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In lesson studies carried out in Western countries, a key role is played by the facilitator, who organizes and leads the entire process. Despite the contributions regarding this issue provided in the literature, the knowledge about the preparation that facilitators need and the challenges that they face in their activity is still fragmented. Thus, the aim of this communication is to present a systematic literature review on the role of the facilitator in lesson studies in mathematics, identifying and synthesizing the necessary skills and knowledge and the challenges faced by facilitators and suggesting directions for future research.

Keywords: Lesson study facilitator, knowledge, skills, challenges.

Introduction

Lesson study (LS) is a collaborative and reflective professional development process focused on improving student learning. In a LS, a group of teachers works in cycles of planning, teaching and observing a research lesson, and reflecting on this lesson. In the lesson studies carried out in Japan, the so-called "knowledgeable other" plays an important role, as an external expert who, in most cases, intervenes mainly in post-lesson reflection in order to enlarge and deepen the participants' understandings about students learning. In lesson studies carried out in Western countries, another figure tends to assume a key role, the facilitator, who is responsible for organizing and leading the entire process (Hourigan & Leavy, 2021; Huang et al., 2021; Lewis, 2016).

Recent studies indicate that the role of this facilitator is complex and underline its relevance in structuring LS and leading its sessions (Hourigan & Leavy, 2021; Lewis, 2016; Mynott & Michel, 2022). This facilitator "must be strong enough to guide, yet invisible enough to give participants agency to determine their learning" (Mynott & Michel, 2022, p. 57). To perform these functions, the facilitator needs to understand the many facets of school life and teaching, have knowledge about LS, and a broad and deep mathematical and didactic knowledge to be able to guide teachers in a process of collaborative learning and continuous improvement (Hourigan & Leavy, 2021; Lewis, 2016).

Despite the various contributions on the facilitators' role in LS provided in the literature, the knowledge about the preparation necessary and the challenges they face in their activity is still fragmented (Moeller et al., 2022; Mynott & Michel, 2022). A systematic review of the literature therefore can help to provide a clearer and more articulated view of the various facets of the facilitator's role in a LS. Thus, the aim of this review is to synthesize the existing literature on the role of the facilitator in LS in mathematics, seeking to identify what this literature says about the

necessary skills and knowledge and challenges faced by facilitators in LS and to suggest directions for future research.

Methods

On November 14, 2023, we conducted a systematic search of the Scopus, Web of Science, and ERIC databases, using a specific search strategy to identify relevant articles on the topic of study. The search strategy was configured to search in the title, abstract and keywords of the articles, with the following formulation: ("lesson study" OR "learning study") AND ("facilitator" OR "facilitation" OR "teacher educator" OR "teacher of teacher"). To ensure the quality and relevance of the results, we apply filters to restrict the results to peer-reviewed scientific articles, with no limits on year of publication, written in English. We included articles that met the following criteria: (i) empirical studies; (ii) studies focused on LS with in-service teachers, from primary to secondary education, or in the preparation of facilitators. Articles related to LS in the initial teacher education, pre-school or higher education educators were excluded.

The process of identification and selection of articles was conducted by two independent researchers. Initially, the researchers analysed the titles, abstracts, and keywords to select articles for the eligibility study. The selected articles underwent a comprehensive analysis to determine their inclusion in the final corpus of analysis. In case of disagreement between the researchers, a third researcher was consulted to solve the issue. Cohen's Kappa coefficient was calculated to measure inter-rater agreement, resulting in strong agreement for the inclusion of articles in the eligibility study ($k = 0.895$, $p < 0.001$) and inclusion in the final analysis corpus ($k = 0.885$, $p < 0.001$). The steps of this identification and selection process are given in Figure 1. This process led to the identification of thirteen articles which summary is provided in Table 1.

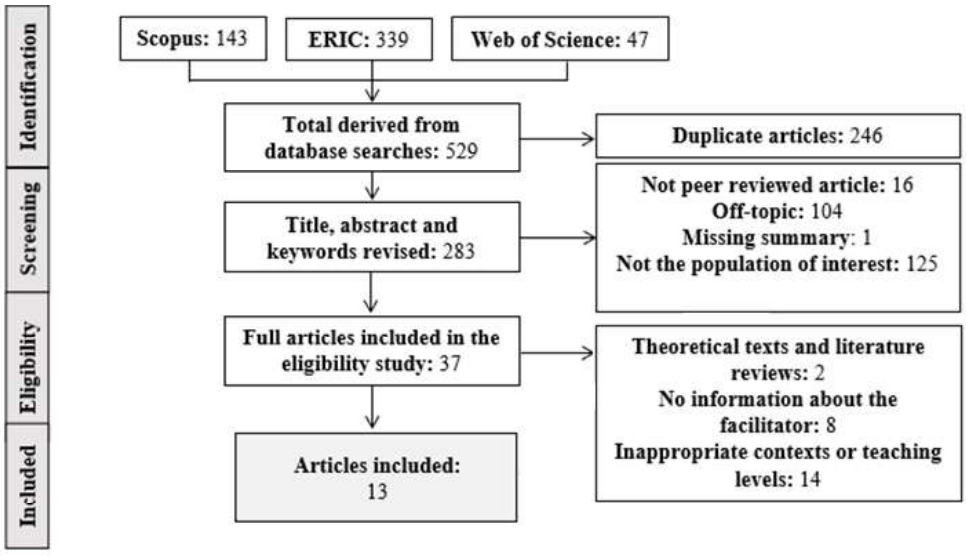

Figure 1: Identification and selection process of the articles for the literature review

In the first stage of the analysis, SciSpace software was used to identify relevant information regarding the two dimensions of interest: the "necessary skills and knowledge" and the "challenges faced by the facilitator". Based on this, three researchers carried out a detailed analysis of the articles,

identifying main categories in the previously identified dimensions.

Table 1: Brief description of the articles

Authors	Aim of articles	Main results
Akiba et al., 2019	To examine which design features of mathematics LS support effective teacher collaboration and professional development	Facilitators significantly influenced teachers' learning by focusing on student thinking and providing relevant resources. Effective facilitation of in-depth discussions enhanced critical thinking and fostered collaboration. Facilitators needed strong knowledge of content and student reasoning to lead discussions for meaningful teacher learning.
Clivaz et al., 2023	To examine how dialogic interactions contribute to knowledge construction	In lesson planning, both facilitators and teachers used their knowledge of instructional practices and of students. The facilitators, particularly the math teacher educator, mainly adopted a guidance role, although new ideas came mainly from teachers. As a teacher, the other facilitator played a key role in the dialogue for arousing reasoning development.
Hourigan & Leavy, 2021	To explore the practice of two mathematics teacher educators acting as novice facilitators of LS	Having noted participants' resistance in the first session, the facilitators sought resources to fit teachers' needs and context, while balancing supporting and promoting their agency. Managing the participants' involvement and considering their busy schedules, is challenging for facilitators and can limit teachers' learning.
Huang et al., 2021	To analyze how digital platforms facilitate teacher learning and collaboration by an online cross-cultural LS	The LS cycle and expert facilitators were crucial for teachers to develop their content knowledge (concept of probability). Although several technical challenges emerged, teachers and facilitators collaborated to improve the lessons, linking research to practice. Teachers' learning also included technology, pedagogy, and instructional design skills.
Jiang et al., 2022	To understand how and what teacher and teacher educators learn collaboratively in LS	The facilitator realised the importance of addressing teachers' concerns, moving from being the one "to learn from" to the expert who works with teachers to understand how they learn and the decisions they make in practice. This form of collaboration may impact teachers' work and professional learning, as well as the facilitators' knowledge.
Joubert et al., 2020	To explore the use of LS in a blended format to help isolated teachers to integrate technology into their teaching	Facilitators were essential in providing guidance and prompting teachers' reflective practices, along with peer-facilitators that emerged during LS. Smaller groups, reflection questions and lesson planning forms enhanced collaborative learning. Nonetheless, the allocation of teacher time was vital for successful collaboration and teacher learning.
Lewis, 2016	To analyse how novice facilitators learn to lead LS	Facilitators enhanced their knowledge by drawing on their prior LS experience and addressing challenges such as teacher resistance and time

		management, while balancing guidance with teachers' autonomy. They emphasized collaboration and combining pedagogical, content, and school-based knowledge to address participants' needs.
Lim et al., 2016	To investigate how LS can enhance teaching practices and improve student learning	Facilitators played a crucial role promoting the development of teachers' pedagogical practices and beliefs, namely by promoting collaborative work at lesson planning, facilitating productive discussions, providing feedback and encouraging reflective practices. The authors also highlight the importance of considering the local cultural needs.
Moeller et al., 2022	To understand how facilitators influence the implementation and effectiveness of a professional learning program (PLP)	Local facilitators played a critical role in adapting PLP, like LS, ensuring fidelity to its core principles while making contextual adjustments. Collaboration between teachers, school, district and external facilitators was crucial for scaling up PLP effectively. Facilitators benefited from program experience, but their needs varied based on roles and expertise.
Mynott & Michel, 2022	To analyse how two facilitators from different continents support and lead LS cycles	Facilitators needed to prepare teams for effective collaboration, avoid dominating discussions, and guide participants, yet be invisible enough to give teachers agency to determine their learning. Sustaining LS cycles required participant-focused facilitation, establishing strong relationships, norms, and considering standards of LS facilitation.
Preciado-Babb & Liljedahl, 2012	To understand common and differential elements of groups of teachers, involved in collaborative design processes	The authors highlight the value of collaboration in empowering teachers and improving their ability to creatively address classroom challenges. Facilitators played a crucial role in guiding teachers into a collaborative process by structuring the sessions, organizing discussions focusing on student learning, and maintaining focus on goals.
Richit, 2020	To analyse LS in Portugal, identifying their challenges, adaptations, and specificities.	Facilitation of LS by an external team and adjusting the number of sessions according to the LS cycle goals are important adaptations to the context. The specificities include the exploratory approach as teaching approach, the development of micro-investigations on teaching, and collaboration, highlighting the importance of understanding the context.
Schipper et al., 2017	To investigate whether LS promotes teachers' professional development in adaptive teaching	The LS facilitator significantly influenced teacher professional growth by managing the process, stimulating teachers to apply theoretical knowledge, and fostering a focus on student learning and collaboration. Time constraints remained a challenge for full teacher participation.

Results

In these articles we find several categories, with some articles fitting in more than one of them. For the issue *necessary skills and knowledge*, the categories emerging concerned: (1) the creation of a

collaborative work environment and promotion of communication (with a subcategory of guiding teachers) and (2) the organization of professional learning situations, appearing in 10 papers, (3) the general planning and organization, appearing in 8 papers, (4) mathematical, pedagogical and didactic knowledge and knowledge about the LS process in 7 papers, and (5) reflection skills in 5 papers. As for the *challenges faced by facilitators*, the categories identified were: (1) managing the logistics of the process in 11 papers, (2) promoting the teachers involvement in the LS, in 9 papers, (3) promoting communication and creating a collaborative environment (with a subcategory of conducting discussions without dominating them) appearing in 5 papers, (4) making the necessary adaptations, (5) dealing with work pressure and other professional issues, both in 4 papers, and (6) getting the support of the administration in 3 papers. In the following, we provide a brief description of what we found in these categories and indicate their frequency in the articles.

Necessary skills and knowledge

All thirteen articles on the LS facilitator have relevant ideas about necessary skills and knowledge required for effective facilitation. First, 10 articles give especial attention to the capacity of the facilitator to create collaborative environment in the group in which there is a stimulating communication among the participants. One example is Lewis (2016), who highlights that facilitators should be able to co-design learning opportunities with teachers so they can tailor the learning experiences to the specific needs and interests of the group, thereby enhancing the relevance and significance of the learning process. Within this category, some articles refer that facilitators need the capacity of playing a pivotal role in guiding teachers (7 articles). For instance, Schipper et al. (2017) state that "the LS facilitator seems to play an important role in guiding teachers ... and stimulating the teachers to use theory and new insights in terms of PCK" (p. 299). They highlight the importance of facilitators "introducing the team members to LS, stimulating the LS team to focus on content and to exchange ideas" (p. 297).

Second, another group of articles concern the role of the facilitator in organizing the content of sessions, providing the opportunities for professional learning and the necessary materials to use in each session (10 articles). For example, Jiang et al. (2022) suggests the facilitator should create a learning space for mutual learning, pointing that "using teaching language with care to reach students", "anticipating students' misconceptions with forward-thinking", "addressing students' misconceptions", and "understanding students' perspectives/voices" (p. 66) prompt it. This is also referenced by other researchers (e.g., Clivaz et al., 2023; Schipper et al., 2017) that emphasize the importance of promoting "in-depth discussion of student thinking and actively engaging teachers in discussions" (Akiba et al., 2019, p. 7). Additionally, Lim et al. (2016) and Richit (2020) point to the importance of discussions in lesson planning and post-lesson reflection, which led to changes in teachers' beliefs and practices, and allowed them to acquire new professional learning.

Third, a set of articles refer to the facilitator's skill of planning and making the global organization of the LS, including the structure of different phases (8 articles). One example is the paper by Akiba et al (2019) which identifies specific design features that enhance teacher participation and learning in LS, namely facilitator's focus on student thinking and active teacher participation in the inquiry process. Richit (2020) emphasizes the significance of understanding the needs and cultural features

of the setting where LS is carried out, while Joubert et al (2020) focus on organizing LS in virtual settings and conclude that, while online LS is feasible, it requires smaller teacher groups for success. By organizing the different phases of the process, selecting appropriate resources, and adapting LS to the specific context of each school, facilitators contribute to the professional development of teachers and the improvement of teaching quality.

Fourth, several articles refer that facilitators need mathematical, pedagogical and didactical knowledge as well as a comprehensive understanding of the LS process (7 articles). For example, Akiba et al. (2019) and Clivaz et al. (2023) identify content and pedagogical content knowledge as fundamental, encompassing the selection of tasks with high cognitive demand and the ability to select materials based on research, as well as knowing students and teaching practices. Akiba et al. (2019) stress the need for expertise in LS. This knowledge is vital for selecting challenging tasks, guiding student-centred discussions, and ensuring in-depth dialogues, thus enhancing teachers' learning.

Fifth, there is also reference to the reflective capacity that facilitators need to have, to improve their facilitation practice (5 articles). This is seen as a capacity that allows the facilitators to deepen their knowledge about their role and improve their practice. For example, Lewis (2016) highlights the iterative nature of facilitator development, as they gain confidence and adaptability over successive cycles, being "more comfortable presenting less, [and] expressed more confidence in their ability to respond to teachers in the moment" (p. 535).

Challenges faced by facilitators

Concerning the challenges faced by facilitators, eleven of the thirteen articles point issues to consider. First, the most common category related to the challenges faced was managing logistical aspects (11 articles), primarily involving the management of available resources. For example, Hourigan and Leavy (2021) highlight the "inflexible timeframe" (p. 663) as a key constraint, while Jiang et al. (2022) pointed out the difficulty of coordinating lesson observation schedules.

Second, another category is to achieve the involvement of teachers in the LS (9 articles). This includes recruiting teachers to participate and also to get an effective participation of teachers in the sessions. For example, Hourigan and Leavy (2021) acknowledge that they "under-estimated the complexities of engaging teachers in LS" (p. 658), noting resistance from teachers. Moreover, they perceived a lack of interest in individual professional development among teachers. Lewis (2016) highlights the challenges associated with managing teacher resistance, particularly when facilitators possess inadequate training to address this issue.

Third, another challenge identified in five articles is to promote the communication withing the group and create a collaborative environment (5 articles). Four of these articles, as Jiang et al. (2022) and Mynott and Michel (2022), address a specific aspect of communication: to lead discussions without dominating them, allowing the participants to actively engage and make independent decisions. Lewis (2016) and Lim et al. (2016) highlight how a dominant facilitator can hinder teacher participation.

Fourth, another category concerns the need to make adaptations taking into account the cultural context and the curriculum (4 articles). This is pointed, for example, by Richit (2020). Sometimes, modifications are necessary to accommodate local needs, as demonstrated by Lim et al. (2016), who

encountered challenges related to finding availability to re-teaching the lesson.

Fifth, another challenge for facilitators is to manage teachers' work pressure (4 articles). In Hourigan and Leavy (2021) research, teachers were unwilling to dedicate their free time to professional development which, additionally to schedule issues, led to a significant number of teachers missing one or more sessions and limited the teachers' involvement. Participants in the study of Schipper et al. (2017) also reported "being under pressure to realize the objectives within the given time frames" (p. 298).

Sixth, there is yet another aspect mentioned in three articles: the need to get support from the school leadership and other administrative instances. For example, Moeller et al. (2016) emphasize the need for funding and time allocation as well as the importance of school administration to provide time for collaboration. Schipper et al. (2017) and Richit (2020) similarly underscore the importance of administrative support, arguing that without it, teachers lack the time and resources necessary for full engagement in professional development.

Conclusion

This systematic literature review provides the identification of important features regarding the necessary skills and knowledge of facilitators and the key challenges that they face. Taken overall, the articles reviewed indicate that facilitators need mathematical, pedagogical and didactic knowledge as well as knowledge about the LS process, need knowledge about the general planning and organization of LS, need to know how to organize professional learning opportunities as well as how to create collaborative work environments and how to promote communication in the group, guiding the teachers along the way, and, finally, as in any other complex activity, need reflection skills. Taken together, these are all relevant aspects regarding the skills and knowledge of facilitators, and the issue that remains is the depth and specific features of each of them.

As for the challenges faced by facilitators, the categories identified were making adaptations in the LS structure, content and process, promoting communication and creating a collaborative environment, including the challenge of leading discussions without dominating them, and getting teachers involved. Further challenges were managing the logistics of the process, dealing with work pressure and with professional issues and getting the support of the administration. Another issue, that we do not address here, is to know what research says about how these challenges may be faced in order to deal with them. That may be the subject of further study.

This review shows that there is already important knowledge about the facilitator's necessary knowledge and skills and about challenges faced by them. This knowledge, which is scattered through many different journals, provides a rather impressive global picture. However, other issues remain to be studied, such as to know what the literature says about how facilitators may be prepared to undertake this complex activity.

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