan, there is space for non-Japanese education researchers to identify social and cultural norms in Japan's school context. This implies that researchers and teachers in Japan have to provide enough information to educators outside of Japan who wish to design lesson study.

Through lesson study within the professional learning community, teachers can improve their knowledge base and teaching competencies. In order to bridge the gap between theory and practice in education, enhancing reflection with researchers based on collected data using analysis tools of PCK models such as those conceptualized by Magnusson et al. (1999), Loughran et al., (2006, 2012), and Gess-Newsome (2015) is important. Therefore, in the collaborative design process of lesson study with teachers, researchers should adopt the PCK model to analyse the transformation of teachers from being a novice to experienced ones and provide adequate feedback to them. However, it is relatively difficult to change teachers' beliefs through CPD involving the lesson study (Isozaki, 2020). In the short term, researchers as knowledgeable others can provide teachers with opportunities to reflect on what knowledge is transformed and why in a particular unit, as well as help teachers draw on their knowledge to decide what and how to teach in a *particular* unit. In the long term, researchers as knowldgeable others should be able to actively increase teachers' CPD and aid in the development of more reflective practices. For example, they can monitor teachers and provide them adequate advice for developing PCK and PCK & S, as conceptualized by Shulman and other researchers, according to the stage of their teaching experiences. Furthermore, as argued by Lampley et al. (2018), lesson study is a promising approach for graduate teaching assistants at the higher institution to reflect on their teaching practice. This implies that lesson study can be useful for young researchers becoming knowledgeable others as well.

As a result, teachers' in-depth analysis of collected data and reflection with researchers *after* lesson study can elucidate students' authentic learning in the classroom, both within Japan and beyond. It is worth noting that the development of teacher knowledge and skill is not limited to the preparation phase, but can also be developed through a continuous process of lesson study.

Acknowledgements We express our gratitude to the two elementary and secondary school teachers who provided materials and information on case studies.

Funding This study was supported by the Japan Society for the Promotion of Science (KAKENHI Grant No. JP16K12761, JP17H01980, JP17K04758, and 20K20832).

Declaration of Interest Statement There are no conflicts of interest to declare.

References

Bartalo, D. (2012). *Closing the teaching gap: Coaching for instructional leaders*. Corwin Press.

Bishop, K., & Paul, D. (2007). *Learning science teaching: Developing a professional knowledge base*. McGraw-Hill/Open University Press.

Black, P., & William, D. (1998). *Inside the black box: Raising standards through classroom assessment*. School of Education, King's College London.

Bosch, M., & Gascón, J. (2006). Twenty-five years of the didactic transposition. *International Commission on Mathematical Instruction Bulletin, 58*, 51–63.

Carlson, J., Stoke, L., Helms, J., Gess-Newsom, J., & Gardner, A. (2015). The PCK summit: A process and structure for challenging current ideas, provoking future work, and considering new directions. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 14–27). Routledge.

Chevallard, Y. (1989, August). On didactic transposition theory: Some introductory notes. Retrieved from http://yves.chevallard.free.fr/spip/spip/Iarticle.php3?id_article=122. In *Proceedings of the International Symposium on Selected Domains of Research and Development in Mathematics Education* (pp. 51–62). Bratislava.

Chevallard, Y. (1999). *Didactique*? Is it a *plaisanterie*? You must be joking! A critical comment on terminology. *Instructional Science, 27*, 5–7.

Clivaz, S., & Takahashi, A. (2017). Mathematics lesson study around the world: Conclusions and looking ahead. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. NíShúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 153–164). Springer.

Doig, B., Groves, S., & Fujii, T. (2011). The critical role of task development in lesson study. In L. C. Hart, S. Alice, & A. Murata (Eds.), *Lesson study research and practice in mathematics education* (pp. 181–199). Springer.

Elliott, J. (2019). What is lesson study? *European Journal of Education, 54*, 175–188.

Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53*, 393–405.

Fujii, T. (2014). Implementing Japanese lesson study in foreign countries: Misconceptions revealed. *Mathematics Teacher Education and Development, 16*(1), 65–83.

Fujii, T. (2017). Lesson study and teaching mathematics through problem solving: Two wheels of a cart. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. NíShúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 1–21). Springer.

Gess-Newsome, J. (2015). A model of teacher professional knowledge and skill including PCK: Results of the thinking from the PCK Summit. In A. Berry, P. Friedrichsen, & J. Loughran (Eds.), *Re-examining pedagogical content knowledge in science education* (pp. 28–42). Routledge.

Isozaki, T. (2015). Lesson study research and practice in science classroom. In R. Gunstone (Ed.), *Encyclopedia of science education* (pp. 615–618). Springer Reference.

Isozaki, T. (2020). Exploring the professional learning values inherent in Japan's lesson study. In D. Corrigan, C. Butting, A., Fitzgerald, & A. Jones (Eds.), *Values in science education: The shifting sands* (pp. 139–152). Springer Nature.

Isozaki, T., & Isozaki, T. (2011). Why do teachers as a profession engage in lesson study as an essential part of their continuing professional development in Japan? *International Journal of Curriculum Development and Practice, 13*(1), 31–40.

Isozaki, T., Nozoe, S., & Isozaki, T. (2019). Science teachers' pedagogical development: Focusing on lesson study. In *Electronic proceedings of the ESERA 2019 conference. The beauty and pleasure of understanding: Engaging with contemporary challenges through science education, Part 14* (co-ed. C. Fazio, & M. Welzel-Breuer) (pp. 1606–1614). University of Bologna.

Lampley, S. A., Gardner, G. E., & Barlow, A. T. (2018). Exploring pedagogical content knowledge of biology graduate teaching assistants through their participation in lesson study. *Teaching in Higher Education, 23*, 468–487.

Lewis, C. (2002). *Lesson study: A handbook of teacher-led instructional change.* Research for Better Schools.

Lewis, C. C., Perry, R. R., & Hurd, J. (2009). Improving mathematics instruction through lesson study: A theoretical model and North American case. *Journal of Mathematics Teacher Education, 12*(4), 285–304.

Lewis, C., & Hurd, J. (2011). *Lesson study step by step: How teacher learning communities improve instruction.* Heinneman.

Loughran, J., Berry, A., & Mulhall, P. (2006, & 2012 (2nd ed.)). *Understanding and developing science teachers pedagogical content knowledge.* Sense Publishers.

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & L. Leaderman (Eds.), *Examining pedagogical content knowledge: The construction and its implications for science education* (pp. 95–114). Kluwer Academic Publishers.

Organization for Economic Cooperation and Development (OECD). (2011). *Strong performers and successful reformers in education: Lessons from PISA for the United States.* OECD publishing.

OECD. (2014). *Results from TALIS 2013, country note: Japan.* OECD. Retrieved from http://www.oecd.org/japan/TALIS-2013-country-note-Japan.pdf

OECD. (2019). *Results from TALIS 2018, Country note: Japan.* OECD. Retrieved from https://www.oecd.org/education/talis/TALIS2018_CN_JPN.pdf

Sato, M. (2009). *Kaikaku no doukou* [Trend of reform]. In National Association for the Study of Educational Methods (Ed.), *Lesson study in Japan* (pp. 104–114). Gakubunsha. [in Japanese]

Schön, D. (1983). *The reflective practitioner: How professionals think in action.* Basic Books.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–23.

Stigler, J. W., & Hiebert, J. (1999). *Teaching the gap: Best ideas from the world's teachers for improving education in the classroom.* Free Press.

Takahashi, A., & McDougal, T. (2016). Collaborative lesson research: Maximizing the impact of lesson study. *ZDM, 48*, 1–15.

Takahashi, A., & McDougal, T. (2019). Using-wide collaborative learning research to implement standards and improve students learning: Models and preliminary results. In R. Huang, A. Takahashi, & J. P. da Ponte (Eds.), *Theory and practice of lesson study in mathematics: An international perspective* (pp. 263–284). Springer.

van Driel, J. H., & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational Researcher, 41*, 26–28.

Winsløw, C. (2007). Didactics of mathematics: An epistemological approach to mathematics education. *The Curriculum Journal, 18*(4), 523–536.

Winsløw, C., Bahn, J., & Rasmussen, K. (2017). Theorizing lesson study: Two related frameworks and two Danish case studies. In M. Quaresma, C. Winsløw, S. Clivaz, J. P. da Ponte, A. NíShúilleabháin, & A. Takahashi (Eds.), *Mathematics lesson study around the world: Theoretical and methodological issues* (pp. 123–142). Springer.