International Journal of Educational Research Open 5 (2023) 100272

Contents lists available at ScienceDirect

International Journal of Educational Research Open

journal homepage: www.elsevier.com/locate/ijedro

A conceptual model for teachers' continuous professional development through lesson study: Capturing inputs, processes, and outcomes☆

Klara Kager [a,*], John Paul Mynott [b], Miriam Vock [a]

[a] Department for Empirical Instruction and Intervention Research, University of Potsdam, Karl-Liebknecht-Str. 24–25, Potsdam 14476, Germany
[b] School of Education, University of Aberdeen, Aberdeen, United Kingdom

ARTICLE INFO

Keywords:
Lesson study
Continuous professional development
Conceptual model
Learning outcomes
Teacher learning

ABSTRACT

Global interest in Lesson Study (LS), an iterative professional development model, is growing rapidly and has resulted in a rich body of findings that report mixed outcomes and impacts on teacher learning. In this conceptual paper, we argue that the field of LS currently lacks a conceptual model that can help tie these findings more closely to a common schematic and descriptive framework. Reviewing research on professional development, we derive the purpose of such a model and criteria that it should fulfill. We then examine current LS models, showing that several aspects, such as inputs, learning processes, LS' iterative character, and outcomes over time, are not sufficiently addressed. To fill these gaps, we draw on wider perspectives on teacher learning and organizational psychology and propose an updated model of LS. Lastly, we discuss concrete ways in which this model can be used in research and practice.

Lesson Study (LS) is collaboration-based and teacher-driven approach to continuous professional development (PD). Over the span of several weeks, a group of teachers jointly investigates a problem of practice by studying the curriculum, planning a lesson, teaching and observing a live research lesson, and reflecting on their observations (Lewis et al., 2006). LS therefore includes several key characteristics of effective PD, that is, it addresses teachers' practice and real problems, focuses on students' learning, encourages collaboration and reflection, and is a sustainable and ongoing process (Borko et al., 2010). In the past three decades, LS has gained momentum across the globe and research reports that through LS teachers can, for instance, enhance their pedagogical and content knowledge (e.g., Coenders & Verhoef 2019; Lewis et al. 2013) and increase their awareness for students' needs (Dudley, 2013).

There are, however, some tensions that surface repeatedly in the research literature. LS has been imported from its land of origin, Japan, to other education systems as a borrowed policy and adapted to fit diverse national and local contexts (Hadfield & Jopling, 2016; Seleznyov et al., 2021; Stigler & Hiebert, 2016). Not all LS adaptions are equally successful or produce similar outcomes (Adamson & Walker, 2011; Bjuland & Mosvold, 2015; Canonigo, 2016). In fact, how teachers learn within LS and its adaptations remains largely underconceptualized (Cheung & Wong, 2014; Elliott, 2012; Stigler & Hiebert, 2016) and crucial learning mechanisms, such as observation and reflection, are predominantly underdescribed in LS publications (Larssen et al., 2018; Kager et al., 2022b). Sustaining LS practices over a long time period can prove challenging and while several studies report assessments of the impact of LS (Dudley et al., 2019; Godfrey et al., 2019; Lewis & Perry, 2017; Schipper et al., 2020; Takahashi & McDougal, 2016), there seems to be no consensus on how to best evaluate LS outcomes (Cheung & Wong, 2014).

This means that we have accumulated a rich body of mostly descriptive and qualitative research on LS (Seleznyov, 2019; Xu & Pedder, 2014), yet it is difficult to systematically learn from its findings, as we lack both a shared conceptual framework of how local LS adaptations compare to one another as well as a language to talk about it. A conceptual model that systematically describes aspects that are potentially critical to continuous PD through LS and depicts long-term LS outcomes could establish such a common schematic framework for the field. The goal of such a model would be to connect diverse LS implementations, support the development of a shared understanding of teachers' sustained learning through LS, and suggest avenues for future empirical research on LS.

The aim of this conceptual paper is to therefore develop a descriptive

☆ We have no conflict of interest to disclose.

* Corresponding author.
E-mail address: kager@uni-potsdam.de (K. Kager).

https://doi.org/10.1016/j.ijedro.2023.100272
Received 27 February 2023; Received in revised form 20 July 2023; Accepted 24 July 2023
Available online 29 July 2023

and theory-informed model of continuous PD through LS that systematically depicts its inputs, processes, and outcomes and can be used by both researchers and practitioners to assess short- and long-term impacts of LS. In a first step, we pinpoint what such a conceptual model should offer to the field. We then analyze the commonalities and differences of existing LS models and identify crucial issues that are currently insufficiently addressed, such as the means by which LS groups generate outcomes, as well as the emerging nature of these outcomes. To find ways to resolve these issues, we look beyond the field of LS and draw on influential models from research on professional development and organizational psychology. We then integrate these perspectives to propose an updated descriptive model that allows us to view continuous PD through LS not as a narrow and isolated event, but as a continuous, dynamic, and sustainable process that can and should be continuously evaluated and improved. Lastly, we discuss concrete ways in which this model can serve as a roadmap and a tool of analysis and evaluation for both researchers and practitioners.

The purpose of a conceptual model of continuous professional development through lesson study

Darling-Hammond et al. (2017) emphasize that the goal of any professional development (PD) is to enhance teachers' knowledge and student learning. The primary concern when adopting a PD model, such as LS, is thus to test whether it can lead to these changes (Guskey, 2021). Testing the effectiveness of PD, however, presents several challenges. PDs are implemented in vastly different school contexts, which makes it almost impossible to replicate them without adaptations (Guskey, 2009). It is further inherently difficult to assess and quantify whether participation in a PD can lead to sustained changes in teacher's knowledge, since such changes, even if measurable, do not guarantee an immediate shift in teacher's daily practice (Korthagen, 2016) or an increase in student achievement (Guskey & Yoon, 2009). The evaluation of a PD and its outcomes is nevertheless crucial to ensure that the required resources are translated to a worthwhile outcome (Guskey, 2021; King, 2014).

Bryk (2015) argues that examining a PDs effectiveness might not be enough, especially for an iterative continuous improvement approach, such as LS (Lewis, 2015). Instead of asking only whether an innovation works, it might make more sense to also ask which features need to be adapted or improved to make the innovation work for different agents under diverse conditions and over time (Bryk, 2015; Stigler & Hiebert, 2016). Even Guskey (2009, 2021), who advocates for rigorous assessments of PDs that yield replicable and comparative data, agrees that identifying and describing core elements that make PD effective, and ways in which they may be adapted, can be a productive way to circumvent the above-described challenges.

Along these lines, a group that perceives their LS work as ineffective does not need to immediately abandon the approach. They could, instead, assess factors that influenced their LS work, such as context conditions and how individual LS steps were implemented, and thereby pinpoint areas in which improvement or additional resources are needed. This formative and continuous evaluation could help ensure that LS can be a sustainable continuous PD model for diverse schools, instead of, in Lewis et al.'s (2006) words, "a short-lived fad". This scenario presupposes, however, that the group has a clear understanding of LS and how to critically assess their achievements. In other words, they would need a model by which they can evaluate their outcomes and trace the steps by which they arrived there.

Concerning research, such a model could systematize how we describe and conceptualize LS, aid the theorization of LS (Stigler & Hiebert, 2016), as well as the development of a rich descriptive knowledgebase of LS (Lewis et al., 2006). Kitada (2022), who examined modifications of Japanese LS in the US context, argues that adaptations to LS are unavoidable and need to be taken into account holistically in research. As Kitada (2022) these adaptions are influenced at least in part by differences in ecological conditions and diverging teacher cultures, which impact the way we conceptualize PD in general and LS in particular. We therefore argue that a model that describes such conditions as well as teachers' learning processes and possible outcomes of LS could support the effort to methodically contextualize LS descriptions in research.

Such a model is currently missing in the LS literature and its development is challenged by the complexity of evaluating continuous PD. As Vanblaere and Devos (2021) note, assessing school improvement through continuous PD is difficult in general: the assessment needs to be long-term and rich in description, identify different developmental stages, and allow for comparisons of these stages in order to better understand what characterizes them. Davidoff et al. (2015) suggest that the use of a shared theory or conceptual framework can bring a research field together by, first, systematizing features and their conditions that are crucial to an event, and, second, by ensuring that researchers are, in fact, investigating the same object of interest. A conceptual model in particular allows for the simplification of a complex event and provides a visual representation that ties research together (Jaakkola, 2020).

Based on the reviewed evidence on PD and models of assessment, we posit that a model of LS that could serve as a conceptual grid to various stakeholder groups would need to

- be applicable to different cultural contexts, LS adaptations, and subject areas,
- systematically describe the context factors that influence the implementation of LS, the LS steps and processes, and evolving short- and long-term outcomes,
- be useable for researchers to frame and explain their research, as well as to pinpoint areas of further research interest,
- and be useable for researchers and practitioners to conduct continuous and formative evaluation of LS cycles.

As a next step, we will review current models of LS and assess their suitability to address the above identified criteria.

Review of current models of professional development through lesson study

A survey of the literature indicates that the most frequently used LS model is circular and focuses exclusively on the LS core stages of study, plan, teach, and reflect, or variations thereof (e.g., Arani, 2006; Gutierez, 2016; Celik & Guzel, 2020; Chua, 2019; Dick et al., 2022; Dudley, 2013; Fujii, 2014; Isoda, 2015; Joubert et al., 2020; Lewis, 2009; Moss et al., 2015). These circular models provide a useful description of how LS steps are conceptualized, yet they largely leave contextual factors, specific learning processes, and learning outcomes in the dark.

Some models, summarized in Fig. 1, extend beyond the circular illustration of LS' core stages. They usually aim to conceptualize how teachers learn through LS and frequently follow a linear structure that resembles an input-process-output model (I-P-O model). The I-P-O model (Hackman, 2012; Hackman & Morris, 1975) is traditionally considered a useful paradigm to conceptualize how group interaction processes are influenced by input factors and yield certain outputs.

According to Driskell et al. (2018), *input* refers to contextual conditions and participants' characteristics. This dimension is regarded as crucial in research on teacher learning, as factors such as the school and classroom context, participants' knowledge and motivation, material quality, and resources have been shown to affect the outcomes of PD (Borko, 2004; Darling-Hammond et al., 2017). *Process* links the dimensions of input and output by detailing how groups generate results (Driskell et al., 2018). This dimension is frequently described in terms of a "black box" (Cajkler et al., 2013; Hargreaves, 2005; Vrikki et al., 2017), due to the difficulty of analyzing learning processes. This challenge extends to the third dimension, *output*, which describes the results

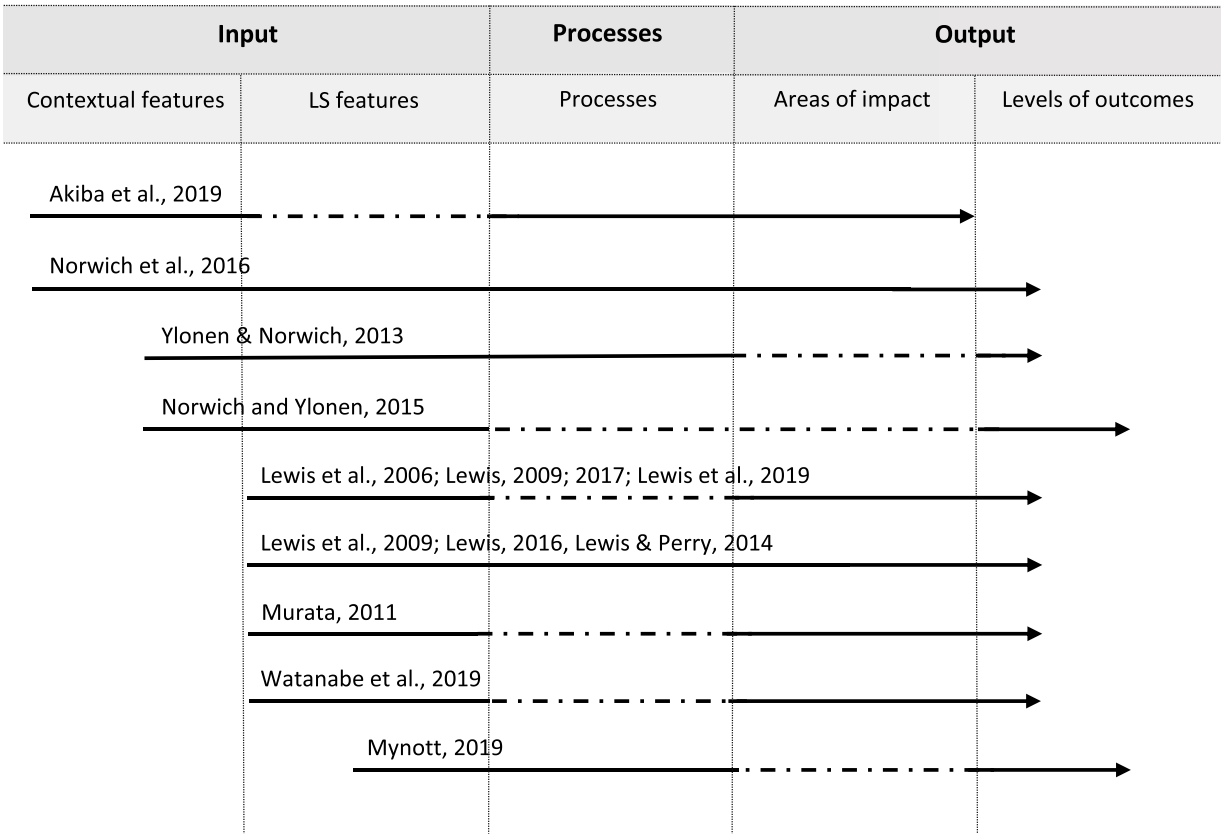

Fig. 1. Analysis of the components and scope of existent LS models that follow the I-P-O structure
Notes. The dashed line indicates that this aspect is not included in a given model. The varying starting and ending point indicate to what extent a certain aspect is illustrated in a given model (e.g., most models describe one or two outcomes, while Norwich and Ylonen (2015) and Mynott (2019) define four to five outcomes).

achieved by a group (Driskell et al., 2018) and is also commonly referred to as *outcomes*. The nature of these outcomes can be manifold and commonly include, for instance, participants' reactions and learning, the application of new learning, and students' learning outcomes (Darling-Hammond et al., 2017; Guskey, 2002). Stake and Schwandt (2006) further speak of a difference between the quality of results as measured (e.g., against a set standard) and as perceived by participants (e.g., gathered from participants' personal reflections).

Returning to Fig. 1, we see that most models in the LS literature structured in line with the I-P-O model neglect one or more of these dimensions. First, the majority of models starts with structural features of LS, excluding any additional contextual aspects. Exceptions are, for example, Norwich and Ylonen (2015), who include "Lesson Study conditions and context" in their model, and Akiba et al. (2019), who specify three areas of input factors: duration, facilitator orientation, and material quality.

Similarly, the majority of models do not explicitly outline the means by which outcomes are achieved, leaving the dimension of process underconceptualized. An example is the influential model proposed by Lewis et al. (2006), which has been advanced in several subsequent publications. The model posits areas of "intervening changes", such as teachers' knowledge and commitment. The specific processes that induce these changes, however, remain largely unspecified. Two versions of the model that do address processes suggest that changes ensue as the group develops an identity and thinking becomes visible (Lewis et al., 2009), or through the collaborative study of materials (Lewis, 2016). These specifications, however, are not consistent and no longer included in the more recent version of the model (Lewis et al., 2019).

Some models address the dimension of processes more explicitly, speaking of "reflective practice" (Norwich et al., 2016) and "effective inquiry process" (Akiba et al., 2019). Mynott's (2019) model, build on Festinger's (1962) notion of cognitive dissonance, arguably places the strongest focus on processes. Effectively merging the two dimensions of process and output, the model defines outputs in terms of the quality of the process that teachers underwent. Thereby, four hierarchical outcomes are suggested: absence of dissonance, dysfunctional dissonance, limited learning dissonance, and rich learning dissonance. This represents a very different take on processes and outputs of LS, as the majority of models keeps these dimensions separate and defines outputs more traditionally in terms of improvement of instruction and student learning (e.g., Lewis et al., 2019; Murata, 2011; Watanabe et al., 2019). These outcomes are further differentiated by Norwich and Ylonen (2015): learner outcomes, quantitative and qualitative teacher outcomes, continued to use LS, and use of LS by school/department.

One aspect largely missing from the models in Fig. 1 is the iterative character of LS. In fact, only the model by Murata (2011) includes an arrow that (re)connects the dimensions of output and input, indicating that teachers' new insights inform future LS processes. Mathieu et al. (2019) note that temporal aspects are often overlooked in the traditional I-P-O model. Repeated cycles are, however, a crucial feature of LS (Seleznyov, 2018), and models that neglect this aspect raise a host of questions. For example, it remains unclear in the models by Mynott (2019) and Norwich and Ylonen (2015) whether the proposed outcomes ensue after one or multiple LS cycles, whether they build on each other, or whether they represent different stages.

Next to the models listed in Fig. 1, the LS literature offers some other models that circumvent the issue of iteration by either depicting multiple LS cycles or favoring a circular structure over the I-P-O structure. Examples of the former are the models by Dudley (2019) and Ylonen and Norwich (2013), which do not include all I-P-O dimensions and seem to be tailored towards local and research-specific versions of LS. Examples of the latter frequently draw on Clarke and Hollingsworth's (2002)

interconnected model of teacher change (e.g., Bae et al., 2016; da Ponte et al., 2022; Schipper et al., 2017; Widjaja et al., 2017). This model defines four domains (personal, external, practice, and consequence) and posits that professional learning is a non-linear but dynamic development embedded in these domains and driven by the processes of enactment of reflection (Clarke & Hollingsworth, 2002). The model's main focus lies on conceptualizing the process of professional learning, and as such, the model does not categorize the development of learning outcomes over time or explicitly include the enhancement of student learning as a result of teachers' learning process. LS models that are based on Clarke and Hollingsworth's (2002) model consequently cannot offer strong explanatory power regarding different stages of outcomes and their development over time.

Fig. 1 shows that existing LS models generally underconceptualize the dimension of learning outcomes. In most cases, outcomes are defined as areas of impact (such as teachers' content knowledge, or beliefs), and illustrated as a rather fixed sequence of changes (teachers' instructional improvement leads to improved student learning). This connects to the vivid debate on whether teacher change follows a specific linear structure (Desimone, 2009; Guskey, 2002) or should be conceptualized as an interconnected and more dynamic process (Clarke & Hollingsworth, 2002; Opfer & Pedder, 2011). It further demonstrates that the base models, on which we draw to inform LS models, come with limitations that will necessarily influence the scope of the LS model.

As Boylan et al. (2018) explain, there is a difference between general models of professional learning (Clarke & Hollingsworth, 2002; Desimone, 2009; Guskey, 2002) and models that classify specific professional learning outcomes (Guskey, 2000; Kennedy, 2005). Our review of the literature indicates that current LS models tend to be adaptations of the former, rather than the latter. That is, they tend to define specific areas of change, such as "mathematics standards" (Watanabe et al., 2019, p. 51) or "[teachers'] self-efficacy" (Akiba et al., 2019), and some add one or two linear outcomes (e.g., changes in the area of teachers' knoweldge and beliefs will lead to instructional improvements, Lewis et al. 2009). As a consequence, these models cannot account for short-, mid- and long-term outcomes, run the risk of becoming too narrow for broad application, and tend to depict a linear view of professional learning nowadays considered as insufficient.

Our review of LS models is by no means exhaustive, but it demonstrates the challenges in modeling a dynamic process in a comprehensive way and indicates the need for the advancement of current approaches. To sum up, a number of conceptual models, aiming to describe varying parts and processes of LS, have been suggested, and each model marks an important contribution to our current understanding of LS. On the surface, many of these models follow the I-P-O structure, which corresponds to the traditional paradigm of evaluating collaborative processes (Driskell et al., 2018; Hackman, 2012). These models do not, however, share a common starting point (Fig. 1) and tend to emphasize on some dimensions, while others remain underconceptualized. Additionally, some models focus on a LS adaptation specific to a piece of research or subject area (da Ponte et al., 2022; Dudley et al., 2019; Norwich & Ylonen, 2013; Watanabe et al., 2019), making it difficult to translate it to other LS contexts. We also saw that LS models based on Clarke and Hollingsworth's (2002) model tend to underdescribe emerging outcomes.

Current models of LS therefore fall short on all three aspects identified by Vanblaere and Devos (2021): they allow only for a limited assessment of long-term outcomes and they neither describe different developmental stages of collaborative work, nor do they allow for the comparisons of these stages within and between schools. However, the synthesis of models demonstrates that the I-P-O structure is generally viewed as a suitable model for LS research and several relevant inputs, processes, and areas of outcomes have already been identified.

At this point, it should be noted that the reviewed LS models were developed within their own specific contexts and provide a highly beneficial abstraction of LS for their purposes. They were not created with the explicit intention of offering a unifying conceptual model for PD through LS, or to meet the criteria we outlined in our introduction. We contend, however, that the versatile and international field of LS has progressed to a point where it is possible, and also necessary, to develop a model of continuous PD through LS that incorporates the benefits of these existing models and attempts to capture all three dimensions.

Next, we will draw on research beyond the field of LS to identify suitable solutions to address these gaps. Specifically, we are seeking ways to represent the iterative structure of LS and coherently describe inputs, processes, and developing stages of outcomes.

Applying models of professional development to the field of lesson study

There are several influential models in and outside the field of education that can help advance our current set of knowledge on LS models. As already established, there is a difference between models that provide a general conceptualization of professional learning, and those that seek to classify professional learning outcomes (Boylan et al., 2018). It seems that a model of continuous PD through LS that comprehensively describes both the LS intervention and its impact would need to reconcile these two approaches.

In this section, we will therefore first consider research on teacher learning, drawing specifically on the work of Guskey (2000, 2002, 2021), which continuous to shape our discussion on the evaluation of PD. Given that LS is a process build on cooperation and that its outcomes are the effort of intense team work, we then take into account pertinent findings from research into team effectiveness and group work (e.g., Ilgen et al., 2005; Marks et al., 2001; Mathieu et al., 2019). The offer-and-use model for PD developed by Lipowsky and Rzejak (2015) has demonstrated that the perspective of organizational psychology can support the conceptualization of PD outcomes in the field of education. We therefore aim to bring together these perspectives from across disciplines in order to advance how we view teachers' continuous PD through LS.

Prior to his prominent model on teacher learning, Guskey (2000) formulated five hierarchical levels of outcomes as a way to systematically document and evaluate PDs. These levels include the teachers' reactions to, and their satisfaction with, a PD program, changes in their knowledge, changes in organizational support on a school-level, changes in teachers' daily practice, and finally change in students' assessments and grades. With these levels, Guskey (2000) proposes a likely sequence of how PDs can lead to immediate and long-term outcomes for several stakeholders. Each level also acts as a precondition for the next level. If teachers are not satisfied with the PD program, for instance, it is unlikely that they will have capitalized on the provided learning opportunities or make changes to their practice.

Guskey's five levels still inform educational research today and have previously been used for the evaluation of LS outcomes. Seleznyov (2019), for instance, used an adapted form to analyze existing findings on LS impacts, showing that there is currently a dearth of studies that rigorously assess mid- and long-term outcomes. One reason for the predominant focus of LS research on Guskey's first level, the participants' reactions, might be that the individual LS cycle is too narrow of a time window to expect or measure changes of subsequent levels (Mynott, 2019). As Mynott (2019) argues, for changes to occur on the organizational or student level, teachers need to engage in LS over a longer period of time.

This emphasizes the gap we earlier identified in the literature: current models do not depict outcomes over time, which might be challenging our conceptualization of how these outcomes could look like or be measured. In their extensive study on LS impact, Godfrey et al. (2019) showed that Guskey's five levels can serve as a useful heuristic to not only evaluate, but to plan and guide LS from the start. These examples suggest that Guskey's (2000) levels of outcomes could be a helpful schematic not only for individual research studies, but as part of a

conceptual model that is shared within the research community.

While helpful in this regard, Guskey's (2000) levels focus exclusively on outcomes, omitting the dimensions of input and process, and also posit a linear sequence. The more recent model by Lipowsky (2014) and Lipowsky and Rzejak (2015) progresses Guskey's (2000) approach by embedding hierarchical outcome levels in an offer-and-use model. The offer-and-use model, similarly to the I-P-O model, provides a systematization of factors that have been shown to influence the effectiveness of a certain learning offer (i.e., a lesson, a workshop) and of the outcomes that the use of this learning offer can lead to. In the context of PD, these factors include the characteristics of the facilitator and the participants, the school context, the PD's structural aspects, and whether or not participants capitalized on the learning moments provided during the PD (Lipowsky & Rzejak, 2015). These interrelated aspects then lead, through a transfer process, to various outcome levels: participants' reaction and satisfaction, the enhancement of participant's knowledge and their instructions, and finally the development of students' performance.

Lipowsky and Rzejak (2015) therefore make to two crucial changes to Guskey's (2000) approach. First, they connect PD outcomes to the dimensions of input and process on a conceptual level. Second, they indicate that outcome levels 2 (changes in teachers' knowledge and beliefs) and 3 (changes in teachers' practice) develop in parallel. This appears to be an effort to soften the implication that these outcomes evolve in a strictly linear fashion. Despite these changes, the model struggles to factor in the cyclical structure of teachers' collaborative continuous improvement and does not explain what a transfer process could entail. Given the omission of Guskey's (2000) outcome level 3 (organizational support and change), the model further neglects the impact teachers' continuous development might have on the organization they are embedded in, and also diminishes the organizations' role in providing the structures and systems necessary to uphold changes. Studies have shown repeatedly that administrative support and resources, such as time and space, can make or break a LS group's efforts (Godfrey et al., 2019; Groves et al., 2016; Lee & Tan, 2020; Lim et al., 2016).

As Boylan et al. (2018) note, models such as those by Clarke and Hollingsworth (2002) and Guskey (2002) - and as we argue also by Lipowsky and Rzejak (2015) - seem limited in their ability to explain the collaborative learning of teachers. At this point, we therefore turn to research on organizational groups and group effectiveness.

Similar to the field of education, research on group effectiveness makes frequent use of the I-P-O model, but has updated the model in order to better fit with the conceptualization of groups as complex and adaptive structures that evolve over time (Driskell et al., 2018; Mathieu et al., 2019). Specifically, there has been a shift in terminology, as the dimension of *process* tends to nowadays be referred to as *mediating mechanisms* (Ilgen et al., 2005). This shift was triggered by the argument that it is not only behavioral processes or acts that turn inputs into outputs, but also emergent cognitive and affective states (Marks et al., 2001). The term *mediating mechanisms* refers to both behavioral processes and emergent states that evolve as groups collaborate, such as group cohesion, trust, climate, and self-efficacy (Mathieu et al., 2019). A second shift in terminology responded to the challenge of conceptualizing dynamic developments along a linear and causal structure. Ilgen et al. (2005) explain that, in order to account for outputs as feedback loops that inform future inputs, an additional "I" (input) was added to the model, which resulted in the term IMOI-model. Further, the hyphens between letters were omitted to signal that "causal linkages may not be linear or additive, but rather nonlinear or conditional" (Ilgen et al., 2005).

These small changes in terminology significantly expand the scope and usability of the model. They also help to better understand existent models of LS that have addressed the dimension of mediating mechanisms. The versions of Lewis' model that include this dimension, for instance, appear to focus on cognitive and affective states, rather than processes. Lewis et al. (2009) note that intervening changes ensue as "community norms, tools, identity, and [teachers'] participation develop", while Lewis and Perry (2014) describe that teachers "assimilate and accommodate knowledge/ beliefs in response to materials, colleagues, students". In both cases, the model specifies dynamic properties of a group that emerge gradually. Other existent models concentrate on behavioral processes, such as the study of materials (Lewis, 2016; Norwich & Ylonen, 2013), observation and planning (Norwich & Ylonen, 2013), reflection (Bae et al., 2016; da Ponte et al., 2022; Norwich et al., 2016), or enactment (Bae et al., 2016; da Ponte et al., 2022; Norwich & Ylonen, 2013). The distinction between processes and emergent states therefore seems a viable solution to circumvent the limited ability of traditional PD models to account for collaborative and co-evolving aspects of learning (Boylan et al., 2018).

Turning to the dimension of outcomes, the IMOI-model offers two distinct advantages over the I-P-O model. First, the added "I" incorporates outcomes as future inputs in the very structure of the model. While this might not be the most elegant solution, and the visual structure of the model remains a linear line, it still signals the circularity of group processes and illustrates that each dimension, even input factors, develops and evolves over time.

Second, given that group effectiveness research is typically conducted in the context of industry or business organizations, outcomes tend to include participants' satisfaction and commitment, but also quality and efficiency of performance (Driskell et al., 2018; Mathieu & Gilson, 2012). Mathieu et al. (2019) classify these outcomes into two distinct types. They speak of tangible outputs or products, which include productivity (quantity), efficiency (quantity relative to a set goal), and quality (value or worth). These types of outcomes need some period of time to develop and grow, and allow for a certain quantification of a group's output (Mathieu et al., 2019).

Next, Mathieu et al. speak of influences on the individual participants as well as on the collective group. These include changes in participant's attitudes, knowledge, or behavior. On a collective level, Mathieu et al. (2019) list cohesion and psychological safety, which refer to experiences shared by the group. Both cohesion and psychological safety could also be conceptualized as emergent states along the dimension of mediating mechanisms, which emphasizes the temporal development of these categories and shows that the boarders between the IMOI dimensions are gradual and subject to definition (Mathieu et al., 2019).

Conceptualizing outcomes in terms of these two categories – tangible outcomes and influence on participants – makes it possible to evaluate LS from various perspectives. As Elliott (2019) points out, there is no straight-forward way to measuring the quality of LS outcomes and research, as quality-as-measured might differ from the quality-as-experienced by the LS participants. A LS model that makes the proposed distinction would allow to take both sides into account. Tangible outcomes, for instance, would include the number of LS cycles completed (productivity), the number of LS cycles completed in relation to a certain goal or project context (efficiency), and the quality of these cycles or value of produced materials and lesson plans (quality). Such a quantitative assessment might be valuable for a school or project group in order to assess and document progress, communicate their productivity to school boards or policy makers, and could be complemented by an analysis of outcomes in regard to the participants individual and collective reactions (i.e., participants' satisfaction with their LS work or changes in their attitudes, measured through e.g., surveys or pre- and post-tests).

In this section, we have drawn on several influential perspectives from outside the field of LS. We have discussed the importance of combining views of professional learning with classifications of learning outcomes, and we have explained how research on group effectiveness has addressed some of the gaps in current LS models. We will integrate these aspects in order to propose a conceptual model of continuous PD through LS.

A conceptual model of continuous professional development through lesson study

In the beginning of this paper, we derived that a shared model of LS should ideally be usable across cultural contexts and adaptations, provide a coherent description of input factors, processes, and various stages of outcomes, and be helpful for both researchers and practitioners to plan, implement, analyze, and evaluate LS. Based on the review and analysis of the wider literature, we now propose a model of LS that is an extension of current LS models and significantly advances the conceptualization of each of the I-P-O dimensions. We further update the structure of the model by using the IMOI framework, rather than the I-P-O framework, in order to include the circular structure of LS and differentiate between processes and mediating mechanisms. In the following, we describe each dimension (inputs, mediating mechanisms, outcomes and future inputs) and their component (Fig. 2).

Input

We suggest the differentiation of three groups of input factors. Compositional features address the LS group itself and include member attributes (e.g., experience, personalities), diversity (demographic characteristics), and faultlines (i.e., factors that split the group into potential subgroups, Mathieu et al., 2019). These aspects have been found to influence and predict group outcomes in studies on team effectiveness (Mathieu et al., 2019). Previous LS research also reports on several of these aspects as significant to a LS groups' work, i.e., members' teaching experience and LS experience and expertise (Bocala, 2015; Widjaja et al., 2017), their prior knowledge, attitudes, and beliefs (Bae et al., 2016; Norwich et al., 2016; Yoshida, 2012), their motivation and willingness to participate (Sjunnesson, 2020; Zhang, 2015), and hierarchical structures within groups (Chikamori et al., 2013; Lee & Madden, 2019). Compositional features therefore address who the individual teachers of a LS group are and how they find together as a team.

Turning to contextual features, the model includes the national, regional, and local school context of the LS group, the support they receive from their school, principal, or project leaders, the status LS has within the school, as well as the classroom context and available resources (i.e., time, space, qualitative materials, access to external expertise and LS facilitators). The crucial role of these input factors have been repeatedly highlighted in the LS literature (e.g., Lee & Tan, 2020; Lim-Ratnam et al., 2019; Seleznyov et al., 2021; Xu & Pedder, 2014; Yoshida, 2012).

As the third component of inputs, the model refers to the structural features of the PD, that is, the way in which LS was conducted. We identified this component (structural features of LS) as the most common starting point for existing LS models (Fig. 1). This component can also be visualized in terms of the typical circular LS model (e.g., Lewis 2009) that describes the core stages of study, plan, teach, and reflect. In our model, we suggest that three types of information are important in order to understand how a LS process is structured. The first concerns the specific type of LS that was adopted, such as Collaborative Lesson Research (e.g., Takahashi & McDougal, 2016), Research Lesson Study (e.g., Dudley et al., 2020), or Community-based Lesson Study (e.g., Yoshida et al., 2021). According to the type of LS, external experts or facilitators might assume diverging roles. The second type of information addresses the specific implementation of LS and its individual steps (i.e., How often did teachers meet? How was the planning stage conducted?). This feature is of interest to research, as the specific implementation of LS stages is likely to deviate even within a LS type. The third type of information relates to the LS materials that were used (e.g., handbook, observation protocols, etc.).

Mediating mechanisms

The next dimension concerns the means by which LS groups learn. Our model splits this dimension into processes and emergent states (Mathieu et al., 2019). Concerning processes, we have synthesized five processes that surface repeatedly across the LS literature and are also increasingly talked about in terms of "skills" teachers need to possess in order to conduct LS, or alternatively, develop through engaging in LS: collaborating, researching, teaching, observing, and reflecting. First, LS is a collaboration-based activity and requires teachers to establish a shared goal and vision, set up norms, and move forward as a group (e.g., Cammarata & Haley, 2018; Quaresma & Da Ponte, 2021). As teachers then conduct classroom research on their own practice, they need to develop research questions, hypothesize about findings, design lesson plans, and analyze observational data (e.g., Fernandez, 2002; Wolthuis

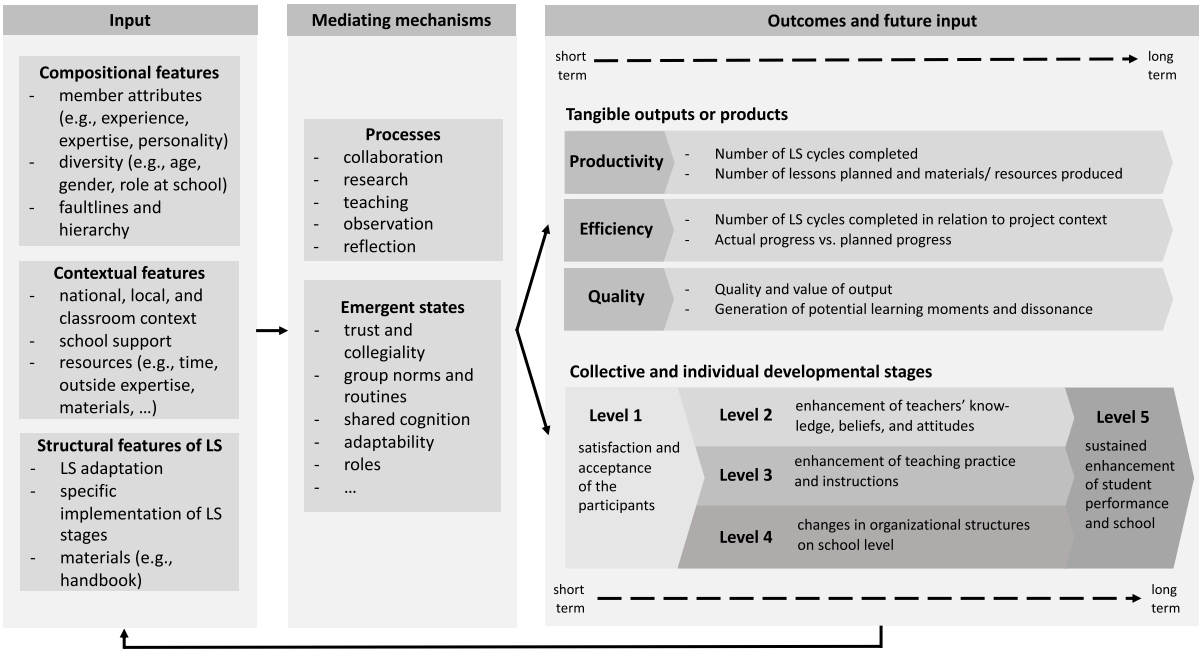

Fig. 2. A conceptual model of continuous professional development through lesson study.

et al., 2020). During this inquiry process, teachers conduct a systematic observation of student learning to produce data, which requires teachers to notice salient classroom events (e.g., Amador & Carter, 2018; Karlsen & Helgevold, 2019). Teachers also need to engage in critical and collaborative reflection at all stages of the LS process, and especially during the reflection stage (e.g., Callahan, 2019; Calleja & Formosa, 2020; Kager et al., 2022a; Mynott, 2019). This process is also frequently discussed in the LS literature in terms of "dialog" and "talk" (e.g., Warwick et al., 2016).

These processes are accompanied by, and give rise to, emergent states, that is, to dynamic group properties (Mathieu et al., 2019). Some emergent states, while not referred to as such, have already been highlighted in the literature. Khokhova (2018), for instance, talks about LS groups developing trust and a sense of collegiality, while others have discussed group norms and routines (Lewis et al., 2019), or the development of groups' orientation towards collaboration (e.g., Quaresma & Da Ponte, 2021; Skott & Møller, 2017). Mathieu et al. (2019) also list a group's shared cognition, adaptability, efficacy, and the development of roles for this dimension. While these aspects have not yet been widely documented in LS research, we hypothesize that they are also relevant to LS groups.

Outcomes and future inputs

In accordance with Mathieu et al. (2019), the model distinguishes between tangible outputs or products, and collective and individual developmental stages. Tangible outputs include three categories: the LS groups' productivity and efficiency, as well as the value or quality of their outputs and products. In this context, we use outputs to refer to new insights, ideas, or intentions that result from the LS work and exist in teachers' minds. Products, on the other hand, include concrete lesson plans, materials, and other resources developed or adapted by the LS group. A LS group's tangible outputs are not fixed in time, but they grow and progress each time that a team engages in a new LS cycle.

Turning to the developmental stages, we suggest to adopt Guskey's (2000) five levels as a heuristic to track how LS impact evolves. This is similar to Lipowsky and Rzejak (2015), however, we assume that levels 2, 3, and 4 (enhancement of teachers' knowledge, teaching practices, and changes in organizational structures) cannot be neatly separated into linear events. We instead hypothesize, as indicated in the model, that changes on these levels develop in a dynamic and parallel fashion. As LS groups finish a cycle, they develop their outcomes and then return to the starting point (input) for the next cycle. This starting point evolves with the group and will look slightly different for each cycle.

Through continuous cycles, LS groups grow their tangible outcomes and, ideally, proceed along the developmental stages. The model emphasizes that these stages might differ between individuals and as a group. Level 5 implies sustained changes in student performance. This is arguably the end-goal of every PD (Darling-Hammond et al., 2017), yet Seleznyov's (2019) review highlights that the majority of LS research has so far either neglected to examine this outcome level or investigated student outcomes after only one or two LS cycle. As Guskey and Yoon (2009) note, demonstrating a clear relationship between any PD and student improvement is a challenge that requires rigorous research designs and thoughtful planning. While the current model does not suggest concrete ways to measure LS' impact on students, it puts us into a better position to gather evidence by conceptualizing LS as an iterative and long-term PD that yields outcomes over time.

How to use the proposed model of lesson study

In a last step, we delineate several ways in which the model can be used in research and practice. Specifically, we suggest that the model serves as both a roadmap and a tool for analysis and evaluation (Table 1).

Concerning its' application in research, the model acts as a roadmap (Jaakkola, 2020) by describing LS's crucial components and assuming relationships between them. Specifically, we suggest that researchers can use the model as a shared point of reference when describing their specific LS work in research articles. The model does not presume a specific LS adaption, cultural context, or subject, but posits components (e.g., the component of structural features of LS, or the component of tangible outputs and products), which researchers can then formulate and specify according to their LS work. By embedding descriptions of LS in the conceptual model, we could ensure the conceptual coherence between research studies and work towards the use of a shared terminology (i.e., by speaking about trust as a dynamic property of LS groups and situating it within the dimension of mediating mechanisms). Further, the model's description of LS outcomes could support the discourse in the field on using appropriate and, importantly, comparable outcome LS measures in research (e.g., Cheung & Wong, 2014; Seleznyov, 2019). Lastly, given that the model is abstract and does not presume specific PD elements, it could also be used to conceptualize Learning Study (e.g., Cheng & Lo, 2013) or similar continuous improvement methods and therefore enables us to better connect research on LS with the wider research field on continuous PD.

Table 1
Recommendations for how the model and it's adapted version can be used.

	Examples for researchers	Examples for practitioners
Roadmap	to describe local LS adaptations and tie them to a shared framework	to introduce schools and teachers to LS and communicate its goals and scope
	to connect LS to the wider field and discourse on PD	to support early goal setting and realistic expectations
	to derive conceptual coherence and a shared terminology for the field	to keep track of LS work, e.g., by revisiting the model after each cycle
Tool	to situate existing research on a shared conceptual grid and derive new areas of research interest	to pinpoint areas in which the group wants or needs to make improvements
	to help explain findings of empirical research studies	to find answers to why certain outcomes have not yet been reached
	to identify and assess LS outcomes and stages of development	to communicate successes and needs to school boards or project leaders

The model acts as a tool (Boylan et al., 2018), insofar that it can guide the analysis of how teachers learn through LS and aid the interpretation of research findings. Specifically, the model assumes relations between the three dimensions and their components factors. These relations can help us to better understand how, for example, a LS cycle develops or why certain LS groups seem more efficient or satisfied than others. While these relations have been examined in previous LS literature (e.g., Kitada, 2022), they have not yet been extensively tested. Empirical research on team effectiveness, however, indicates that input factors can explain and even predict outcomes; for instance, team members' expertise or their sense of how safe and confident they feel in a team can predict team performance (Mathieu et al., 2019). The model we propose can thus act as a tool to identify similar relevant relations that should be further analyzed and tested.

As the model is general, rather than derived from inductive analysis or through the application of a specific theory, it can be combined with various theoretical lenses or methodologies that are commonly used in LS research, such as sociocultural theory (e.g., Vygotsky, 1986) or cultural historical activity theory (e.g., Edwards, 2007). At this point it is also important to note that the proposed model is not meant to replace existing models, but to extend them and be used in combination with them. The model's input component of structural features of LS, for instance, refers to the surfaces features of LS, which are illustrated in the classic model of a LS process in the form of a cycle (e.g., Lewis et al., 2006). Our model does not aim to replace this cyclical LS model, but can be used as an elaboration of the cycle that takes multiple additional

aspects of LS into account.

Turning to the model's application in practice, we share the view that LS is a teacher-led PD and as such, teachers need to be empowered in their role (e.g., Godfrey et al., 2019; Huang et al., 2016; Stigler & Hiebert, 2016). The adapted version of the model (Fig. 3), which poses questions and avoids overly technical language, can achieve this in several ways. First, the model can support schools and teachers new to LS in understanding the scope of continuous improvement and developing realistic expectations concerning its outcomes. Clear goals from the onset further enable teachers to make visible their successes early on, which can provide encouragement to continue (Guskey, 2021). Likewise, the model can act as an initial how-to guide for project leaders or schools in regard to planning LS cycles and establishing short- and long-term goals, but also in finding together as a group and making space and time for LS work. This way, the model acts as a roadmap that accompanies LS groups from the beginning on.

We further suggest that the model can act as tool of analysis and evaluation guideline, allowing teachers to pinpoint or predict potential weaknesses in their own LS work. The idea is to provide teachers with a structure and language that supports them in voicing their own ideas about how LS can work for them, and which aspects need to be tweaked in order for LS to yield useful results. Darling-Hammond et al. (2017) emphasize the importance of credible means for teachers to evaluate their PD work. If practitioners know how to identify conditions needed to improve their outcomes, such as time, space, or additional expertise, this could support their communication of these needs to school boards, administrations, or policy makers (Darling-Hammond et al. 2017). For example, a group may find that they are productive and efficient in their LS work, but generally do not produce new insights or materials, thus doubting the value of LS. By systematically considering the various components of the model, the group could try to identify potential causes and solutions, i.e., they might require additional training in classroom observation, or additional study materials to develop qualitative lesson plans.

Conclusion, unresolved questions, and implications

The LS literature has grown and matured significantly in the past few decades. It has been pointed out that, for the field to move forward and engage in a coherent dialog across the globe, a stronger theorization of LS and a shared conceptual framework are needed (e.g., Cheung & Wong, 2014; Stigler & Hiebert, 2016, Kager et al., 2022b). In this paper, we have proposed a theory-informed model that can serve as such a conceptual framework. The model advances existent LS models by adopting an IMOI-structure and outlining concrete inputs, mediating mechanisms, and two types of outcomes that develop over time. As Bryk (2015) notes, replacing PD programs with something new as soon as they seem ineffective is often just a short-term solution. Focusing instead on understanding how a PD works and why it does not yield the desired results is more likely to lead to continuous and long-lasting progress (Bryk, 2015). We consider the proposed model a crucial step towards viewing LS through the lens of improvement science, as it helps to increase our understanding of how to continuously improve various aspects of LS within a shared conceptual reference frame.

The proposed model nevertheless comes with limitations. Some issues remain unresolved, namely the question of how we can distinguish between inputs, mediating mechanisms and outcomes, how outcomes can be assessed in practice, and the model's empirical application.

The difficulty of placing certain factors within a specific dimension of the model is best illustrated by the example of (outside) expertise. Outside experts or LS facilitators could be reasonably placed within all dimensions and even within all three groups of input factors. For instance, expertise can be considered a compositional feature (i.e., a team members expertise and experience in facilitating LS), a contextual feature (i.e., the school's ability to organize external support), or a structural feature of LS (i.e., the specific role that an external expert assumes based on the type of LS and its concrete implementation). Facilitation could also be placed within the dimension of mediating mechanisms, if we consider it an additional process that supports teachers' learning. Lastly, expertise and knowledge of how to facilitate a LS team can also be viewed as a relevant outcome of LS.

We therefore highlight that, despite bridging some gaps, the

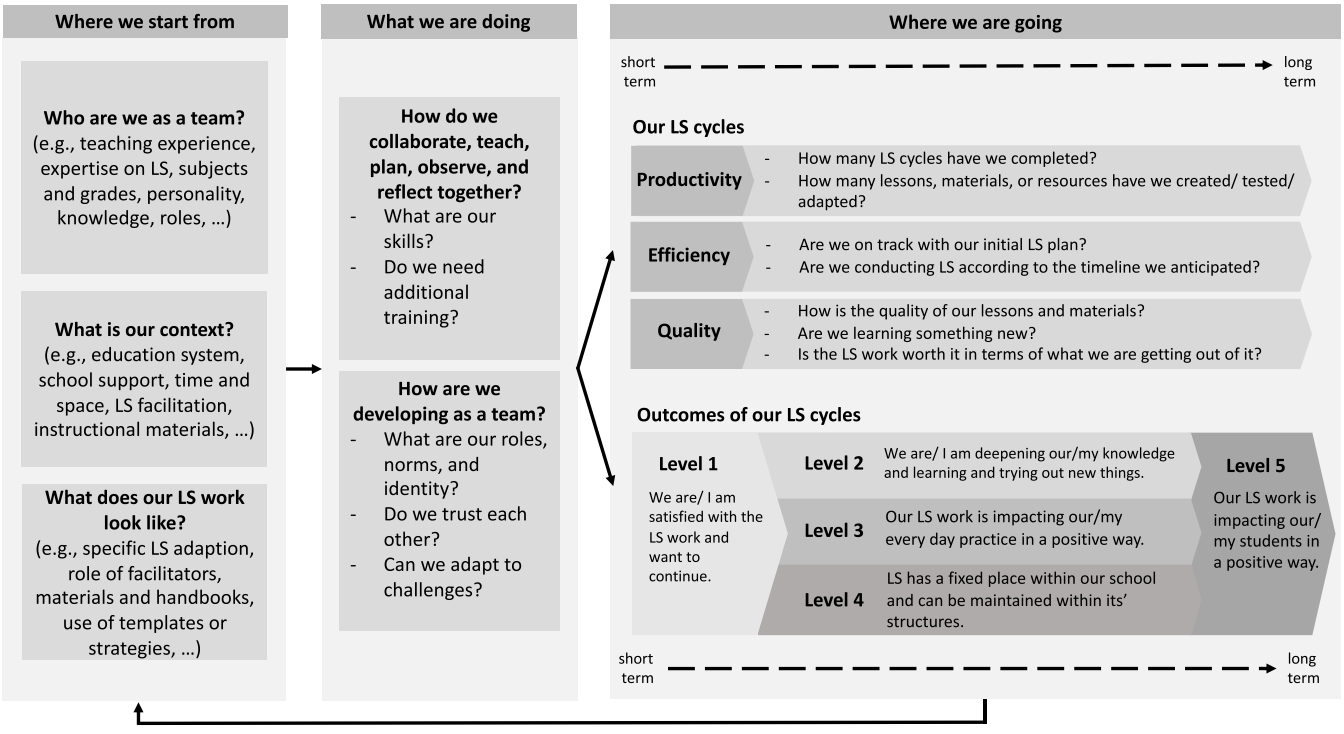

Fig. 3. Adapted version of the lesson study model for teachers' own assessment of their lesson study work.

proposed model cannot yet provide answers to all questions. As a model, it remains an abstraction of the actual LS process. We argue, however, that the model offers a starting point for further research into the nuances of outside expertise and facilitation in LS, a topic that is currently still ambiguous in the research literature (Mynott and Michel, 2022).

Another issue connected to this problem addresses the question of when a learning process becomes an outcome. Given that our model conceptualizes continuous PD through LS, we argue that outcomes are not final, but simply represent a certain stage in a dynamic continuous learning process. This means that a LS team can set their own goals for their LS work and evaluate their progress at selected stages in the process. The model aims to support this continuous evaluation by conceptualizing outcomes of a LS process that serve as inputs for the subsequent process.

Second, the model does not specify ways in which outcomes can be assessed, as this would be beyond the scope of this paper. We point, however, towards literature that has suggested various approaches to the assessment of PD and LS (Dudley et al., 2019; Godfrey et al., 2019; Guskey, 2000; Kennedy, 2005; Seleznyov, 2019), and suggest to explore ways in which they can inform LS research. We also argue that a stronger theorization of the individual processes included in the model can support the development of LS evaluation tools. For instance, different theoretical frameworks, such as dialog and talk (e.g., Karlsen & Helgevold, 2019; Warwick et al., 2016), cognitive conflict (e.g., Calleja & Formosa, 2020; Mynott, 2019), or reflective stages (e.g., Kager et al., 2022a) have been used to explain and analyze how teachers reflect critically in LS. Karlsen and Helgevold (2019) and Mynott (2019) effectively demonstrate that collaborative talk in LS does not guarantee that reflection will take place, but without the dialogic component reflection is unlikely to develop. As Kager et al. (2022a) note, a deeper understanding of reflection is needed in the LS literature and a further exploration of these theoretical frameworks could be an avenue to better understand certain aspects of the model, such as processes and their quality, as well as the outcome category quality of tangible outputs.

Third, the model is, at this point, purely conceptual and has not yet been applied to research or real-life settings. We have put forward concrete recommendations for its usage and encourage to apply and test it rigorously across contexts. We view theorization as an iterative process (Davidoff et al., 2015; Weick, 1989) and thus conclude with the remark that the proposed model should be continually revised based on new empirical insights and optimized over time so that it can best serve the research community as a shared roadmap and tool of analysis and evaluation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This research has been funded by the BMBF (Bundesministerium für Bildung und Forschung, Berlin, Germany).

References

Adamson, B., & Walker, E. (2011). Messy collaboration: Learning from a learning study. *Teaching and Teacher Education, 27*(1), 29–36. https://doi.org/10.1016/j.tate.2010.06.024

Akiba, M., Murata, A., Howard, C. C., & Wilkinson, B. (2019). Lesson study design features for supporting collaborative teacher learning. *Teaching and Teacher Education, 77*, 352–365. https://doi.org/10.1016/j.tate.2018.10.012

Amador, J. M., & Carter, I. S. (2018). Audible conversational affordances and constraints of verbalizing professional noticing during prospective teacher Lesson Study. *Journal of Mathematics Teacher Education, 21*(1), 5–34. https://doi.org/10.1007/s10857-016-9347-x

Arani, M., Matoba, M., Crawford, K., & Arani, M. R. S. (2006). Transnational learning: The integration of Jugyou Kenkyuu into Iranian teacher training. *Lesson study: International perspective on policy and practice* (pp. 37–75). Educational Science Publishing House.

Bae, L. C., Hayes, K. N., Seitz, J., O'Connor, D., & DiStefano, R. (2016). A coding tool for examining the substance of teacher professional learning and change with example cases from middle school science lesson study. *Teaching and Teacher Education, 60*, 164–178. https://doi.org/10.1016/j.tate.2016.08.016

Bjuland, R., & Mosvold, R. (2015). Lesson study in teacher education: Learning from a challenging case. *Teaching and Teacher Education, 52*, 83–90. https://doi.org/10.1016/j.tate.2015.09.005

Bocala, C. (2015). From experience to expertise: The development of teachers' learning in Lesson Study. *Journal of Teacher Education, 66*(4), 349–362. https://doi.org/10.1177/0022487115592032

Borko, H., Jacobs, J., Koellner, K., Peterson, P., Baker, E., & McGaw, B. (2010). Contemporary approaches to teacher professional development. *International encyclopedia of education* (pp. 548–556). Elsevir. Volume 7.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15. https://doi.org/10.3102/0013189X033008003

Boylan, M., Coldwell, M., Maxwell, B., & Jordan, J. (2018). Rethinking models of professional learning as tools: A conceptual analysis to inform research and practice. *Professional Development in Education, 44*(1), 120–139. https://doi.org/10.1080/19415257.2017.1306789

Bryk, A. S. (2015). 2014 AERA Distinguished lecture: Accelerating how we learn to improve. *Educational Researcher, 44*(9), 467–477. https://doi.org/10.3102/0013189X15621543

Cajkler, W., Wood, P., Norton, J., & Pedder, D. (2013). Lesson Study: Towards a collaborative approach to learning in Initial Teacher Education? *Cambridge Journal of Education, 43*(4), 537–554. https://doi.org/10.1080/0305764X.2013.834037

Callahan, C. (2019). Middle school geography teachers' professional development centered around historical photographs. *Journal of Social Studies Research, 43*(4), 375–388. https://doi.org/10.1016/j.jssr.2018.11.003

Calleja, J., & Formosa, L. (2020). Teacher change through cognitive conflicts: The case of an art lesson study. *International Journal for Lesson & Learning Studies, 9*(4), 383–395. https://doi.org/10.1108/IJLLS-05-2020-0028

Cammarata, L., & Haley, C. (2018). Integrated content, language, and literacy instruction in a Canadian French immersion context: A professional development journey. *International Journal of Bilingual Education and Bilingualism, 21*(3), 332–348. https://doi.org/10.1080/13670050.2017.1386617

Canonigo, A. M. (2016). Using a non-coercive process to engage mathematics teachers in lesson study. *International Journal for Lesson and Learning Studies, 5*(4), 329–347. https://doi.org/10.1108/IJLLS-02-2016-0004

Celik, A. O., & Guzel, E. B. (2020). How to improve a mathematics teacher's ways of triggering and considering divergent thoughts through Lesson Study. *International Electronic Journal of Mathematics Education*, (3), 15. https://doi.org/10.29333/iejme/8461

Cheng, E. C. K., & Lo, M. L. (2013). *Learning study: Its origins, operationalisation, and implications. OECD education working papers No. 94*. Paris: OECD Publishing. https://doi.org/10.1787/5k3wjp0s959p-en

Cheung, W., & Wong, W. (2014). Does lesson study work?: A systematic review on the effects of lesson study and learning study on teachers and students. *International Journal for Lesson and Learning Studies, 3*(2), 137–149. https://doi.org/10.1108/IJLLS-05-2013-0024

Chikamori, K., Ono, Y., & Rogan, J. (2013). A Lesson Study approach to improving a biology lesson. *African Journal of Research in Mathematics, Science and Technology Education, 17*(1–2), 14–25. https://doi.org/10.1080/10288457.2013.826967

Chua, V. (2019). Going the distance: A lesson study on deriving the distance formula. *International Journal for Lesson and Learning Studies, 8*(2), 149–159. https://doi.org/10.1108/IJLLS-08-2018-0052

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*(8), 947–967. https://doi.org/10.1016/S0742-051X(02)00053-7

Coenders, F., & Verhoef, N. (2019). Lesson Study: Professional development (PD) for beginning and experienced teachers. *Professional Development in Education, 45*(2), 217–230. https://doi.org/10.1080/19415257.2018.1430050

Da Ponte, J. P., Quaresma, M., & Mata-Pereira, J (2022). Teachers' learning in lesson study: Insights provided by a modified version of the interconnected model of teacher professional growth. *ZDM Mathematics Education, 14*. https://doi.org/10.1007/s11858-022-01367-1

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. https://learningpolicyinstitute.org/product/teacher-prof-dev.

Davidoff, F., Dixon-Woods, M., Leviton, L., & Michie, S. (2015). Demystifying theory and its use in improvement. *BMJ Quality & Safety, 24*(3), 228–238. https://doi.org/10.1136/bmjqs-2014-003627

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher, 38*(3), 181–199. https://doi.org/10.3102/0013189X08331140

Dick, L. K., Appelgate, M. H., Gupta, D., & Soto, M. M. (2022). Continuous improvement lesson study: A model of MTE professional development. *Mathematics Teacher Educator, 10*(2), 19. https://doi.org/10.5951/MTE.2020.0077

Driskell, J. E., Salas, E., & Driskell, T. (2018). Foundations of teamwork and collaboration. *American Psychologist, 73*(4), 334–348. https://doi.org/10.1037/amp0000241

Dudley, P., Xu, H., Vermunt, J. D., & Lang, J. (2019). Empirical evidence of the impact of lesson study on students' achievement, teachers' professional learning and on

institutional and system evolution. *European Journal of Education, 54*(2), 202–217. https://doi.org/10.1111/ejed.12337
Dudley, P., Pratt, M., Gilbert, C., Abbey, J., Lang, J., & Bruckdorfer, H. (2020). Cross-school 'close-to-practice' action research, system leadership and local civic partnership re-engineering an inner-city learning community. *London Review of Education, 18*(3), 390–407. https://doi.org/10.14324/LRE.18.3.05
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, 34*, 107–121. https://doi.org/10.1016/j.tate.2013.04.006
Edwards, A. (2007). Relational agency in professional practice: A CHAT analysis. *Actio: An International Journal of Human Activity Theory, 1*(3), 1–17. http://hdl.handle.net/10112/7572.
Elliott, J. (2012). Developing a science of teaching through lesson study. *International Journal for Lesson and Learning Studies, 1*(2), 108–125. https://doi.org/10.1108/20468251211224163
Elliott, J. (2019). Quality criteria for lesson and learning studies as forms of action research. *International Journal for Lesson and Learning Studies, 9*(1), 11–17. https://doi.org/10.1108/IJLLS-02-2019-0018
Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53*(5), 393–405. https://doi.org/10.1177/0022487102237394
Festinger, L. (1962). Cognitive dissonance. *Scientific American, 207*(4), 93–106. https://doi.org/10.2307/24936719
Fujii, T. (2014). Implementing Japanese lesson study in foreign countries: Misconceptions revealed. *Mathematics Teacher Education and Development, 6*(1), 65–83. https://doi.org/10.3316/aeipt.205654
Godfrey, D., Seleznyov, S., Anders, J., Wollaston, N., & Barrera-Pedemonte, F. (2019). A developmental evaluation approach to lesson study: Exploring the impact of Lesson Study in London schools. *Professional Development in Education, 45*(2), 325–340. https://doi.org/10.1080/19415257.2018.1474488
Groves, S., Doig, B., Vale, C., & Widjaja, W. (2016). Critical factors in the adaptation and implementation of Japanese lesson study in the Australian context. *ZDM: The International Journal on Mathematics Education, 48*(4), 501–512. https://doi.org/10.1007/s11858-016-0786-8
Guskey, T. R., & Yoon, K. S. (2009). What works in professional development? *Phi Delta Kappan, 7*, 495–500. https://doi.org/10.1177/003172170909000709
Guskey, T. R. (2000). *Evaluating professional development.* Corwin Press.
Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching, 8*(3), 381–391. https://doi.org/10.1080/135406002100000512
Guskey, T. R. (2009). Closing the knowledge gap on effective professional development. *Educational Horizons, 87*(4), 224–233. https://www.jstor.org/stable/42923773.
Guskey, T. R. (2021). Professional learning with staying power. *Educational Leadership, 78*(5), 54–59. https://uknowledge.uky.edu/edp_facpub/52.
Gutierez, S. B. (2016). Building a classroom-based professional learning community through lesson study: Insights from elementary school science teachers. *Professional Development in Education, 42*(5), 801–817. https://doi.org/10.1080/19415257.2015.1119709
Hackman, J. R., & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. *Advances in Experimental Social Psychology, 8*, 45–99. https://doi.org/10.1016/S0065-2601(08)60248-8
Hackman, J. R. (2012). From causes to conditions in group research: Causes and conditions. *Journal of Organizational Behavior, 33*(3), 428–444. https://doi.org/10.1002/job.1774
Hadfield, M., & Jopling, M. (2016). Problematizing lesson study and its impacts: Studying a highly contextualised approach to professional learning. *Teaching and Teacher Education, 60*, 203–214. https://doi.org/10.1016/j.tate.2016.08.001
Hargreaves, E. (2005). Assessment for learning? Thinking outside the (black) box. *Cambridge Journal of Education, 35*(2), 213–224. https://doi.org/10.1080/03057640500146880
Huang, R., Gong, Z., & Han, X. (2016). Implementing mathematics teaching that promotes students' understanding through theory-driven Lesson Study. *ZDM: The International Journal on Mathematics Education, 48*(4), 425–439. https://doi.org/10.1007/s11858-015-0743-y
Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual Review of Psychology, 56*(1), 517–543. https://doi.org/10.1146/annurev.psych.56.091103.070250
Isoda, M., Inprasitha, M., Isoda, M., Wang-Inverson, P., & Yeap, B. H. (2015). The science of lesson study in the problem solving approach. *Lesson study: Challenges in mathematics education* (pp. 81–108). World Scientific. https://doi.org/10.1142/9789812835420_0006
Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review, 10*(1–2), 18–26. https://doi.org/10.1007/s13162-020-00161-0
Joubert, J., Callaghan, R., & Engelbrecht, J. (2020). Lesson Study in a blended approach to support isolated teachers in teaching with technology. *ZDM: The International Journal on Mathematics Education, 52*(5), 907–925. https://doi.org/10.1007/s11858-020-01161-x
Kager, K., Jurczok, A., Bolli, S., & Vock, M. (2022a). We were thinking too much like adults": Examining the development of teachers' critical and collaborative reflection in lesson study discussions. *Teaching and Teacher Education, 113*(103683), 1–13. https://doi.org/10.1016/j.tate.2022.103683
Kager, K., Kalinowski, E., Jurczok, A., Vock, M. (2022b). A systematic review of transparency in lesson study research: How do we report on the observation and reflection stages? Manuscript submitted for publication.
Karlsen, A., & Helgevold, N. (2019). Lesson Study: Analytic stance and depth of noticing in post-lesson discussions. *International Journal for Lesson and Learning Studies, 8*(4), 290–304. https://doi.org/10.1108/IJLLS-04-2019-0034
Kennedy, A. (2005). Models of continuing professional development: A framework for analysis. *Journal of In-Service Education, 31*(2), 235–250. https://doi.org/10.1080/13674580500200277
Khokhotva, O. (2018). Lesson study in Kazakhstan: Case study of benefits and barriers for teachers. *International Journal for Lesson and Learning Studies, 7*(4), 250–262. https://doi.org/10.1108/IJLLS-04-2018-0021
King, F. (2014). Evaluating the impact of teacher professional development: An evidence-based framework. *Professional Development in Education, 40*(1), 89–111. https://doi.org/10.1080/19415257.2013.823099
Kitada, Y. (2022). Teacher agency in the modification of Japanese lesson study in the United States. *Educational Studies in Japan, 16*(0), 45–57. https://doi.org/10.7571/esjkyoiku.16.45
Korthagen, F. (2016). Inconvenient truths about teacher learning: Towards professional development 3.0. *Teachers and Teaching*, 1–19. https://doi.org/10.1080/13540602.2016.1211523
Larssen, D., Cajkler, W., Mosvold, R., Bjuland, R., Helgevold, N., Fauskanger, J., et al. (2018). A literature review of lesson study in initial teacher education: Perspectives about learning and observation. *International Journal for Lesson and Learning Studies, 7*(1), 8–22. https://doi.org/10.1108/IJLLS-06-2017-0030
Lee, V., & Madden, M. (2019). We're in this together": Principals and teachers as partners and learners in lesson study. *NASSP Bulletin, 103*(1), 51–64. https://doi.org/10.1177/0192636519826717
Lee, L., & Tan, S. (2020). Teacher learning in Lesson Study: Affordances, disturbances, contradictions, and implications. *Teaching and Teacher Education, 89*, Article 102986. https://doi.org/10.1016/j.tate.2019.102986
Lewis, C., & Perry, R. (2014). Lesson study with mathematical resources: A sustainable model for locally-led teacher professional learning. *Mathematics Teacher Education and Development, 16*(1), 22–42. https://doi.org/10.3316/aeipt.205652
Lewis, C., & Perry, R. (2017). Lesson Study to scale up research-based knowledge: A randomized, controlled trial of fractions learning. *Journal for Research in Mathematics Education, 48*(3), 261–299. https://doi.org/10.5951/jresematheduc.48.3.0261
Lewis, C., Perry, R., Hurd, J., & O'Connell, M. P (2006a). Lesson study comes of age in North America. *Phi Delta Kappan, 88*(4), 273–281. https://doi.org/10.1177/003172170608800406
Lewis, C., Perry, R., & Murata, A. (2006b). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher, 35*(3), 3–14. https://doi.org/10.3102/0013189X035003003
Lewis, C., Perry, 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. https://doi.org/10.1007/s10857-009-9102-7
Lewis, J. M., Fischman, D., Riggs, I., & Wasserman, K. (2013). Teacher learning in lesson study. *The Mathematics Enthusiast, 10*(3), 538–619. https://scholarworks.umt.edu/tme/vol10/iss3/5.
Lewis, C., Friedkin, S., Emerson, K., Henn, L., Goldsmith, L., Huang, R., Takahashi, A., & da Ponte, J. P. (2019). How does lesson study work? Toward a theory of lesson study process and impact. *Theory and practice of lesson study in mathematics* (pp. 13–37). Springer International Publishing. https://doi.org/10.1007/978-3-030-04031-4_2
Lewis, C. (2009). What is the nature of knowledge development in lesson study? *Educational Action Research, 17*(1), 95–110. https://doi.org/10.1080/09650790802667477
Lewis, C. (2015). What is improvement science? Do we need it in education? *Educational Researcher, 44*(1), 54–61. https://doi.org/10.3102/0013189X15570388
Lewis, C. (2016). How does lesson study improve mathematics instruction? *ZDM: the international journal on mathematics education, 48*(4), 571–580. https://doi.org/10.1007/s11858-016-0792-x
Lim, C. S., Kor, L. K., & Chia, H. M. (2016). Revitalising mathematics classroom teaching through lesson study (LS): A malaysian case study. *ZDM: The International Journal on Mathematics Education, 48*(4), 485–499. https://doi.org/10.1007/s11858-016-0779-7
Lim-Ratnam, C. T. L., Lee, C. K. E., Jiang, H., & Sudarshan, A. (2019). Lost in adaptation? Issues of adapting Japanese lesson study in non-Japanese contexts. *Educational Research for Policy and Practice, 18*(3), 263–278. https://doi.org/10.1007/s10671-019-09247-4
Lipowsky, F., & Rzejak, D. (2015). Key features of effective professional development programmes for teachers. *Ricercazione, 7*(2), 27–51.
Lipowsky, F., Terhart, E., Bennewitz, H., & Rothland, M. (2014). Theoretische Perspektiven und empirische Befunde zur Wirksamkeit von Lehrerfortund -weiterbildung [Theoretical perspectives and empirical findings on the effectiveness of teacher professional development]. *Handbuch der forschung zum lehrerberuf* (2nd ed., pp. 511–541). Waxmann.
Marks, M. A., Mathieu, J. E., & Zaccaro, S. (2001). A temporally based framework and taxonomy of team processes. *The Academy of Management Review, 26*(3), 356–376. https://www.jstor.org/stable/259182.
Mathieu, J. E., Gilson, L. L., & Kozlowski, S. W. (2012). Criteria issues and team effectiveness. Ed.. *The Oxford handbook of organizational psychology (Volume 2)* USA: OUP. https://doi.org/10.1093/oxfordhb/9780199928286.013.0027
Mathieu, J. E., Gallagher, P. T., Domingo, M. A., & Klock, E. A. (2019). Embracing complexity: Reviewing the past decade of team effectiveness research. *Annual Review of Organizational Psychology and Organizational Behavior, 6*(1), 17–46. https://doi.org/10.1146/annurev-orgpsych-012218-015106
Moss, J., Hawes, Z., Naqvi, S., & Caswell, B. (2015). Adapting Japanese lesson study to enhance the teaching and learning of geometry and spatial reasoning in early years

classrooms: A case study. *ZDM: The International Journal on Mathematics Education, 47*(3), 377–390. https://doi.org/10.1007/s11858-015-0679-2
Murata, A., Hart, L. C., Alston, A. S., & Murata, A. (2011). Introduction: Conceptual overview of Lesson Study. *Lesson study research and practice in mathematics education* (pp. 1–12). Netherlands: Springer. https://doi.org/10.1007/978-90-481-9941-9_1
Mynott, J. P., & Michel, D. (2022). The invisible leader: Facilitation in lesson study. *Educational Process International Journal, 11*(3), 48–61. https://doi.org/10.22521/edupij.2022.113.3
Mynott, J. P. (2019). Lesson study outcomes: A theoretical model. *International Journal for Lesson and Learning Studies, 8*(2), 117–134. https://doi.org/10.1108/IJLLS-08-2018-0057
Norwich, B., & Ylonen, A. (2013). Design based research to develop the teaching of pupils with moderate learning difficulties (MLD): Evaluating lesson study in terms of pupil, teacher and school outcomes. *Teaching and Teacher Education, 34*, 162–173. https://doi.org/10.1016/j.tate.2013.04.012
Norwich, B., & Ylonen, A. (2015). A design-based trial of lesson study for assessment purposes: Evaluating a new classroom based dynamic assessment approach. *European Journal of Special Needs Education, 30*(2), 253–273. https://doi.org/10.1080/08856257.2015.1009702
Norwich, B., Koutsouris, G., Fujita, T., Ralph, T., Adlam, A., & Milton, F. (2016). Exploring knowledge bridging and translation in lesson study using an inter-professional team. *International Journal for Lesson and Learning Studies, 5*(3), 180–195. https://doi.org/10.1108/IJLLS-02-2016-0006
Opfer, V. D., & Pedder, D. (2011). Conceptualizing teacher professional learning. *Review of Educational Research, 81*(3), 376–407. https://doi.org/10.3102/0034654311413609
Quaresma, M., & Da Ponte, J. P. (2021). Developing collaborative relationships in lesson study. *PNA. Revista de Investigación En Didáctica de La Matemática, 15*(2), 93–107. https://doi.org/10.30827/pna.v15i2.16487
Schipper, T., Goei, S. L., de Vries, S., & van Veen, K. (2017). Professional growth in adaptive teaching competence as a result of lesson study. *Teaching and Teacher Education, 68*, 289–303. https://doi.org/10.1016/j.tate.2017.09.015
Schipper, T. M., de Vries, S., Goei, S. L., & van Veen, K. (2020). Promoting a professional school culture through lesson study? An examination of school culture, school conditions, and teacher self-efficacy. *Professional Development in Education, 46*(1), 112–129. https://doi.org/10.1080/19415257.2019.1634627
Seleznyov, S., Goei, S. L., & Ehren, M. (2021). International policy borrowing and the case of Japanese lesson study: Culture and its impact on implementation and adaptation. *Professional Development in Education*, 1–15. https://doi.org/10.1080/19415257.2021.1973069
Seleznyov, S. (2018). Lesson study: An exploration of its translation beyond Japan. *International Journal for Lesson and Learning Studies, 7*(3), 217–229. https://doi.org/10.1108/IJLLS-04-2018-0020
Seleznyov, S. (2019). Lesson study beyond Japan: Evaluating impact. *International Journal for Lesson and Learning Studies, 8*(1), 2–18. https://doi.org/10.1108/IJLLS-09-2018-0061
Sjunnesson, H. (2020). Initializing phase of lesson study: Communication a special didactic tool in mathematics. *International Journal for Lesson and Learning Studies, 9*(3), 261–275. https://doi.org/10.1108/IJLLS-02-2020-0007
Skott, C. K., & Møller, H. (2017). The individual teacher in lesson study collaboration. *International Journal for Lesson and Learning Studies, 6*(3), 216–232. https://doi.org/10.1108/IJLLS-10-2016-0041
Stake, R., Schwandt, T., Shaw, I., Mark, M., & Greene, J. (2006). On discerning quality in evaluation. *Handbook of evaluation* (pp. 405–418). SAGE Publications Ltd. https://doi.org/10.4135/9781848608078.n18
Stigler, J. W., & Hiebert, J. (2016). Lesson Study, improvement, and the importing of cultural routines. *ZDM: The International Journal on Mathematics Education, 48*(4), 581–587. https://doi.org/10.1007/s11858-016-0787-7
Takahashi, A., & McDougal, T. (2016). Collaborative lesson research: Maximizing the impact of lesson study. *ZDM : the international journal on mathematics education, 48*(4), 513–526. https://doi.org/10.1007/s11858-015-0752-x
Vanblaere, B., Devos, G., Beverborg, O. G., Feldhoff, T., Maag Merki, K., & Radisch, F. (2021). Learning in collaboration: Exploring processes and outcomes. *Concept and design developments in school improvement research: Longitudinal, multilevel and mixed methods and their relevance for educational accountability* (pp. 197–218). Springer International Publishing.
Vrikki, M., Warwick, P., Vermunt, J. D., Mercer, N., & Van Halem, N. (2017). Teacher learning in the context of lesson study: A video-based analysis of teacher discussions. *Teaching and Teacher Education, 61*, 211–224. https://doi.org/10.1016/j.tate.2016.10.014
Vygotsky, L. S. (1986). *Thought and language*. Massachusetts Institute of Technology.
Warwick, P., Vrikki, M., Vermunt, J. D., Mercer, N., & van Halem, N. (2016). Connecting observations of student and teacher learning: An examination of dialogic processes in Lesson Study discussions in mathematics. *ZDM : The International Journal on Mathematics Education, 48*(4), 555–569. https://doi.org/10.1007/s11858-015-0750-z
Watanabe, T., Takahashi, A., & Barham, A. I. (2019). Implementing school-wide collaborative lesson research in Qatar. *Journal of Institutional Research South East Asia, 17*(2), 47–70. http://www.seaairweb.info/journal/articles/JIRSEA_v17_n02/JIRSEA_v17_n02_All.pdf#page=58.
Weick, K. E. (1989). Theory construction as disciplined imagination. *Academy of Management Review, 14*, 516–531. https://doi.org/10.5465/amr.1989.4308376
Widjaja, W., Vale, C., Groves, S., & Doig, B. (2017). Teachers' professional growth through engagement with lesson study. *Journal of Mathematics Teacher Education, 20*(4), 357–383. https://doi.org/10.1007/s10857-015-9341-8
Wolthuis, F., Hubers, M. D., de Vries, S., & van Veen, K. (2020). More than mundane matters: An exploration of how schools organize professional learning teams. *International Journal of Leadership in Education*. https://doi.org/10.1080/13603124.2020.1790668
Xu, H., Pedder, D. (2014). Lesson Study: An international review of the research. In Lesson study: Professional learning for our time. 10.4324/9780203795538.
Ylonen, A., & Norwich, B. (2013). Professional learning of teachers through a lesson study process in England: Contexts, mechanisms and outcomes. *International Journal for Lesson and Learning Studies, 2*(2), 137–154. https://doi.org/10.1108/20468251311323388
Yoshida, N., Sugita, H., Kumai, S., Fukuda, A., Kim, J., Yoshida, N., Iwata, S., & Kawaguchi, H. (2021). Lesson study with multiple stakeholder: Community-based Lesson study. *Lesson study-based teacher education: The potential of the japanese appraoch in global settings* (pp. 183–198). Routledge.
Yoshida, M. (2012). Mathematics lesson study in the United States: Current status and ideas for conducting high quality and effective lesson study. *International Journal for Lesson and Learning Studies, 1*(2), 140–152. https://doi.org/10.1108/20468251211224181
Zhang, Y. (2015). Sustaining Lesson Study in schools with positive peer leadership: A case study in Hong Kong. *International Journal for Lesson and Learning Studies, 4*(2), 140–154. https://doi.org/10.1108/IJLLS-07-2014-0018