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Online lesson study: virtual teaming in a new normal

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Abstract

Purpose – The purpose of this study is to explore how lesson study (LS) can be transitioned to an online mode, with the purpose to derive recommendations for performing online LS while being loyal to the defining elements of a face-to-face LS.

Design/methodology/approach – A theoretical analysis into the core components and procedures of LS resulted in five big ideas that capture essentials of LS. Using these big ideas, constraints were derived for online LS and a pilot online LS was performed. Data were collected on the process and team members' reflections. The experience in the pilot was mapped against the outcomes of the theoretical analysis.

Findings – Setting up close collaboration and the observation of the online lesson appeared to be the most challenging issues. A set of recommendations in the form of do's and don'ts was derived from the experience.

Practical implications – The set of recommendations can be applied by practitioners who face the challenge of performing LS in an online environment, and can serve as a start for further research in online LS.

Originality/value – The original contribution of the article is the combination of the theoretical analysis of LS combined with the practical experience in the pilot. This gives rise to a framework that can help understanding LS in general and online environments in particular.

Keywords Online lesson study, Computer-supported collaborative learning, Lesson study essentials, Virtual teams

Paper type Conceptual paper

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1. Introduction

As a result of the coronavirus disease 2019 (COVID-19) pandemic, the traditional approach of lesson study (LS) was disrupted. Overnight, education shifted to the digital space due to "lockdowns" making face-to-face meetings impossible. The usual on-site LS-approach involves teacher teams participating in inquiry cycles of collaborative lesson planning to explore a research question, teaching and "live" observing the resulting research lesson (RL) with a focus on students' learning, and then discussing implications for teaching and learning (Lewis *et al.*, 2012). Often a facilitator guides the team and helps eliciting new theories and insights (Schipper *et al.*, 2017). The latter is also often done by an expert, or so-called "knowledgeable other" (Takahashi, 2014).

In 2016, de Vries *et al.* (2016) presented the Dutch LS-model, based on the model by Stepanek *et al.* (2006) and the model by Dudley (2013). Lesson plans, observations and post-lesson discussions are organized around so-called "case pupils" (Dudley, 2013). Subsequently, "case pupils" and other students in the class are briefly interviewed after each RL to learn their experience. Another distinguishing feature of the Dutch LS-model is the addition of a trained facilitator and/or a knowledgeable other (de Vries *et al.*, 2016).

To re-invent this blueprint of LS into an online format became a challenge to explore. Also, we saw online teaching and learning rapidly developing, together with heavier technology usage. We assume this change is a call for a different balance of teaching interventions and pedagogy to be deployed in LS.

Studies on blended (Mahadewi and Teguh, 2017; Marsono, 2016) or fully online LS (Ayfer Budak, 2012; Koutsouris *et al.*, 2017; Sharma and Pang, 2015; Soto *et al.*, 2019) are limited and mainly reported practical issues, such as the need for a joint online working environment (like Google Docs), and problems with online observing students. Regarding the latter, Koutsouris *et al.* (2017) report the use of multiple cameras and carefully choosing the camera positions surface as the most important issues in observation through video. They write that observers note that the lack of contextual information hinders the interpretation of the lesson. They also found video conferencing to be quite smooth, meaning the absence of technical difficulties and the presence of document sharing and a common whiteboard. Choppin *et al.* (2020) and Skultety *et al.* (2017), addressed the use of video to support lesson observation in a synchronous collaborative mode. Both mention the benefits of video for enabling closer observation, partly because of the possibility for replay, and arrive at recommendations regarding the length of sessions and the use of annotation software.

Huang *et al.* (2020) performed a *Technology-assisted Lesson Study* focussing on the observation and post-lesson discussion, and remark the main merits are the removal of practical barriers such as travel time, while keeping the benefits of collaboratively examining student learning.

Because online LS-experiences are relatively limited and largely focus on practical issues they do not help in re-inventing the blueprint of LS into a mode wherein a substantial part of communication and teamwork is occurring online. It is important to think through and as such better understand how a genuine LS can be maintained and supported in an online environment.

In this article, we will address the challenge of re-inventing LS into a virtual mode and report on the process of virtual teaming the Dutch Lesson Study consortium (LSNL) undertook in trying out LS in a fully online environment. We explored how LS can be realized in an online format using an online working environment and virtual tooling. A pilot LS-team was set up, consisting of LSNL-experts and the team went through the whole LS-process. The following research questions were addressed:

(1) Is it possible to deploy the LS-process online and at the same time be loyal to the defining elements of a face-to-face LS? (RQ1)

(2) What are the merits and struggles of an online LS? What kind of online tooling and platforms are available to support online collaboration, teaming and lesson observation? (RQ2)

(3) Can we discern recommendations based on our experience? (RQ3)

In the following, we will first focus on identifying the defining elements of LS based on literature as to formulate what is necessary in *online* LS. We searched for literature that addressed the main features of LS and the various shapes it takes worldwide.

1.1 Defining elements of lesson study: identifying core components, procedures and big ideas

LS has internationally proven to be a popular approach to teacher professional development (PD) (Xu and Pedder, 2014). Because of LSs popularity, its subsequent spread as well as the necessary transfer to the digital space, we felt the need to vet out the defining elements of LS. It can be assumed that LS has distinctive core features which need to be implemented with fidelity, the extent to which core features, key elements, theoretical characteristics or components of LS are implemented as intended (Murata, 2011). Adaptations to make LS fit more closely to the (national) school context, must be in line with its fundamentals to avoid weakening the potential efficacy of the original practice (Fujii, 2014; Hadfield and Jopling, 2016).

Other authors in the field of LS have mentioned or identified LS's core, critical or necessary components (Seleznyov, 2018), critical or essential features (Akiba *et al.*, 2019; Cerbin and Kopp, 2006; Takahashi and McDougal, 2016) or essential structures and stages (Bruce *et al.*, 2016) that may account for the working ingredients of LS (Murata, 2011). Basically, they all boil down to a shared description of the following components, (1) consider (long-term) goals for student learning and development; (2) plan RLs based on these goals; (3) during the RL, carefully observe student learning and collect data on student learning and development; (4) use these data to reflect on the lesson and on instruction more broadly and (5) if desired, revise and reteach the RL.

However, we could not find an unambiguous description of core, critical or necessary components of LS in the literature, partly because several authors use slightly different concepts such as "guiding principles", "characteristics", "key features" or "(core) features, components, and procedures". For the purpose of this paper, we define a core component as a prominent, essential component of LS. Besides core components, we propose a distinction between the core components of the LS-model, which are considered to be solid, and the procedures, which vary according to context and are used to put those core components in place. Enacting the RL by one teacher whilst others observe this lesson live, collecting evidence of learning, is for example a core component, while observing and interviewing selected "case pupils" are considered procedures.

Identifying and formulating LS as consisting of core components or critical features is not enough to explain the deceivingly simple consecutive plan-do-check-act cycle by which LS is often depicted. Thinking of LS only in core components or critical features will limit inquiry and reflection about learning and teaching to just going through the motion of the building blocks of the LS-cycle. Therefore, we introduce the notion of "big ideas" into the discussion of LS's working ingredients. Big ideas are pedagogically powerful because they offer direction to educators in ways that enhance teaching and student learning (Mitchell *et al.*, 2016).

So, what are the big ideas of LS? We will not claim an exhaustive answer to this question, but we would like to propose a workable set, that serves our analysis of LS in the context of assessing the process of taking LS online without harming its essentials. Based on LS-literature, we derived the following five big ideas:

(1) *Big idea 1*: *The essence of LS is that teachers collaboratively* perform research *on their lessons*. Core to LS is that it is inquiry-focussed in order to systematically examine student learning experiences, and the ways to reach this (Murata, 2011). This makes LS a research activity for teachers (Murata, 2020).

(2) *Big idea 2*: *LS involves* combining practical knowledge and external knowledge. This entails the study of relevant material, like in the Japanese *kyouzai kenkyuu*, (Sarkar Arani, 2017), literature and input from experts (e.g. Takahashi, 2014). LS team members bring in their practical knowledge and study how the two interact.

(3) *Big idea 3: LS is about* learning from students' learning. The goal of LS is to improve student learning and experiences for better outcomes. Essential in the inquiry process of LS is to scrutinize how teaching affects the learning process (Dudley, 2013; Murata, 2011). As the practitioner focusses on the goals for learning and development, the capturing of data as a proof of learning (processes) should concern exactly that: how does student learning take place?

(4) *Big idea 4: LS is a* collaborative effort *by teachers*. Teachers engage in intensive professional dialogue wherein they discuss their own practice theory, the outcomes of the study of materials and the curriculum, and when designing the learning experiences for student learning. In all writings the collaborative nature of LS is emphasized in order to sustain joint knowledge creation and spreading of that knowledge (e.g. Takahashi and Yoshida, 2004).

(5) *Big idea 5*: *LS requires* repeated cycles of research lessons. LS's goal is not to arrive at a "perfect" lesson, but rather to unravel the teaching and learning process in the setting of an actual lesson situation. This inquiry process entails the cyclical design of lessons in order to identify the interaction between teaching and learning (e.g. Amador and Weiland, 2015; Chikamori *et al.*, 2013; Fujii, 2014; Lewis, 2016; Seleznyov, 2018).

The big ideas as presented here, serve as lenses through which we can make sense of the "translation" of an on-site version of LS to online LS-activities that capture LSs' essentials and to derive design criteria for online LS environments.

2. Method

We used a theoretical analysis of collaborative online learning environments combined with a case study of a fully online LS-pilot. The results of the theoretical analysis were matched to the big ideas of LS, providing a basis for answering RQ1. RQ2 was addressed by performing a pilot LS cycle as a case study, and reviewing the process based on session recordings and team members' reflective logs. Using these data, we created a reconstruction of the LS-process and the RL to assess the features and characteristics of online LS in our attempt to do justice to the defining elements of LS. Answering RQ3 was done by combining the theoretical analysis and our case study experiences by deriving recommendations for online LS.

3. Results

Sections 3.1–3.3 present the analysis of collaborative online learning environments and how this answers RQ1. Section 3.4 presents the reconstruction of LS cycle in the case study performed to address RQ2. The combination of these sets of results leads us to answer RQ3 in the conclusions.

3.1 Collaborative online learning environments

The study of collaborative online learning environments is part of the field of computer-supported collaborative learning (CSCL). CSCL addresses learning environments where students work online in a shared environment, using tools such as video-conferencing, chat and shared representations. Various frameworks were created to describe, understand, and shape the learning processes in this field, including knowledge building (Scardamalia and Bereiter, 2006) and communities of inquiry (CoI, Fiock, 2020), both stressing the importance of community building. Within the knowledge building community, also the importance of joint knowledge representation is stressed. As a consequence, in CSCL, knowledge advancement is seen as a community effort, leading to the iterative improvement of ideas. Finally, in both frameworks, existing, authoritative information coming from literature, experts or other sources is constructively used in the knowledge advancement process.

Since the development of CSCL environments, many general purpose tools were released that can support online collaboration and the building of joint knowledge artefacts (Bouton *et al.*, 2021; Harasim, 2000). Examples are Google Docs for creating joint texts and representations, various online conferencing tools that allow for sharing of screens and collaborative work. Hu (2015) reports on the use of such tools for virtual team building and stresses the importance of collaborative artefacts as well as attention for active team building, including the acknowledgement of team members' geographical and cultural diversity. Hu also stresses explicit attention for supportive communication and conflict resolution to form successful teams which requires explicit management of communication and innovative use of available technologies, such as the comment feature in Google Docs.

Larson *et al.* (2017) distinguish asynchronous, synchronous and management features of the tools. Asynchronous tools, such as file sharing and discussion boards, have a function in building common representations. Synchronous features (e.g. video conferencing and screen sharing) support real-time communication and collaborative content creation. Finally, management functions are needed for archiving and monitoring of progress. Many online tools offer one or more of these features. In practice, teams will often collaborate using a suite of tools to support the various functions needed.

3.2 Online tooling for lesson study

LS can be characterized as a collaborative and reflective practice around a classroom-based problem or issue the team members mutually agreed upon. Similarities can be identified between the major aspects of CSCL and LS. The first big idea, LS being a research activity, touches directly on main ideas in CoI, seeing learning as inquiry. The second big idea, combining practical and external knowledge hooks clearly into ideas of constructivism as advocated in knowledge building (see Scardamalia and Bereiter, 2006). The fourth big idea is core to the CSCL approaches we discussed here, explicitly present in the CoI framework. The third and fifth big ideas do not match with known CSCL approaches as explicitly as the other three, as they are very specific to LS. So, how can we use online environments to sustain all five big ideas and the way they are elaborated in a LS cycle?

Linking the main issues of CSCL and knowledge building and the major characteristics of LS, we can see that CSCL and its associated tools should be able to support LS in a virtual mode. Participating in a LS-team means working on a shared research question, designing a RL, using resources, holding constructive and reflective professional dialogues, as well as enacting and observing the RL focussing on students' learning. As a consequence, we can enumerate a number of elements that an online environment sustaining LS should provide:

(1) *Shared representations.* In order to keep track of the joint work, the online environment provides a place where the research question, ideas, partial and complete products can be shared such that the representation is visible and editable

by all. A simple solution is provided by Google Docs or similar shared document-editing tools (Larson *et al.*, 2017). More advanced tools such as shared concept maps or planning tools also fall in this category.

(2) *Platform for free and open discussion.* Free and open discussion is essential for LS. Participants should have equal opportunity to contribute to the dialogue as guided by the LS-facilitator (see also Hu, 2015). In a synchronous mode, a video-conferencing tool can be used; in a asynchronous mode, a discussion platform can function.

(3) *Online access to resources.* Literature and materials used to design the RL can be stored and retrieved in a shared online archive.

(4) *Performing and observing the RL.* The modality of the RL determines its enactment and observation. When the RL is enacted fully online, observers can enter the virtual classroom, and observation of students can be a challenge. When the RL is on-site, online observation is possible via live streams or watching a video at another time.

3.3 Embedding lesson study in a virtual mode: online lesson study

In this section we provide a tentative answer to RQ1 by discussing how the LS-cycle can be implemented in an online environment; we will focus on the expected differences between face-to-face and online LS. We do so by following the five big ideas and exploring the ways in which these ideas can be realized in an online environment.

3.3.1 Big idea 1: teachers collaboratively perform research on their lessons. Usually, LS starts with considering goals for student learning, deciding on a mutually agreed learning problem or issue, resulting in a research question. This process requires the construction of a joint knowledge base. We can draw upon the *knowledge building* paradigm where joint representations of shared knowledge play a key role (Scardamalia and Bereiter, 2006). Nowadays, many online environments provide excellent tools to benefit from in this knowledge building process, offering shared editable documents, allowing note taking, exchanging ideas, hypotheses and resources to become a collaborative effort. In an online LS, such tools can be used to create and maintain the shared focus on the problem, the research question and all the arguments that team members contribute.

3.3.2 Big idea 2: combining practical knowledge and external knowledge. The RL is planned and developed around goals for student learning and development, case-pupils are selected, and their behaviour is predicted as a preparation for observation in the RL. Apart from the professional dialogue, this entails finding and using resources, literature and input of knowledgeable others. This requires support for co-design and co-construction, such as offered by shared editing environments, as well as access to relevant literature. As noted above, the online environment allows keeping an eye on these multiple sources: research questions, literature, its synthesis, as well as the ongoing lesson design.

In online LS, external knowledge in the form of resources or literature can be managed synchronously and asynchronously. Care should be taken for engaging a knowledgeable other in the environment (Takahashi, 2014), who in the Dutch LS-model takes part in the design of the lesson (de Vries *et al.*, 2016).

3.3.3 Big idea 3: learning from students' learning. In an on-site LS, team members collect data on student learning by observing students closely. If the team remains online (i.e. does not have the opportunity to attend the live lesson) observation takes place using digital means and observers can join in the online learning environment. In case of a live RL, video recordings form a possible means of observation, in addition to recording students' online work, for instance when they work on a computer. In both cases, observing student learning is a challenge and will need creative collection of data and observations. In an online environment, students tend to be less verbal and outspoken partly due to concurrent

communication being impossible in online environments. The question is therefore how to detect students' behaviour via a screen, even if the camera is on. This is especially the case in full classrooms. In breakout sessions, observers can join in and are able to experience the student activities and track the joint work by the students.

Using video observation, when the number of cameras is limited, close observation of individual students will be impossible, especially "looking over a student's shoulder" is not feasible. Another drawback is that possibly observers, who cannot be present in the classroom, will be less connected to the lesson, especially when the lesson is recorded and the observation takes place at a later stage (Koutsouris *et al.*, 2017).

Connectedness is especially important in the debriefing process, where the LS-team reflects and discusses the data and observations collected, and plans possible adaptations to the RL. Such discussions can best be held with the data and observations of the RL fresh in mind, hence without a long pause between the end of the lesson and the start of the post-lesson discussion. In online conditions, this poses a serious problem. A possible technical solution could be to stream the lesson, preferably with multiple cameras. In an online environment, the lesson can then be evaluated at a distance.

3.3.4 Big idea 4: a collaborative effort by teachers. Collaboration requires shared representations, and an open way of communication. In this regard, the role of a facilitator becomes important in order to guarantee an effective and equal contribution of all team members. More than in a face-to-face setting the facilitator's task in supporting the communication is to ensure that all participants receive speaking time and are able to contribute to the joint work being created in the online environment. Also, smooth and effortless technology is a necessity. In a video meeting a poor connection or not being familiar with the technology used can exclude team members from the discussion.

Typically, online meetings tend to be shorter than face-to-face gatherings; staying on-task and focussed is much harder than in real life. This yields the risk that the content of the meeting focusses on planning issues and the division of work. This would damage the collaborative nature of LS and turn it into a co-operative project. It will be the facilitator's role and responsibility to keep the meetings' dialogue focussed on the research question, the inquiry stance that goes with it, and to keep track of new insights and (practical) theories.

3.3.5 Big idea 5: LS requires repeated cycles of research lessons. In an online post-lesson discussion, it is important that every team member provides a reflection on the lesson. The facilitators task is to give every team member a turn to provide their report uninterrupted, as is the case in on-site LS. During this phase and the discussion that follows, observation notes and recordings can be shared, which can serve as input for the next LS cycle.

3.4 Pilot with online lesson study

In April 2020, one month after the Dutch government announced that schools should be closed and should switch to online education and all workers were asked to work from home whenever possible, a LS-team consisting of seven LSNL-participants started a fully online LS. This case study was designed to address RQ2 into the merits and struggles of an online LS. In total, the team held eight weekly sessions of 60–90 min. Six were used to plan the RL and one was a reflection session after the enacted lesson and one was a reflection on the whole process. One participant acted as the facilitator and one participant was the knowledgeable other on online learning. One participant was a secondary school math teacher who taught his students online. Most sessions were attended by a LS-expert who acted as a quiet observer and critical friend. Notes and minutes were collected as well as participants' reflection notes. For each meeting, the notes were consulted and the aspects that the team deemed important were highlighted.

Meeting 1: this meeting centred around the mode of LS by discussing questions like "Which adaptations are needed to perform LS online. Which tools can we use? How do we collect data? How do we observe? To what extent can we see what students do/learn in an online LS?". Problems with logging into the online environment (Microsoft Teams) impacted the flow of the discussion. Participants noted that due to inexperience with online tooling and the many factors to take into account, it was difficult to structure the session. Also, simultaneously designing the lesson and thinking about the online LS-format stretched our creativity.

Meeting 2: in this meeting, decisions were made regarding the online platform for collaboration (i.e. Zoom) and for enacting the RL (i.e. MS Teams). The latter because the school of the teacher only used this. For each step in the LS-cycle the team decided what could be done online and what not. This stressed the importance of an online shared space (Google Docs was chosen) for defining the research question, engaging with theory, work on the design of the lesson and selecting the case-pupils. The conclusion was that online LS should be feasible, nonetheless the team foresaw problems with observing the online RL.

Meeting 3: the RL was planned and issues that might arise while conducting an online lesson were discussed. The dialogue focussed on how to interpret differences between student learning in an online LS. The team concluded that a dashboard (all students visible in one screen) would be useful to see how students actually participate.

Meeting 4: in the fourth meeting, the team continued with lesson preparation and planning. An e-learning tool (Meesterplan, 2020) was introduced by one of the members and case-pupil selection was prepared. *Meesterplan* is a tool developed to support teachers to design versatile detailed theory-based lesson plans and data-driven team/seating plans, thereby enabling differentiated and co-operative learning in a time-efficient manner. For this lesson, the functionality to monitor the individual student progression during an online formative test was explored in an online co-operative learning setting. *Meesterplan* was employed to serve as a kind of dashboard to monitor student progress during the online RL. As a criterion for case-pupil selection, the team decided on usual classroom behaviour: categories were "usually silent", "impulsive" and "thoughtful". It was decided to develop a script of how interaction patterns take place during the lesson.

Prior to the 5th meeting, research literature about online student activation was read by the team, this felt as a necessity by the participants, because most decisions seemed to be based on "gut feeling".

Meeting 5: in this meeting, the team discussed whether they were still on track regarding the formulated research question. An abundance of research literature was made available by the knowledgeable other. "Gut feelings", such as the need for joint representations, were confirmed by several studies (e.g. Hu, 2015). The lesson plan was still not finished after the 5th meeting and technical issues with the online tool resulted in a tentative decision not to use it. Teacher input about the RL was collected, but decisions about the lesson design/plan still had to be made.

Between the 5th meeting and 6th meeting, the teacher participant finished the lesson plan. The plan entailed that students would work in groups in separate online channels on practice problems in mathematics, preparing for a test. Using *Meesterplan*, the teacher would be able to see individual student progress on these problems and enter students' group channels if groups were apparently struggling with the given problem.

Meeting 6: the teacher participant presented the lesson script while other team members gave feedback and consequently the team collaboratively finalized the lesson plan. Also, the teacher presented a final choice for the case-pupils and observers were appointed a student to observe without knowing what type of student he/she would observe. Practical issues were discussed on recording the lesson, the use of cameras and an observation schedule.

After the 6th meeting an observation scheme was developed on the online platform. Observation forms were exchanged and were discussed via e-mail. The RL was conducted online as planned. The teacher reported that switching between the MS Teams breakout groups was very intensive and was hard to combine with keeping an eye on the Meesterplan dashboard. Observers reported difficulties with students not turning their camera on and the group chat being invisible for them.

Meeting 7: a post-lesson discussion took place 15 min after the enacted online RL. The team exchanged experiences and observations of the online session and the first draft of recommendations of online LS formulated. Main discussion points were problems with observation and the difficulties the teacher had performing the lesson as intended. Possible changes to the lesson were discussed, but, due to practical circumstances, there was no opportunity to re-teach the lesson.

Meeting 8: a reflection meeting was held five days after the RL. The team indicated that they did not feel the lesson really was a joint product, but rather created by the teacher. Also, they extensively discussed the role of the facilitator, who intensively managed the structure of the discussion, keeping a balance between giving space for the discussion and maintaining focus. Also, the use of the monitoring functionality of *Meesterplan* for this purpose during an online lesson was evaluated.

4. Discussion and conclusion

In this final section, we return to the research questions. Regarding RQ1, we performed a theoretical analysis of both LS and online learning and combined the two into requirements for LS in a virtual mode. The theoretical analysis resulted in five big ideas that, in our opinion, characterize LSs essentials. Matching these ideas to the literature on collaborative online learning environments showed that in principle these essentials can be honoured by smart use of available tools to support online collaboration. With respect to RQ2, the reported case study showed that online LS is feasible, based on these requirements and provides valuable insights on how to conduct LS in the circumstances where on-site meetings are impossible.

The main results of both the theoretical analysis and the case study are summarized in Table 1. The five big ideas were taken as the organizing principle for both the analysis and presenting the findings from the case study.

Although the team struggled with a number of technical issues and needed some time to obtain a set of online tools that was workable, these issues were resolved during the process. Many of the experiences match the findings by the literature we reviewed in the pursuit of RQ1, such as the need for supportive communication (Hu, 2015) and shared knowledge representations (Scardamalia and Bereiter, 2006). However, as becomes clear from Table 1, issues regarding the collaborative aspect and the lesson observations remained unsolved. The meetings were mainly used for exchange of ideas and for planning, but hardly for actual collaborative work on the RL. This affected joint ownership of the designed lesson and the way students were selected for observation. Also, lesson observation in an online environment proved to be a main challenge. Both issues had some impact on the quality of the enacted LS.

RQ3 is answered by combining the outcomes of the first two questions into concrete recommendations:

(1) Ensure all participants are familiar with the technology. Lack of a smooth working platform will seriously hinder the level of collaboration needed for LS. This includes video-conferencing tools and tools for shared development.

(2) In an early stage, consider the options for recording the RL, and discuss with the team what the goal of such recordings is, related to the research question. This will help in choosing the most suitable option.

Big idea	Theoretical analysis	Case study experience
(1) The essence of LS is that teachers perform research on their lessons	Online discussion and shared representation of research questions is essential. Technological hurdles should be avoided. Facilitator role is important for ensuring equal input from all members	Lack of technological smoothness hindered discussion at the start. Facilitator's role proved essential. Shared representations proved helpful in keeping focus
(2) LS involves combining practical knowledge and external knowledge	Sources of external knowledge are available and used as input, practical knowledge often from the team itself. Resources are available and explicitly discussed	The team started from "gut feelings" on online learning based on their own practice. In a later stage these were substantiated by literature and an analysis by the knowledgeable other
(3) Lesson study is about learning from students' learning	Focus of the research is on observing student behaviour. Selecting case-pupils, predicting their behaviour and close observation of these students needs special preparation in an online environment	Online observation was feasible in small student groups. However, because student cameras were not on as a rule it was hard to attribute behaviour to students. This made observation difficult
(4) Lesson study is a collaborative effort by teachers	The facilitator needs to ensure that participants receive speaking time and contribute to the joint work created in the online environment. Risk of shorter meetings resulting in division of work rather than collaborating	Meetings were held in a collaborative fashion, with open discussion and equal input from the participants. However, due to shorter meeting times, the actual work was often divided and performed outside the meetings. This led to the observation that the lesson was not seen as a joint product. Similarly, case-pupil selection was not done jointly, but by the teacher
(5) LS requires repeated cycles of research lessons	The post-lesson discussion is the place for reflection and redesign followed by a new enactment of the lesson. Open discussion and joint fine-tuning is essential	Post-lesson discussion was held in an open atmosphere, reflecting on both the lesson and the online LS process. Due to time constraints a second performance of the lesson was not possible

Table 1.
Summary of theoretical analysis and experience from the pilot LS

(3) Plan ample time. At least 90 min per session.

(4) Like in face-to-face LS, take time for the team members to get to know each other, build mutual trust and discuss expectations. In online environments it is tempting to skip this because of time constraints, but do not fall in this rabbit hole.

(5) For the purpose of a professional dialogue where all team members have reciprocity, the facilitator should explicitly give turns to team members to express their contribution and structure the dialogue by advance organisers and verbal prompts.

(6) Ensure that the research question is always visible, e.g. in the chat window or in an online document.

(7) During the planning of the lesson, take into account how student learning can be observed, e.g. by planning for smaller breakout groups.

(8) Ensure this is a collaborative design enterprise. Due to distance and limited online time, it is tempting to just divide tasks and do the main part of the design offline. Try to avoid that.

(9) Use a tool for synchronous co-design, such as Google docs or the Teams whiteboard.

(10) In observing the lesson, use two screens, one for observation, one for notes

(11) Plan ample time for reflection. One session directly after the lesson (allow for a short break) and one later to reflect on the process.

In conclusion, we explored translating LS to an online LS-mode and were able to extract critical aspects to optimize the online LS-procedure. The online LS supported planning, design, enactment and evaluation of the online high school math-lesson. This planned math RL will be described in a separate paper. Experiences like the one reported here can contribute to the general body of knowledge related to online LS. This can benefit the LS community not only in the current times of lockdown and pandemic but also in supporting LS in situations where practical circumstances, such as distance, limit the possibility of face-to-face meetings.

References

Akiba, M., Murata, A., Howard, C.C. and Wilkinson, B. (2019), "Lesson study design features for supporting collaborative teacher learning", *Teaching and Teacher Education*, Vol. 77, pp. 352-365.

Amador, J. and Weiland, I. (2015), "What preservice teachers and knowledgeable others professionally notice during lesson study", *The Teacher Educator*, Vol. 50 No. 2, pp. 109-126.

Ayfer, B. (2012), "Mathematics teachers' engaging in a lesson study at virtual settings", *Educational Research and Reviews*, Vol. 7 No. 15, pp. 338-343.

Bouton, E., Tal, S.B. and Asterhan, C.S.C. (2021), "Students, social network technology and learning in higher education: visions of collaborative knowledge construction vs. the reality of knowledge sharing", *Internet and Higher Education*, Vol. 49, 100787.

Bruce, C.D., Flynn, T.C. and Bennett, S. (2016), "A focus on exploratory tasks in lesson study: the Canadian 'math for young children' project", *ZDM Mathematics Education*, Vol. 48 No. 4, pp. 541-554.

Cerbin, W. and Kopp, B. (2006), "Lesson study as a model for building pedagogical knowledge and improving teaching", *The International Journal of Teaching and Learning in Higher Education*, Vol. 18 No. 3, pp. 250-257.

Chikamori, K., Ono, Y. and Rogan, J. (2013), "A lesson study approach to improving a biology lesson", *African Journal of Research in Mathematics, Science and Technology Education*, Vol. 17 Nos 1-2, pp. 14-25.

Choppin, J., Amador, J.M., Callard, C., Carson, C. and Gillespie, R. (2020), "Synchronous online model for mathematics teachers' professional development", in Wachira, P. and Keengwe, J. (Eds), *Handbook of Research on Online Pedagogical Models for Mathematics Teacher Education*, IGI Global, Hershey, Pennsylvania, pp. 176-202.

de Vries, S., Verhoef, N. and Goei, S.L. (2016), *Lesson Study: Een praktische gids voor het onderwijs*, Garant, Antwerpen.

Dudley, P. (2013), "Teacher learning in lesson study: what interaction-level discourse analysis revealed about how teachers utilised imagination, tacit knowledge of teaching and fresh evidence of pupils learning, to develop practice knowledge and so enhance their pupils' learning", *Teaching and Teacher Education*, Vol. 34, pp. 107-121.

Fiock, H. (2020), "Designing a community of inquiry in online courses", *International Review of Research in Open and Distance Learning*, Vol. 21, pp. 135-153.

Fujii, T. (2014), "Implementing Japanese lesson study in foreign countries: misconceptions revealed", *The Mathematics Teacher Education and Development Journal*, Vol. 16 No. 1, pp. 65-83.

Hadfield, M. and Jopling, M. (2016), "Problematizing lesson study and its impacts: studying a highly contextualised approach to professional learning", *Teaching and Teacher Education*, Vol. 60, pp. 203-214.

Harasim, L. (2000), "Shift happens: online education as a new paradigm in learning", *Internet and Higher Education*, Vol. 3 Nos 1-2, pp. 41-61.

Hu, H. (2015), "Building virtual teams: experiential learning using emerging technologies", *E-Learning and Digital Media*, Vol. 12 No. 1, pp. 17-33.

Huang, R., Kimmins, D., Winters, J. and Rushton, G. (2020), "Does a technology-assisted lesson study aproach enhance teacher learning while eliminating obstacle of traditional lesson study?", *Contemporary Issues in Technology and Teacher Education*, Vol. 20 No. 4, available at: https://citejournal.org//proofing/does-a-technology-assisted-lesson-study-approach-enhance-teacher-learning-while-eliminating-obstacles-of-traditional-lesson-study (accessed 2 December 2020).

Koutsouris, G., Norwich, B., Fujita, T., Ralph, T., Adlam, A. and Milton, F. (2017), "Piloting a dispersed and inter-professional lesson study using technology to link team members at a distance", *Technology, Pedagogy and Education*, Vol. 26 No. 5, pp. 587-599.

Larson, B., Leung, O. and Mullane, K. (2017), "Tools for teaching virtual teams: a comparative resource review", *Management Teaching Review*, Vol. 2 No. 4, pp. 333-347.

Lewis, J.M. (2016), "Learning to lead, leading to learn: how facilitators learn to lead lesson study", *ZDM Mathematics Education*, Vol. 48, pp. 527-540.

Lewis, C.C., Perry, R., Friedkin, S. and Roth, J.R. (2012), "Improving teaching does improve teachers: evidence from lesson study", *Journal of Teacher Education*, Vol. 63 No. 5, pp. 368-375.

Mahadewi, L.P.P. and Teguh, I.M. (2017), "Lesson study in blended setting: comparative study on students' skills in producing educational electronic cinema", *Advances in Social Science, Education and Humanities Research*, Vol. 118, pp. 164-167.

Marsono (2016), "Blended cooperative learning with nano lesson study model for the improvement of pedagogic and teaching innovation of prospective teacher", *AIP Conference Proceedings*, Vol. 1778, 030041.

Meesterplan (2020), available at: https://meesterplan.eu/ (accessed 30 September 2020).

Mitchell, I., Keast, S., Panizzon, D. and Mitchell, J. (2016), "Using 'big ideas' to enhance teaching and student learning", *Teachers and Teaching*, Vol. 23 No. 5, pp. 1-15.

Murata, A. (2011), "Introduction: conceptual overview of lesson study", in Hart, L.C., Alston, A.S. and Murata, A. (Eds), *Lesson Study Research and Practice in Mathematics Education: Learning Together*, Springer, Berlin, pp. 1-12.

Murata, A. (2020), "Lesson study as research", in Murata, A. and Lee, C. (Eds), *Stepping Up Lesson Study*, Routledge, New York, pp. 4-13.

Sarkar Arani, M.R. (2017), "Raising the quality of teaching through kyouzai kenkyuu – the study of teaching materials", *International Journal for Lesson and Learning Studies*, Vol. 6 No. 1, pp. 10-26.

Scardamalia, M. and Bereiter, C. (2006), "Knowledge building: theory, pedagogy, and technology", in Sawyer, K. (Ed.), *Cambridge Handbook of the Learning Sciences*, Cambridge University Press, pp. 97-118.

Schipper, T., Goei, S.L., de Vries, S. and van Veen, K. (2017), "Professional growth in adaptive teaching competence as a result of lesson study", *Teaching and Teacher Education*, Vol. 68, pp. 289-303.

Seleznyov, S. (2018), "Lesson study: an exploration of its translation beyond Japan", *International Journal for Lesson and Learning Studies*, Vol. 7 No. 1, pp. 217-229.

Sharma, S.A. and Pang, S. (2015), "Creating new opportunities for lesson study in an online reading clinic", *Literacy Research: Theory, Method, and Practice*, Vol. 64 No. 1, pp. 415-428.

Skultety, L., González, G. and Vargas, G. (2017), "Using technology to support teachers' lesson modifications during lesson study", *Journal of Technology and Teacher Education*, Vol. 25 No. 2, pp. 185-213.

Soto, M., Gupta, D., Dick, L. and Appelgate, M. (2019), "Bridging distances: professional development for higher education faculty through technology-facilitated lesson study", *Journal of University Teaching and Learning Practice*, Vol. 16 No. 3, pp. 1-19.

Stepanek, J., Appel, G., Leong, M., Turner Mangan, M. and Mitchell, M. (2006), *Leading Lesson Study: A Practical Guide for Teachers and Facilitators*, Corwin Press, Thousand Oaks, CA.

Takahashi, A. (2014), "The role of the knowledgeable other in lesson study: examining the final comments of experienced lesson study practitioners", *Mathematics Teacher Education and Development*, Vol. 16 No. 1, pp. 4-21.

Takahashi, A. and McDougal, T. (2016), "Collaborative lesson research: maximizing the impact of lesson study", *ZDM*, Vol. 48, pp. 513-526.

Takahashi, A. and Yoshida, M. (2004), "Ideas for establishing lesson-study communities", *Teaching Children Mathematics*, Vol. 10 No. 9, pp. 436-443.

Xu, H. and Pedder, D. (2014), "An international review of the research", in Dudley, P. (Ed.), *Lesson Study: Professional Learning for Our Time*, Routledge, London, pp. 29-58.

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