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Design principles for teacher collaboration fostering educational innovations and inclusion: insights from Lesson Study experiences

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This study outline design principles for teacher collaboration that can drive educational innovations and inclusion. Employing abductive analysis anchored on constructivist grounded theory, the study examined how the cyclical nature of Lesson Study (LS) can enhance the quality of teachers' collaboration. The findings illustrate how a student-centered, transdisciplinary, and iterative form of collaboration fostered educational innovations and inclusion. This study further identified that context awareness, integration of support services, and distributed leadership during collaboration facilitated educational innovation and inclusive practices. The cyclical LS process empowered teachers to develop student-centered pedagogies, integrated technology, and adapted physical learning environments to ensure the success of diverse learners. The identified design principles aim to provide more targeted guidance for teacher training and professional development programs by defining the components of teacher collaboration. The findings of this study also offer practical insights for policymakers seeking to develop and support meaningful collaborative practices among teachers that can foster both inclusion and educational innovations.

KEYWORDS

educational innovations, inclusion, lesson study, special education, teachers' collaboration

1 Introduction

In today's rapidly evolving, competitive, and knowledge-based educational landscape, innovation is crucial for all educational institutions (Koon et al., 2025; Mydin et al., 2025). Contemporary education requires 21st-century learners to move beyond rote memorization and prioritize the development of a holistic skill set. This essential foundation includes cognitive, digital, and interpersonal competencies crucial for success in a rapidly changing global landscape. Therefore, the capacity of teachers to develop and implement innovative strategies in constantly changing environments is crucial. Meanwhile, current scholarship advocates for instructional flexibility and contextual awareness to effectively serve diverse learners (Atanasova and Papan, 2025; Korthals Altes et al., 2024). Research suggests that when inclusion is woven into the

educational fabric, it leads to superior academic results and a more equitable system (OECD, 2015b; UNESCO, 2019). Moreover, exposure to diverse perspectives within these environments fosters the development of critical thinking and creative problem-solving skills necessary for modern success (Gurin et al., 2002). To establish a truly innovative and inclusive learning environment, educators must intentionally address social, physical, behavioral, and academic factors to guarantee the full participation and inclusion of every student. Research underscores that a collaborative approach involving diverse educational stakeholders is fundamental for generating the innovations required in such inclusive settings (DeMathews et al., 2020; Ghedin, 2021). Thus, this study aims to propose design principles for teacher collaboration and outline the groundwork for building collaborative relationships. It also specifies the elements that could enable teachers to engage in collaborative activities that foster inclusion and educational innovations. These design principles aim to provide more targeted guidance for teacher training and professional development programs by defining the components of teacher collaboration. The findings of this study also offer practical insights for policymakers seeking to develop and support meaningful collaborative practices among teachers that can foster both inclusion and educational innovations.

1.1 Conceptualizing teachers' collaboration

To synthesize the evolving landscape of collaboration, it is essential to move beyond a singular definition and examine the shifting models that categorize professional interaction. Collaboration is currently understood as a multifaceted concept that encompasses social, cultural, and structural constructs, requiring a deep respect for the diverse roles and specialized skills of each team member (Welch and Tulbert, 2000). For teachers, understanding these models is not merely an academic exercise; it serves as a critical guide for the planning, implementation, and evaluation of educational initiatives. By mapping the intricate interdependencies between various elements of teamwork, teachers can better identify the inherent strengths and challenges of their collaborative efforts (Stephanie, 2010; Utley and Rapport, 2002). In terms of activity and depth of engagement, collaboration is often classified into a three-tiered hierarchy: exchange, division of work, and co-construction (Gräsel et al., 2006). At the foundational level, "exchange" involves the simple sharing of information, while "division of work" requires joint goal-setting where individual contributions are combined to achieve a collective outcome. The most sophisticated level, "co-construction," occurs when partners work concurrently to build new, shared knowledge. This depth of engagement varies significantly across different collaborative approaches. For instance, the intradisciplinary approach fosters innovation by bringing together specialists from the same field to work toward shared standards (Bruer, 2005; Pimmer et al., 2012). In contrast, the multidisciplinary approach emphasizes clear communication and flexible role definition among a diverse team to benefit from various disciplinary viewpoints (Masters et al., 2013; Strachan et al., 2023). Ultimately, the most integrated model is the transdisciplinary approach, which prioritizes the pooling of

expertise from disparate fields to generate "larger ideas" and transferable intellectual frameworks (Daneshpour et al., 2022; Klein, 2018). Unlike the siloed nature of intradisciplinary work or the parallel efforts of multidisciplinary teams, transdisciplinary collaboration demands open communication and a shared sense of responsibility for the final educational outcome (Hernandez, 2013). In the field of education, these collaborative structures act as a reflection of the members' collective values and skills, serving as a hallmark of effective education service delivery (Rainforth and England, 1997; Welch and Tulbert, 2000). By adopting these more integrated models, teachers can move toward a unified pedagogical approach that effectively addresses the needs of a diverse and challenged group of learners.

1.2 The idea of educational innovations

Innovation in the classroom is characterized by a move toward student-centred learning experiences, the strategic use of educational technology, and the transformation of traditional classroom spaces into flexible learning hubs (Fletcher et al., 2023; Grannäs et al., 2025; Page et al., 2024). Various studies have investigated innovative strategies categorized as student-centred pedagogies. These strategies encompass explicit instruction (Yakubova et al., 2024), gamification (Tomé Klock et al., 2024), differentiated instruction (Gheysens et al., 2023), and embodied learning (OECD, 2016). In this study, student-centered learning and pedagogies are defined as instructional frameworks that prioritize the active agency of the learner in the construction of knowledge (Hannafin and Land, 1997; Reigeluth et al., 2017). However, rather than a purely democratic or conversational model, student-centeredness here refers to a pedagogical responsiveness where the learning environment, technology, and teacher scaffolding are dynamically adjusted based on observable student engagement data.

Integrating technology into the classroom is another cornerstone of educational innovation that enhances student outcomes through personalized instruction (Andrés et al., 2025), data-driven analytics (Paolucci et al., 2024), and streamlined assessment tools (Bešić et al., 2024). Beyond academic performance, these digital advancements promote inclusivity and retention by providing flexible learning formats that cater to the specific needs of marginalized or disadvantaged students (Conde and Rodríguez-Sedano, 2024; Khalil et al., 2024). Another form of innovative learning environments is the merging of physical space redesign with pedagogical flexibility to better align instruction with the diverse social and academic needs of students (Mahat et al., 2018). By adapting class structures and contextualizing materials, these modifications foster deeper student engagement by creating inclusive and supportive atmospheres that optimize overall educational outcomes (Grannäs et al., 2025; Page et al., 2024).

While student-centered learning, utilization of educational technology, and transformation of learning spaces are often cited as hallmarks of modern schooling, they are not universally synonymous with innovation. In the context of this study, educational innovation is conceptualized not merely as the adoption of novel pedagogical tools, but as a generative process of reconfiguring pedagogical practices to address complex

classroom challenges (Baena et al., 2022; Liu and Sun, 2025). Rather than claiming the creation of unprecedented pedagogical techniques, this research defines innovation as the recontextualization and systemic integration of high-leverage practices within a traditional educational ecosystem (Rogers, 2003). By shifting the focus from “new-to-the-world” inventions to the strategic adaptation of evidence-based strategies, innovation in this study is framed as a deliberate disruption of entrenched norms to better serve diverse learner needs.

1.3 Cultivating inclusive environments

Scholars highlight that teachers need to modify their instructional methods to accommodate a wide variety of requirements, ensuring that the entire educational context is considered (Atanasova and Papen, 2025; Debasu and Yitayew, 2024). These integrated settings are documented to enhance scholastic achievement (OECD, 2015b) while reinforcing broader goals of diversity, equity, and inclusion within the education system (UNESCO, 2019). Apart from academic progress, such environments deepen the educational experience by stimulating creativity, critical analysis, and problem-solving abilities (Gurin et al., 2002), and they cultivate interpersonal empathy by providing opportunities for students to engage with a diverse peer group (Rutland et al., 2005). However, while modernizing pedagogical practices is frequently associated with increased inclusivity (OECD, 2015a; Page and Davis, 2023), researchers warn that several novel methodologies may unintentionally marginalize at-risk learners (Baena et al., 2022; Everatt et al., 2019), specifically children with special educational needs (CSEs). For example, innovative frameworks that emphasize high levels of self-regulation, inquiry-based exploration, and peer collaboration (Hornstra et al., 2014) can present significant obstacles for students dealing with behavioral, emotional, or cognitive difficulties (White et al., 2016). Consequently, teachers need to be discerning in their selection and implementation of innovative strategies to ensure they meet the needs of the entire student population. In this study, inclusion is operationalized as a transformative educational stance that moves beyond mere physical placement, aiming instead for the removal of barriers to participation and achievement for all learners (Baena et al., 2022; UNESCO, 2019).

1.4 Lesson study: a nexus for collaboration, innovation, and inclusion

Collaboration in education, such as Lesson Study (LS), can provide teachers with opportunities to develop educational innovations and identify diverse learner needs, which are essential in creating a truly inclusive learning environment (Dibaba et al., 2024; Dudley et al., 2019; Wood and Cajkler 2020). This is achieved through the LS cyclical process specifically designed for the continuous improvement of teaching practices (Baptista et al., 2025). Specifically, LS functions as a sophisticated model of “professional collaboration,” characterized by a deep, mutual interdependence among educators (Hargreaves and O’Connor, 2018). Through

the iterative cycle of collaborative planning, peer observation, and shared reflection, LS transcends basic coordination to foster a high-level professional synergy that is essential for the successful adoption of educational innovations (Lewis et al., 2006; Liu and Sun, 2025; Pan et al., 2024). This collaborative framework is particularly vital for developing the adaptive teaching strategies needed to address diverse learner requirements and establish truly inclusive environments (Baena et al., 2022; Norwich and Ylonen, 2015; Page et al., 2024). Recent evidence suggests that when teachers engage in LS, the resulting collaborative dialogue facilitates the design of innovative practices specifically tailored for inclusion (Basister et al., 2025a). By participating in such structured professional development, educators can bridge the gap between classroom instruction and broader learning support services, effectively mitigating the professional isolation often experienced in the field. Consequently, LS serves as a powerful mechanism for both general and special education (SPED) teachers to deepen their pedagogical content knowledge and refine strategies for engaging marginalized or challenged learners (Cheung and Wong, 2014; Dudley et al., 2019; Verhoef et al., 2014). Ultimately, the discursive and reflective nature of the LS process empowers teachers to internalize complex educational concepts—such as curricular innovation and inclusive synergy—thereby transforming their everyday classroom practices.

Although collaborative practices, such as LS, offer potential benefits for various facets of educational development, the heterogeneity of education stakeholders, stemming from their diverse backgrounds, goals, and strengths, can introduce substantial obstacles (Ozdemir et al., 2023). These obstacles can impede team integration and attainment of the overarching objective of enhancing educational outcomes for all learners (Wullschleger et al., 2022). Other scholars further express varied and conflicting perspectives on the advantages and disadvantages of collaboration. Hargreaves (1994) cautions that collaboration can be wasteful, harmful, and counterproductive for teachers, potentially resulting in groupthink, administrative control, and the imposition of externally defined objectives. Johnson (2003) similarly warns that working collaboratively may present challenges, including the risk of overburdening participants, diminishing individual control, generating conflicts, and creating divisions within the group. Nevertheless, both Hargreaves (1994) and Johnson (2003) acknowledge that collaboration positively affects several aspects of teaching, such as increasing teachers’ confidence in their abilities, fostering their professional development, expanding opportunities for learning, promoting a sense of ownership over their work, encouraging more thorough examination of their teaching methods, and lessening their workload.

While collaborative experiences may present some possible drawbacks, their advantages are considerable. Therefore, creating enabling conditions and fostering positive interpersonal dynamics among teachers is essential for cultivating a collaborative environment that fosters both inclusion and educational innovations. Previous studies showed that collaborative practices, such as LS, cultivate interdependence among teachers (Basister et al., 2026; Miller-Young and Yeo, 2015; Peter, 2013) and are vital for driving both inclusive education (Basister et al., 2025a; Paulsrud and Nilholm, 2023) and educational innovations

(Basister et al., 2025b; Methlagl, 2021; Pan et al., 2024). Despite the growing interest in LS, there remains a significant gap in understanding how the collaboration through LS functions when pre-service, in-service, general, and SPED teachers must negotiate power hierarchies while simultaneously developing innovations and addressing inclusion. This study seeks to bridge that gap by examining how a structured LS framework can act as a catalyst for both pedagogical innovation and inclusive synergy. For these reasons, this study addressed the research question: What essential design principles for teacher collaboration, synthesized from LS experiences, can be proposed to foster inclusion and educational innovations? The description of proposed design principles for a teacher collaboration is informed by an analysis of LS implementations.

2 Materials and methods

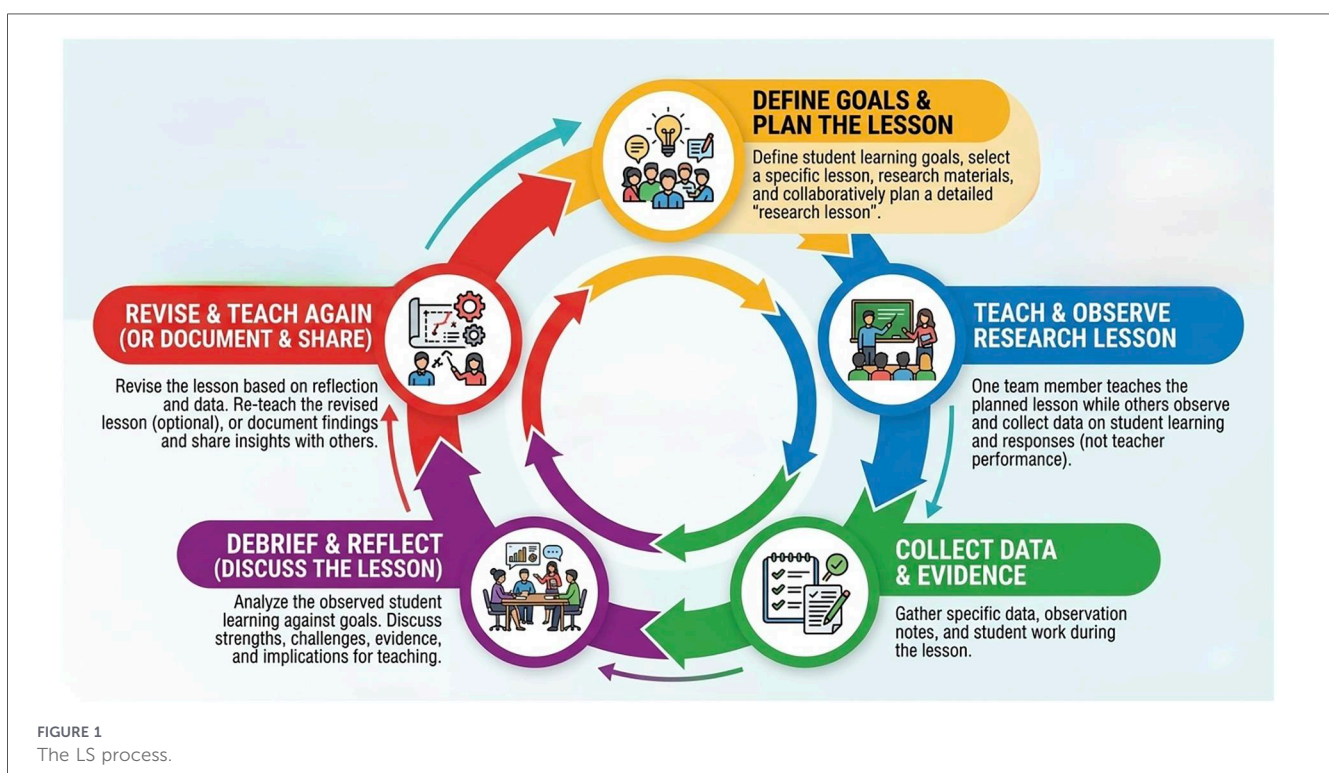
This study is part of a larger research project that examined the mental models of collaboration (Basister et al., 2026), educational innovations (Basister et al., 2025b), and perceived teaching competencies (Basister et al., 2025a) of teachers who participated in LS implementations. The present study followed the LS model implemented by Basister et al. (2025a, 2025b, 2026), which involved a group of educators (preservice, in-service, mathematics, and SPED teachers) who collaborated for a period of four months to design, implement, test, and refine lessons referred to as “research lessons.” The LS cycle begun with joint planning of the lesson, followed by one teacher teaching it while others observe. The team then met for evaluation and reflection, leading to revision and, finally, sharing the results of the improved lesson. As further illustrated in

Figure 1, this structured collaboration is essential for helping teachers identify the diverse needs of their learners and successfully adopt educational innovations, ultimately creating more inclusive learning environments.

Centred on the grounded theory approach, the present study focused on describing design principles for a teacher collaboration fostering inclusion and educational innovations. Specifically, a constructivist approach (Timmermans and Tavory, 2012) was selected from the grounded theory variants as it provides a robust rationale for outlining the design principles for teacher collaboration. This approach allows the outlined design principles to emerge from the data itself, rather than being imposed by pre-existing theories or assumptions (Al-Eisawi, 2022; Tie et al., 2019). However, this approach also recognizes that theories may offer a starting point for understanding phenomena (Coffey and Atkinson, 1996; Kelle, 1995). Constructivist grounded theory recognizes the researcher’s part in the research, notably in examining the meanings and social contexts of the subject under study and in jointly developing a framework derived from participants’ experiences (Charmaz and Thornberg, 2021). The following subsections outline the process for developing design principles that aim to reflect the participants’ realities of teacher collaboration while promoting inclusion and educational innovations.

2.1 Theoretical underpinnings

Aside from specifying the development process, it is also essential to establish the theoretical foundation upon which these design principles are built. Thus, this subsection identifies the core concepts and established theories from the literature that inform and further justify the approach taken in this study.



Employing abductive analysis, this study is grounded in specific theoretical perspectives to frame the understanding of how teacher collaboration can foster inclusion and educational innovations. One of these perspectives is the sociocultural theory (Vygotsky, 1978), which highlights social interaction, more knowledgeable others, and the zone of proximal development. The first element of Vygotsky's assertion is that social interaction drives cognitive development and precedes individual development. LS implementations typically involve joint lesson planning, lesson observations, and post-lesson conferences between and among participating teachers (Basister et al., 2025a; Kager et al., 2024). Such LS activities should enable LS team members to interact, build relationships, and learn from each other (Basister et al., 2025b). Centred on Vygotsky's theory, the authors argue that LS cycles could improve teachers' professional knowledge and practice through social interaction and refining teaching practices.

The second element of sociocultural theory introduces the concept of individuals with a greater understanding or higher ability concerning a specific task, process, or concept. In the study of Basister et al. (2025a, 2025b), the LS implementations involved preservice, in-service, mathematics, and SPED teachers. Given their deeper understanding of teaching and learning processes, in-service teachers serve as the more knowledgeable others for pre-service teachers within these LS implementations (Baptista et al., 2025). Typically, the LS process involves collaboration with team members to generate and refine ideas for improving their practice (Kager et al., 2024). Such collaborative support aligns with the zone of proximal development, which describes the gap between what an individual can achieve with assistance and what they can achieve independently. Vygotsky asserted that learning occurs within this zone and is facilitated by meaningful social interaction. Scaffolding is another key element of sociocultural theory and is recommended as a strategy to support learning within the zone of proximal development (Vygotsky, 1978). For these reasons, the collaborative structure of LS cycles has the potential to expand the range of reflective and investigative teaching approaches employed by a group of pre-service and in-service teachers.

LS implementations can also be examined for fostering educational innovations through collaboration between a participating group of teachers. This examination can be drawn from the concerns-based adoption model (Hall, 1979) in framing the approach to educational innovation. The concerns-based adoption model positions teachers as change agents who are crucial for the successful implementation of innovations in the classroom (Stevens et al., 2024). This model is particularly relevant to education, where change has often been implemented in a top-down fashion (Acton, 2020; Alzoraiki et al., 2024). It emphasizes the importance of considering the perspectives of teachers, who are both affected by and responsible for developing and implementing new practices (Aldridge and McLure, 2024; de Jong et al., 2025). The collaborative nature of the LS process can provide opportunities for teachers to voice and work through their concerns, facilitating smoother adoption of innovative practices. By addressing the teachers' concerns throughout the innovation development and adoption process, the challenges associated

with changes as a result of these educational innovations can be mitigated (Georgiou and Ioannu, 2019).

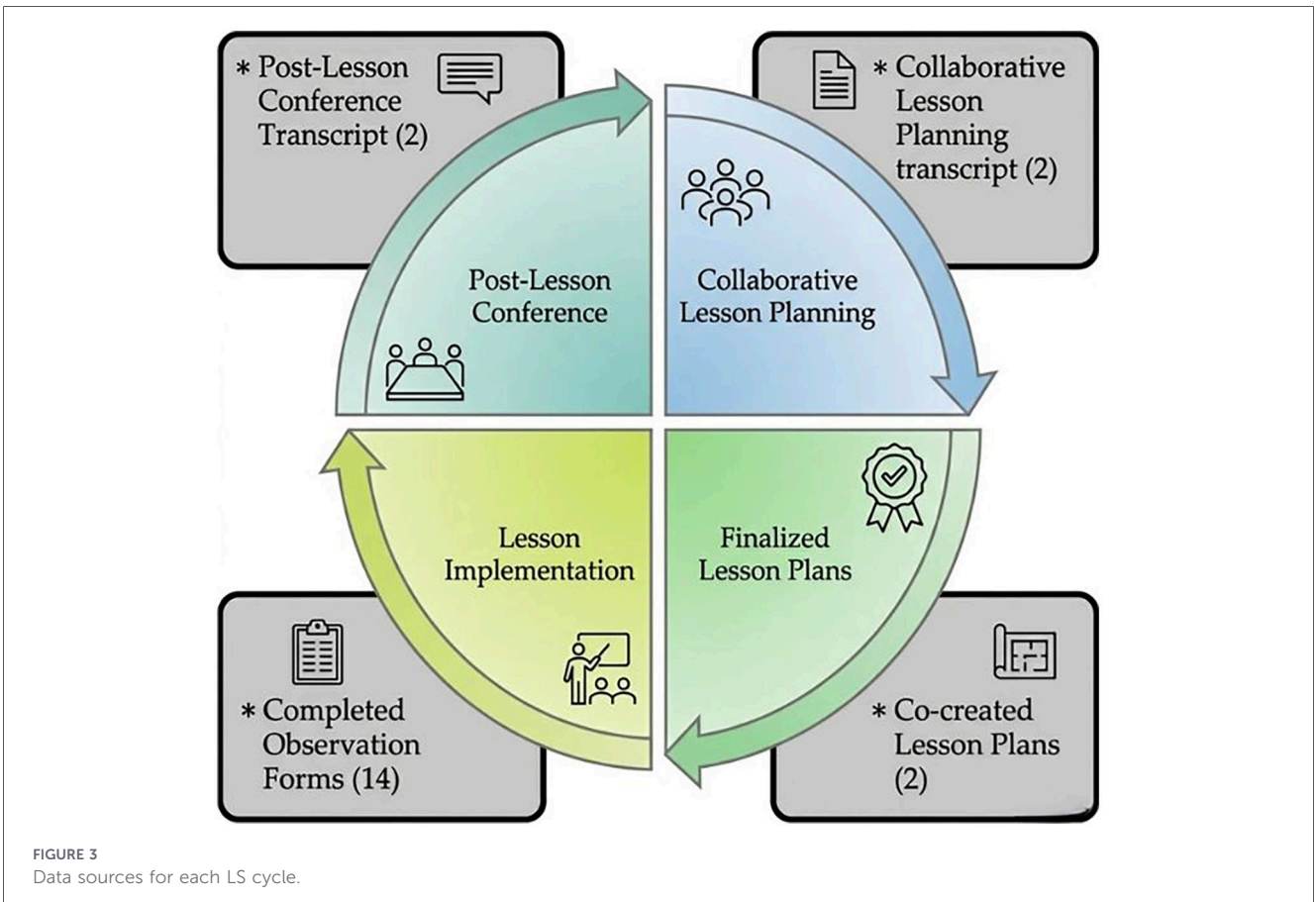
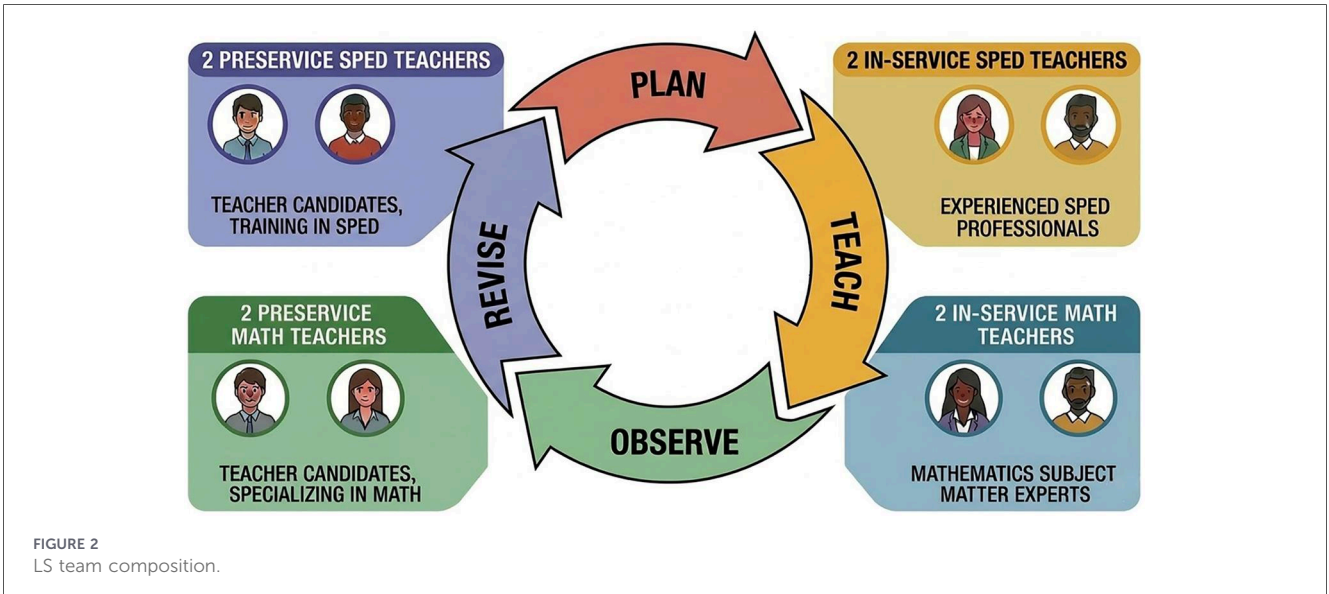
Another framework where this study was anchored is the Universal Design for Learning (UDL). The conceptual foundation of UDL originated in the field of architecture (Almumen, 2020), specifically in the principles of Universal Design (UD). UD sought to proactively create physical environments—such as buildings incorporating ramps, elevators, and automatic doors—that were inherently accessible to individuals with disabilities (Johnstone and Niad, 2022). Within teaching and learning, UDL serves as a framework to optimize instruction by ensuring that the curriculum is designed from the outset to be accessible to the widest possible range of learners (Johnson-Harris and Mundschenk, 2014). It mandates providing multiple, flexible options for students to access content, demonstrate knowledge, and stay engaged with the material (Rao and Meo, 2016). This ensures the core curriculum applies to diverse learners, including those with varied backgrounds, learning preferences, and abilities (Almeqdad et al., 2023). Ultimately, UDL promotes inclusion for all students, specifically supporting those with disabilities and those at risk of academic failure (Karisa, 2023). While not a theory of learning itself, UDL is a research-based framework that informs the design of flexible learning environments that accommodate individual differences. For this reason, it directly underpins the design principles for collaboration aimed at promoting inclusion, ensuring that the resulting innovations from collaborative practices, such as LS, are accessible and useful for all students, regardless of their background or ability.

2.2 Data collection

Before data collection, written informed consent was obtained from each participant. This consent process involved explaining the ethical standards followed, their specific involvement, the study's purpose, and how the results would be disseminated. In the larger research project, a total of sixteen (16) participating teachers formed two LS teams. As shown in Figure 2, each eight-member LS team comprised a specific subgroup of teachers.

Each team carried out four cycles of LS implementations between January and April 2024. Figure 3 shows the corresponding data sources for each cycle. Throughout the observation of "research lesson" deliveries, participants utilized structured observation protocols to document the instructional process. These tools captured qualitative data on teaching strategies, student-teacher interactions, and spontaneous pedagogical shifts. Additionally, a spatial observation map was employed to provide a visual record of classroom dynamics and the trajectory of student engagement during each lesson. The first author, serving as participant-observer in all phases of LS cycles, also conducted pre- and post-LS interviews with each participant. Additionally, as part of the design principles development for this study, two focus group discussions were conducted with participants: one with five participants and another with four participants. These focus group discussions aimed to confirm and refine analytic themes to establish the design principles.

Thus, from the total of eight LS cycles, the data sources for this study comprised 16 collaborative lesson planning transcripts, 16



jointly prepared lesson plans, 112 lesson observation forms completed by LS members, 16 post-lesson conference transcripts, 16 pre-LS interview transcripts, 16 post-LS interview transcripts, two focus group discussions, and the first author’s research diary. Additionally, relevant issuances from government agencies overseeing implementations of basic and higher education services were also included as sources of data.

2.3 Data analysis

After anonymizing the collected data, a constructivist grounded theory approach, utilizing abductive analysis, was employed to address the research question for this study. Abductive analysis is a reasoning process that begins with theory and data in dialogue, with the express purpose of

modifying or creating a new theory (Timmermans and Tavory, 2012). This process involves identifying a cause-and-effect relationship, recognizing similarities to known phenomena, or formulating new general descriptions (Dubois and Gadde, 2002). Essentially, abductive analysis is a type of inference that operates in a “bottom-up” fashion, where individual facts are collected and linked together to develop propositions (Richardson and Kramer, 2006). This method is also understood as a form of logical inference that begins with an observation or set of observations, aiming to identify the most straightforward and plausible explanation (Lu and Liu, 2011). In qualitative studies, abductive analysis develops new theoretical insights via theoretical sensitivity and methodological heuristics (Richardson and Kramer, 2006; Timmermans and Tavory, 2012).

This study followed the four-phase model (exploration, specification, reduction, and integration) for abductive analysis in developing grounded theory (Richardson and Kramer, 2006). The exploratory phase involved initial literature reviews, data collection (through observations, interviews, focus group discussions, and document analyses), open coding, and thematic analysis of the collected data. This facilitated the researchers’ abductive analysis of data based on the participants’ experiences of LS. It also provided the necessary foundation for constructing the initial design principles for teacher collaboration. The specification phase, after the exploratory phase, was crucial in refining and structuring the tentative themes and explanations. This phase enables researchers to transition from broad, initial explanations to more specific, focused propositions. To further improve the first round of analyses, “theoretical potentials” were explored. This involves exploring possible explanatory approaches derived from prior research and theoretical literature (Thornberg, 2012). Through these exploration and specification phases, more theoretically informed themes were abstracted from the empirical material. The results of the reviews of prior research and frameworks on teacher collaboration, inclusion, and educational innovations are expounded in the next subsection.

During the reduction and integration phases, an initial set of design principles for understanding teacher collaboration that promotes inclusion and educational innovations was constructed. The initial design principles of the teacher collaboration were presented in the first focus group discussion ($n = 5$), where LS participants suggested improvements to its clarity, applicability, and information density. These suggestions were utilized to improve the initially presented principles of teacher collaboration. Then, a second focus group discussion ($n = 4$) with LS participants was conducted to further concretize and specify the analytic themes that formed the basis for revising the design principles of teacher collaboration. These activities facilitated the reduction and concretization of core themes and their integration into substantive theoretical explanations. To ensure coherence between the study’s framework and its findings, the theoretical underpinnings of this study functioned generatively rather than purely in a confirmatory capacity. Specifically, the core tenets of Vygotsky’s sociocultural theory, concerns-based adoption model, and UDL served as ‘sensitizing concepts’ that informed the initial coding architecture. This theory-informed coding allowed for a deeper interpretation of the data, moving the analysis beyond

descriptive reporting to a theoretically grounded exploration of how transdisciplinary collaboration facilitates inclusive innovation. [Supplementary Appendix A1](#) provides a summary of how these theoretical lenses guided specific analytic decisions.

In alignment with the constructivist paradigm (Charmaz and Thornberg, 2021), the researcher acknowledged that the ‘design principles for teacher collaborations’ generated in this study were not a passive discovery but were co-constructed through the dynamic interaction between the researcher, the participants, and the multi-layered data streams. The researcher’s professional background in mathematics education, special education, and educational administration fostered the theoretical sensitivity necessary to discern subtle nuances in teacher collaboration. This insider perspective facilitated a deeper rapport with participants during the interviews conducted. However, to mitigate the risk of this ‘insider’ status manifesting as bias, the researcher utilized field notes and reflexive memos to explicitly document and interrogate personal assumptions regarding the ideal LS implementation. Furthermore, in conducting research across two study sites, the researcher remained cognizant of the inherent power dynamics between an external researcher and participating teachers. To minimize the risk of social desirability bias—wherein participants might provide responses they perceived as ‘correct’ or ‘expected’—the researcher adopted a collaborative stance throughout the LS cycles. By positioning as a ‘critical friend’ rather than an evaluator, the researcher fostered an environment of professional trust, ensuring that the data reflected authentic participants’ realities.

3 Results

The following subsections present the final constructs that emerged from the abductive analysis. The data were the following: Forms of teacher collaboration before and during LS implementations; the self-reported impact of LS collaboration on participants’ perceived teaching competencies; and the resulting educational innovations.

3.1 Teacher collaboration

[Table 1](#) illustrates the various forms of collaboration among teachers before and during LS implementations. These forms were grouped into three main categories: activities, structure, and goals. The collaboration practices identified before the LS implementation continued to exist alongside the practices observed during the LS implementation.

3.1.1 Activities

The analysed education department issuances (CMO No. 75, 2017; DM No. 008, 2023) show that before LS implementations, several collaborative activities participated in by both preservice and in-service teachers include field studies and teaching internships. The Philippine Commission on Higher Education (CHED) Memorandum Order (CMO No. 75 (2017) specifies that Field Studies I and II, and Teaching Internships, are integral to the country’s teacher education. The memorandum

TABLE 1 Forms of teacher collaboration before and during LS implementations.

Collaboration	Before LS implementation	During LS implementation
Activities	<ul style="list-style-type: none"> • Field studies • Teaching internships • Lesson observations • Learning action cells 	<ul style="list-style-type: none"> • Collaborative lesson planning • Post-lesson conferences • Lesson revisions • Lesson re-implementations
Structure	<ul style="list-style-type: none"> • Collaboration with members mostly from the same field 	<ul style="list-style-type: none"> • Collaboration with members having various specializations
Goals	<ul style="list-style-type: none"> • Discuss teaching strategies • Benchmark teaching practices • Performance evaluation 	<ul style="list-style-type: none"> • Co-creation of educational materials • Promote inclusive learning

specifies that Field Studies I involves classroom observation and documentation, while Field Studies II includes observation and limited participation in in-service teacher activities. As the memorandum stipulates, Teaching Internships conclude the field study experience, enabling preservice teachers to take full responsibility for a class. These collaborative experiences between preservice and in-service teachers aim to bridge the theory-practice gap, equipping preservice teachers with the knowledge, skills, and dispositions for effective teaching. These practices were confirmed during pre-LS interviews with participating preservice math (PM) and preservice SPED (PS) teachers.

“During FS1, we just purely observed the delivery of the lesson.” (PM1) “While on FS2, we were allowed to participate in lesson delivery. Examples of these involvements are facilitating group activities, preparing the lesson materials, and checking students’ output.” (PS3) “Throughout teaching internships, we prepare lesson plans and were given the opportunities to deliver it under the guidance and supervision of our cooperating teacher.” PM4

Pre-LS interviews also revealed that lesson observation is a common collaborative activity in the participants’ schools. According to participants, the education leaders use the observation tool prescribed by the country’s education department (DepEd). Document analysis of DepEd Memorandum (DM No. 008, 2023) shows that this observation tool has nine indicators, though observers focus only on six indicators per quarter. The same document specifies that these indicators assess: i) application of content knowledge within and across the curriculum, ii) utilization of teaching strategies to improve learners’ literacy and numeracy skills, iii) application of teaching strategies to critical, creative, and higher-order thinking skills, iv) management of the classroom structure to engage learners, v) management of learners’ behavior to ensure learning-focused environments, vi) utilization of differentiated and developmentally appropriate learning experiences, vii) planning, managing, and implementing developmentally sequenced teaching and learning processes, viii) selecting, developing, organizing, and

using appropriate teaching and learning resources, and ix) designing, selecting, organizing, and using diagnostic, formative, and summative assessment strategies consistent with curriculum requirements.

Further analysis of the available document, DepEd Order (DO No. 35, 2016), indicates that learning action cells are another pre-existing collaborative activity. This document specifies that the learning action cells, a nationwide practice, aim to bring together teachers and experts from various fields. The teachers in these learning action cell sessions collaborate in groups to address shared school challenges. These action cells typically follow a process that includes team formation, identification of assessment, agenda prioritization, resource identification, intervention implementation, and evaluation. The document further specifies that sessions may involve lectures, practicums, orientations, coaching, workshops, and the creation and use of instructional materials. The same document also emphasized that these collaborations aim to enable teachers to develop interventions such as learning materials, equipment, facilities, teaching strategies, teaching modalities, and educational programs. Below are some of the learning action cell experiences shared by participating in-service SPED (IS) and in-service math (IM) teachers during pre-LS interviews:

“We conduct learning action cell sessions every quarter.” IM2 “Some of the activities include workshops, where we share strategies and techniques to engage learners during the conduct of the lessons.” IM1 “In one of the learning action cell sessions I participated in, one of our colleagues shared the results of their study about the impact of a specific teaching strategy on the performance of her students.” IM4

Following LS implementations, interviewed participants emphasized the value of collaborative lesson planning in enhancing teaching and learning. During LS implementation, team members observed the delivery of collaboratively planned lessons, focusing on student responses to identify strengths and areas for enhancement. Another part of LS activities is the post-lesson conference, which allows team members to share observations and inform lesson revision and subsequent re-implementation. During post-LS interviews, several preservice math and SPED teachers specifically shared that

“the collaborative lesson planning of LS cycles facilitated the exchange of ideas,” (PM3, PM1) “for developing effective learning activities and materials.” (PS1).

“previously, I consider lesson observation as a tool for performance evaluation. However, because of LS’s joint lesson observations and post-conferences, I realized that observing lessons and conducting post-conferences is also an opportunity to learn from other teachers’ practices.” (IM1)

“the lesson revisions and re-implementation stages of the LS cycle provided us opportunities to utilize the reaction of students to our designed activities and materials” (IM3) “and further modify and improve the delivery of the lessons.” (IS3)

3.1.2 Structure

The conducted document analyses indicated that existing collaborative structures were mainly composed of preservice, in-service, and master teachers from the same field. Specifically, lesson observations and post-lesson conferences are primarily conducted between in-service and master teachers, sometimes including head teachers or school heads (DM No. 008, 2023). As outlined in the specified education department issuance, these observations served two main purposes: coaching or mentoring and teacher performance evaluation based on education department standards. For field studies and teaching internships, CHED (CMO No. 75, 2017) requires that preservice and in-service teachers be paired by specialization. The same document also emphasized that field studies aimed to give preservice teachers practical classroom experience through observing and assisting in-service teachers within their specialization. The memorandum further indicated that teaching internships are semester-long activities of preservice teachers supervised by an assigned cooperating in-service teacher from the same discipline at a selected school.

Another analysed document (DO No. 35, 2016) stipulated that schools may establish learning action cells with teachers from the same or different departments. As outlined in this document, a typical learning action cell includes a leader (school head), facilitator (school head, head teacher, or master teacher), documenter, and members (in-service teachers). While external experts may be involved, internal expertise is preferred. During pre-LS interviews, one participating in-service math teacher described that

“the learning action cells utilized observation, reflection, and experimentation to collectively enhance our teaching practices.” (IM4)

During post-LS interviews, several participants claimed that after their LS experiences, they are more willing to collaborate with teachers from diverse backgrounds.

“I think it’s healthy to collaborate with other teachers to learn and upgrade your knowledge and skills in delivering lessons.” (IM1)

“as an in-service teacher, I can say that the involvement of preservice teachers helped the team in discussing age-appropriate ideas, strategies, and learning resources for the effective delivery of our research lessons.” (IM2)

“the active participation of SPED teachers offered the team additional insights on how to tailor math lesson materials and strategies for CSEs.” (PM1)

3.1.3 Goals

Regarding collaboration goals, participants initially favoured activities with teachers from the same field. The analysed document relevant to field studies and teaching internships (CMO No. 75, 2017) requires that preservice teachers collaborate with in-service teachers from the same field to enhance their knowledge and skills in teaching lessons in a specific discipline. During pre-LS interviews, both in-service math and SPED teachers shared that

“we primarily utilized lesson observations and post-lesson conferences to discuss strategies with colleagues in the same department.” (IM1, IM4)

“the lesson observations conducted by our master teachers and school heads also served as a tool to evaluate our performances as teachers.” (IS4, IM3)

Following the LS experiences, participants adopted a more transdisciplinary approach, aiming to co-create inclusive classroom materials. During post-LS interviews, the participants shared that

“the presence of preservice teachers during LS activities provided new ideas in designing instructional materials for young learners,” (IM2) “and integrating technology in implementing our research lessons.” (IM1)

“because we collaborated with SPED teachers, I became more interested to learn the various strategies to accommodate the needs of CSEs.” (IM4)

3.2 Collaboration and perceived teaching competencies

Table 2 illustrates the self-reported impact of LS experiences on participants’ perceived teaching competencies. Specifically, this impact is examined through post-LS interview transcription and is grouped into four key areas: understanding diversity, teaching methods, support services, and community engagement.

3.2.1 Understanding diversity

Through analyses of interview transcripts, specific developments in teachers’ perceived understanding of diversity

TABLE 2 Self-reported impact of LS on perceived teaching competencies.

Dimension of teaching competencies	Self-reported impact of LS on perceived teaching competencies
Understanding diversity	<ul style="list-style-type: none"> • Improved knowledge about the diverse needs of students. • Awareness of modifying activities and materials based on learners' needs. • Developed confidence in the various abilities of students. • Motivated to learn more about CSENs.
Teaching methodology	<ul style="list-style-type: none"> • Improved knowledge and skills in preparing lesson plans. • Awareness of the importance of blackboard plan and structure. • Enhanced classroom management skills. • Additional ideas on various teaching and learning strategies and materials.
Support services	<ul style="list-style-type: none"> • Acquired new insights from interactions with other teachers. • Improved perception of lesson observation. • Awareness of the role of SPED teachers.
Community engagement	<ul style="list-style-type: none"> • Improved self-esteem. • Established open communication. • Developed shared ownership and accountability.

can be attributed to their LS experiences. During post-LS interviews, several participants expressed that their LS involvement provided them with opportunities to deepen their knowledge of how to support diverse learners. They specifically shared that they became

“knowledgeable in identifying CSENs,” “learned various strategies in accommodating their needs,” and “sustaining their engagement during lesson delivery” (IM3, PM4, IM1)

Empowered by additional knowledge about CSENs, LS teams were able to design and implement inclusive classroom activities utilizing appropriate teaching and learning materials. During post-LS interviews, participants shared that

“my participation in LS cycles enhanced my knowledge and skills related to designing lessons catering to the diverse needs of learners.” (PM1)

“after participating in the series of LS activities, I realized that CSENs can successfully engage in classroom activities when provided with appropriate support and materials.” (IM4)

“the LS experiences I had, fuelled my motivation to engage in further professional development activities, specifically those about inclusive education practices.” (IM3)

3.2.2 Teaching methodology

Further analysis of interview transcripts demonstrated specific effects of LS on teachers' perceived competencies in terms of teaching methodology. In every LS cycle, all team members participated in lesson planning, where they addressed: i)

students' existing knowledge, skills, and educational needs; ii) intended skill and competency development; iii) facilitation of teaching and learning through suitable materials and strategies; and iv) monitoring and assessment of student learning outcomes. Pre-service teachers pointed out that some aspects of LS lesson planning were new to them, including identifying or integrating lesson parts that allow students to apply knowledge across and within the curriculum. Specifically, one preservice teacher shared that

“the joint lesson planning sessions helped me to realize the importance of aligning lesson objectives, classroom activities, instructional materials, and assessment tools.” (PS1)

One of the key takeaways for many LS team members during lesson planning was the concept of blackboard planning. Post-LS interviews revealed that

“through LS participation, I realized the importance of the blackboard plan and structure.” (IS1) “It helped me track and capture student ideas during discussions.” (PS3)

Organizing and managing classrooms is a key skill for teachers. During post-LS interviews, participants reported that

“LS implementations helped me develop effective classroom management strategies,” (IM3) “particularly in selecting lesson-aligned activities” (IM1) and “improving time management during lesson implementations.” (IM4)

Post-LS interviews also showed that LS involvement offered participants opportunities to compare different teaching strategies and materials for their learners.

“I encountered several techniques in teaching specific lessons that are different from what I usually do in my classes.” (IM2) “Some of the strategies used by teachers we observed were not discussed during our preservice education courses.” (PM3)

3.2.3 Support services

Interviews also highlighted specific effects of LS on teachers’ perceived competence in support services. A major benefit was the opportunity for teacher collaboration and idea sharing. Post-LS interviews revealed that participants

“I valued hearing the ideas and experiences of other teachers, especially the SPED teachers,” (IM3). “Our collaboration with younger teachers gave me additional insights on how to design more age-appropriate teaching strategies” (IM1) and “learning resources for our students.” (IS1)

Lesson delivery observations were another key feature of LS. Participants were informed during LS orientation that the primary focus of observing the research lesson delivery was student reactions. During post-LS interviews, participants shared that

“the lesson observation we had in LS changed my perception of lesson observation from a mere tool for performance appraisal to an alternative tool for improving the teaching and learning process.” (IM1)

The SPED teachers’ involvement in lesson planning made it simpler to aid CSEs during lesson implementation. Specifically, some participants shared that

“SPED teachers’ participation in the LS process provided us with the opportunity to discuss ideas in selecting appropriate learning materials for CSEs.” (IS2)

3.2.4 Community engagement

The interviews also indicated specific LS effects on the participants’ perceived teaching competency in terms of community engagement. Post-LS interviews revealed that preservice participants were hesitant in sharing ideas during lesson planning and evaluations.

“First, I was hesitant to share my ideas during LS sessions since I am aware that the other participants are of veteran status and hold leadership roles.” (PM1) “With the encouragement of participating veteran teachers to hear from us, I eventually developed confidence in sharing my thoughts during LS sessions.” (PM3)

During both lesson planning sessions and post-lesson conferences, all team members were encouraged to comment on the positive aspects and areas needing improvement in a lesson

plan or its implementation through structured turn-taking protocols in post-lesson conferences. During post-LS interviews, participants claimed that

“the shared ideas and feedback during joint planning of lessons and conferences after lesson implementations were instrumental in enhancing my lesson delivery.” (IM3) “Having pre-service and younger teachers in the team was instrumental in incorporating technology into the research lessons.” IS3 “The participation of SPED teachers helped us in modifying teaching materials and approaches to accommodate the varied learning needs of students.” (IM2)

Moreover, several in-service teachers also emphasized during post-LS interview that before participating in LS, they felt solely responsible for their students’ learning outcomes. However, post-LS interviews revealed that after engaging in several LS cycles,

“the improvement in my lesson plans was the result of the series of discussions and the sharing of ideas among LS team members.” IM4 “The enhanced quality of our lesson plans and teaching practices was a direct result of the time and effort invested by the LS team.” (IM2)

3.3 Collaboration, inclusion, and educational innovations

To illustrate the educational innovations identified and their origins in LS implementations, relevant excerpts are presented below. The innovations inferred from the analysed data were summarized in Table 3, which focuses on three important facets: pedagogical approaches centred on students, the incorporation of technology, and changes to learning environments.

3.3.1 Student-centred pedagogies

The analysis of collected data shows that LS implementations have fostered the development of specific examples of student-

TABLE 3 Educational innovations from the LS collaborations.

Educational innovations	Innovative strategies
Student-centred pedagogies	<ul style="list-style-type: none"> • Concrete-Representation-Abstract (CRA) Approach • Game-based learning • Problem posing • Arts-integrated learning
Technology integration	<ul style="list-style-type: none"> • Use of educational technologies • Use of learning analytics
Learning space modifications	<ul style="list-style-type: none"> • Contextualization of lesson materials • Flexible class structure

centred pedagogies. Such examples include the CRA scaffolding, gamified learning, systematic problem posing, and the integration of the arts into core instruction.

The CRA approach was used in four of the 16 lessons during the LS implementations. Described below is one of the instances where the CRA approach was utilized in delivering the lesson.

A teacher employed a four-step instructional sequence to introduce the concept of circular permutations. The lesson began with a hands-on activity where students physically manipulated three objects of different colors to determine all unique circular arrangements. Following this physical modeling, the objects were assigned symbolic labels (A, B, C), and the students were tasked with listing all the possible arrangements using these symbols. In the final step, the formal formula for circular permutations was presented by the teacher. Students then concluded the lesson by verifying the answers derived from the mathematical formula against the lists they had generated manually.

(Research diary, 19 March 2024 Lesson implementation)

The LS activities enabled the LS team to develop lesson plans and materials, indicating the utilization of the CRA approach. Specifically, during the post-lesson conference for the described lesson above, the exchange of ideas between participants was essential in improving the overall lesson design and delivery.

IM1 and IS2 both shared that the use of tangible and multicolored teaching and learning materials helped the learners follow the movement of objects in the various possible arrangements made. IS1 and IM2 suggested that the materials can be enhanced in terms of their size and floated the idea of having students themselves to represent the objects.

(Research diary, 19 March 2024 post-lesson conference)

From the 16 observed lessons during LS implementations, game-based learning was used in six instances. During collaborative lesson revision for the topic on parallelograms, one participant (IM1) suggested the use of exciting games and other interactive activities. During the post-lesson conference, another participant (IM3) shared that the students demonstrated greater engagement when interactive games were integrated into the lesson described below.

To begin the parallelogram lesson, the teacher organized the students into six teams and distributed jigsaw puzzle pieces to each team. Once the puzzles were assembled, every group was required to analyze and report on the formed shape, noting its specific attributes, including the number and nature of its sides, angles, and corners, in addition to identifying its name.

(Research diary, 27 February 2024 Lesson implementation)

The problem posing strategy was also apparent in three of the 16 research lessons during LS implementations. For instance, in

the lesson about exponents, student understanding was assessed in a manner contextualized to their abilities. Specifically, in the lesson assessment part, students were given opportunities to formulate mathematical problems using data provided by the teacher. During the post-LS interview, a member of the LS team noted that

“the problem posing strategy helped the team in assessing student learning by identifying the strengths and weaknesses of students in terms of mastering specific learning competency.” (IM2)

Embodied learning is one of the student-centred pedagogies that was apparent in two lessons during LS implementations. This strategy emphasizes the role of the body and emotions in learning, beyond purely mental aspects. One collaboratively planned lesson during LS cycles incorporated song and dance to facilitate students' recall of relevant concepts. The song lyrics were structured to reinforce prior lesson concepts and lay the groundwork for discussing zero and negative exponents. In the examined observation forms, several participants indicated that the singing and dancing increased student engagement due to the lyrics' connection to mathematical concepts (PM2) and that arts-based activities enhanced student motivation and creativity while providing an opportunity to apply previously learned skills (PS2).

3.3.2 Technology integration

LS implementations led to the emergence of several educational innovations involving technology integration. These innovations included the use of educational technology and learning analytics in lesson delivery. Ten of the 16 research lessons delivered during LS cycles incorporated available educational technologies, such as TV screens, LCD projectors, digital presentations, and mobile phones. In several post-LS interviews conducted, participants shared that

“our collaboration with preservice teachers during lesson planning facilitated the development of additional ideas for technology integration.” (IM2)

“the use of educational technologies in lessons increased student engagement, interest, and excitement due to its relevance to our students' generation.” (PM1)

Learning analytics was incorporated in two of the 16 lessons delivered during the LS cycles. The application of learning analytics involves employing various tools to collect, analyse, and report learning data. In one lesson within the LS cycles, a mobile application was used to assess students' understanding, as described in the researchers' diary below

“The Quizizz mobile application was utilized to evaluate student proficiency regarding quartiles in ungrouped data. This digital platform captured and archived participant responses to specific inquiries concerning measures of position. Through this mobile interface, performance metrics

were computed instantaneously and projected onto a classroom television screen for collective viewing. These real-time visual displays illustrated the distribution of student selections across the various answer choices for every question presented.”

(Research diary, 12 April 2024 Lesson implementation)

During the post-LS interview, one participant (IM1) noted that younger teachers' ideas helped them navigate the benefits of technology integration in the lessons. Another participant (IS1) indicated in her observation form that a mobile application increased the efficiency of collecting and analysing student responses during an informal assessment within the learning analytics lesson.

3.3.3 Learning space modifications

The flexibility of pedagogical spaces represents another form of educational innovation. This specifically entails transforming teacher-student roles and strengthening students' connections with their learning materials, environment, and peers. These learning space modifications included the contextualization of lesson materials and flexibility in class structures. During the LS cycles, 11 out of 16 observed lessons showed lesson contextualization. These lessons specifically integrate local products, traditions, places, and materials into lesson delivery. Additionally, these lessons involved linking the development of the lesson to students' real-life experiences and situations. In the examined observation forms completed by the LS team members, one participant (IM3) indicated that contextualizing lessons based on students' experiences and situations helped increase student interest and engagement.

The flexibility of class structures is another form of learning space modification. From the 16 observed lessons, 10 demonstrated this flexibility. The collaborative lesson planning sessions included discussions on improving the structures of the class, such as organizing learners' seats and groups. Lesson observations conducted by the first author revealed that classrooms generally had more than one chalkboards and individual desks for each student. However, desk arrangements varied, including rows facing the front, group arrangements, and a forward facing forward U-shaped arrangement. During post-LS interviews, participants shared that

“seating arrangements facilitated student discussion during class activities” (IM2) and “fostered cooperative learning.” (IS3) “Some seating arrangements involved a combination of high-performing and struggling students.” (IM3)

The first author's research diary indicated that most of the research lesson implementations also showed a consistent instructional pattern: the delivering teacher usually began sessions by displaying learning goals prominently on the chalkboard. These lessons typically concluded with student-led summaries, allowing pupils to synthesize the primary takeaways of the discussion.

4 Discussion

Based on the analysed data presented in the previous section, Figure 4 illustrates the proposed design principles of teacher collaboration, outlining the elements of teacher collaboration and highlighting its potential as a vital structure for fostering inclusion and educational innovations.

Following the visual overview provided in Figure 4, the sections that follow serve to deconstruct and analyze each heading. This unpacking offers a detailed examination of the pedagogical implications and practical applications of the proposed design principles of teacher collaboration. Within the framework of constructivist grounded theory (Charmaz, 2014), the design principles formulated in this study are characterized as practice-informed guidelines. Rather than functioning as rigid normative recommendations, they serve as emergent theoretical constructs derived from the abductive analysis of LS implementations. The movement from empirical themes to formalized principles involved a process of theoretical constant comparison. This ensured that each principle was not merely a summary of data, but a high-level abstraction capable of informing collaborative practice in similar inclusive contexts.

4.1 Teacher collaboration

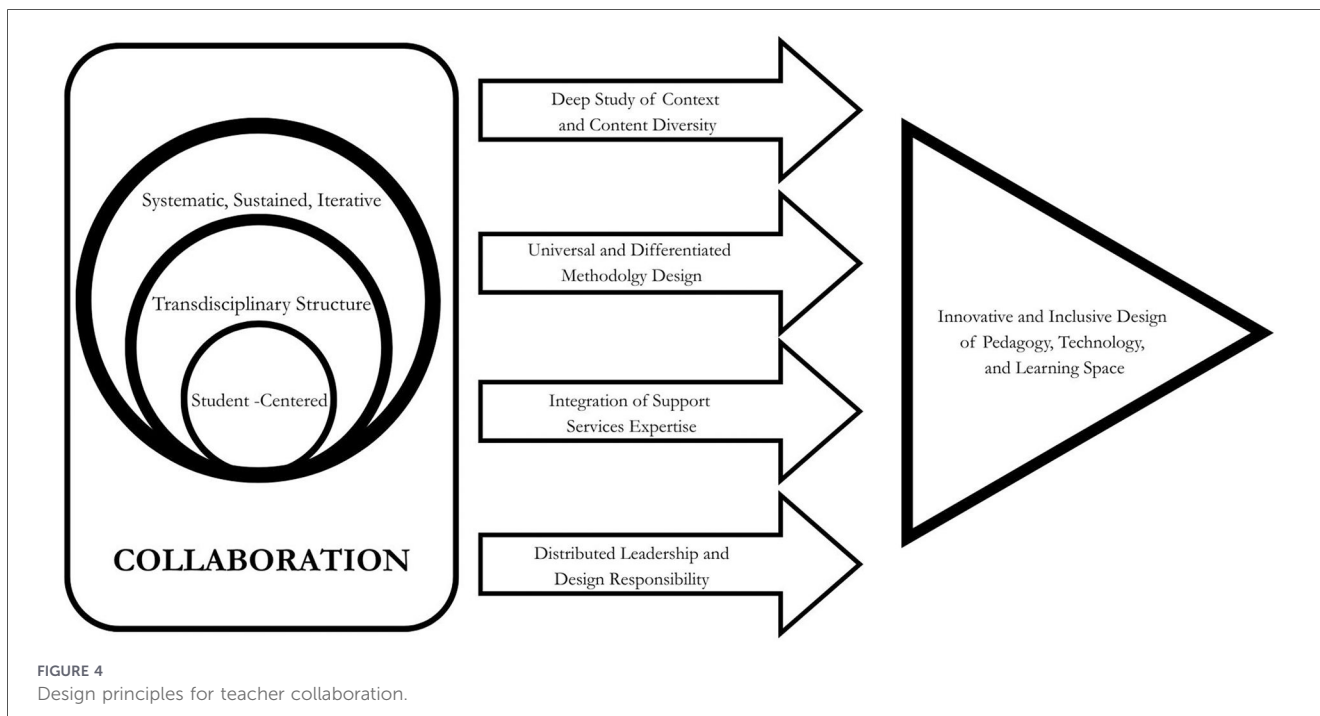
The results section examined how teachers' collaboration — including its activities, structures, and goals — shifted as a result of the LS cycles. It analyzes the empirical data to inform the design principles for teacher collaboration, as illustrated in Figure 4. These design principles aim to foster both inclusion and educational innovation.

4.1.1 Systematic, sustained, and iterative activities

The assessment of pre-LS collaborative activities (e.g., lesson observation, field studies) indicated a limited quality of interdependence, primarily functioning as a means for sharing general ideas and basic planning. However, during LS implementations, collaborative activities shifted from simple idea exchange to jointly setting instructional goals, dividing complex tasks, and collectively engaging in all phases of the LS cycle (planning, observation, reflection, and revision). This heightened collaborative quality was directly reported by participants, including preservice (PM1, PM3, PS1) and in-service (IM3, IS3) teachers during their post-LS interviews. The analyses showed that implementation of the LS cycles acted as a catalyst, driving a substantial change toward high-interdependence collaboration. The cyclical structure of LS serves as a key design principle, fostering a predictable environment for professional inquiry. By establishing this rhythm, the process transforms collaboration from superficial information sharing into sustained, evidence-based pedagogical development.

4.1.2 Transdisciplinary structure

Before the LS implementation, collaboration primarily operated under intradisciplinary structures, where teacher pairings (both preservice and in-service) were dictated by



subject specialization, as mandated by prevailing institutional guidelines (e.g., CMO No. 75, 2017). While occasional multidisciplinary structures existed—such as those found in learning action cells, which formed regardless of specialization (DO No. 35, 2016)—these were not the primary mode of practice. Post-LS interview accounts (IM4, IM1) indicated that their LS experience enriched their understanding of collaboration, promoting a culture of collaborative inquiry. After engaging in the LS cycles, participants reported a shift toward a transdisciplinary approach to collaboration. This transformation encouraged active participation from all teachers in collective lesson planning, observation, and data-driven decision-making, regardless of their specific field. This highlights how the LS framework facilitates the critical integration of theory and practice for preservice teachers, a finding that aligns with the literature on LS and teacher development (Basister et al., 2025b; Baumfield et al., 2022). This integration not only enhanced participants' specialized content knowledge but also sharpened their critical observation skills.

Participants (IM1, IM2, PM1) emphasized that the integration of SPED perspectives provided critical information for contextualizing materials for students with exceptional needs. Additionally, though in-service teachers hold a stronger potential for leading inquiry (Coenders and Verhoef, 2019), their participation in LS with preservice educators challenged established routines. The analyses of the accounts of participating in-service teachers (IM1, IM2) showed that their cross-generational dialogue with preservice teachers helped them identify and “unlearn” outdated practices, favoring strategies and resources better aligned with the needs of contemporary students. Thus, the inclusion of teachers across different career stages and specializations was beneficial. Specifically, the collaboration between mathematics, SPED, in-service, and preservice teachers was a success. This transdisciplinary learning

facilitated by LS directly promoted a more inclusive instructional approach, reinforcing the established literature on the positive impact of collaboration between general and SPED professionals (Basister et al., 2025a; Paulsrud and Nilholm, 2023). Consistent with Vygotskian theory (Vygotsky, 1978), the authors argue that the transdisciplinary form of LS collaboration improves professional knowledge and practice. LS achieves this by utilizing social interaction—a key tenet of socio-cultural learning—as the primary mechanism for collectively refining instructional strategies.

4.1.3 Student-centred goals

Before implementing LS, analyses of documents (CMO No. 75, 2017; DM No. 008, 2023) and pre-LS interview transcripts (IM1, IM4, IS4, IM3) show that the core goal of teacher collaboration was restricted to individual practice improvement. Collaboration was typically intradisciplinary—confined to the same-discipline departments—where team members primarily focused on enhancing their knowledge and skills by comparing existing methods. This goal was sometimes overshadowed by an emphasis on performance evaluation during class observations, a purpose that contrasts sharply with the reflective nature of LS. The LS cycles acted as a catalyst, redefining the purpose of collaboration. Post-LS interviews with participants (IM1, IM2, IM4) reveal a substantial shift toward collective ownership and innovation across disciplines. The new central goal became the co-creation of educational materials designed explicitly to foster inclusive classrooms and address the learning needs of all students. This transformation indicates that the structured inquiry of LS successfully redirected teacher effort from simply improving individual methods to collectively designing solutions for systemic equity challenges. Consistent with Green's (2024) findings, the results of this study suggest that engaging with

teachers who demonstrate a growth mindset is crucial. The collaborative environment enables educators to develop an authentic, relational curriculum that is robust and demonstrably beneficial for both the teachers' professional practice and student learning outcomes, which are metrics for educational innovations (Johnson, 2025; Stevens et al., 2024).

4.2 Collaboration and perceived teaching competencies

The qualitative evidence from the results section establishes LS as a potent form of teacher collaboration capable of improving the perceived teaching competencies of preservice and in-service teachers, particularly in fields such as mathematics and SPED. Thus, the proposed design principles for collaboration, shown in Figure 4, were anchored on areas where the LS cycle actively facilitated several key professional outcomes. This includes raising the perceived competence levels of participants and empowering them to deepen their understanding of classroom diversity, build expertise in inclusive pedagogical content knowledge, adopt a transdisciplinary collaborative structure, and cultivate a powerful sense of collective ownership and accountability.

4.2.1 Deep study of context and content diversity

Qualitative analyses of post-LS interview transcripts confirm that engaging teachers in collaborative activities, such as LS, increases their awareness and concern regarding the diverse needs of their students. Specifically, the accounts from participants (IM3, PM4, IM1) about their increased awareness of CSEs showed that their LS experiences served as a contributing factor for promoting inclusive education. The collaboration between mathematics and SPED teachers within the LS framework proved essential, which seems to have enhanced mathematics teachers' perceived knowledge of inclusive education. LS provided vital actual classroom immersions for preservice teachers (e.g., PM4, PM1), offering firsthand experience with diverse student populations and giving them practical insights into managing varied learners and designing inclusive learning environments for their future classrooms. The structured discussions during lesson planning and evaluation afforded participants crucial opportunities to reflect on and refine practices. For example, the planning phase assisted participants in proactively identifying activities, strategies, and materials that cater to learners' varying needs. LS was also instrumental in challenging and changing teachers' beliefs regarding the capabilities of students with additional learning needs (e.g., IM4). The students' responses to new instructional practices introduced by the teacher seemed to reinforce their reciprocal change in belief and practice. Thus, the LS form of collaboration can be considered an inclusive education tool due to its ability to facilitate this change. Specifically, learner diversity awareness is crucial for applicable and equitable educational innovation. This foundational understanding is critical as it directly shapes the creation of inclusive practices and responsive materials (Basister et al., 2025a). This also leads to a cyclical benefit: enhanced academic

achievement, improved social competence, and superior preparation for navigating a complex, interconnected world (Bakoč et al., 2025; Dell'Anna et al., 2020; Wood and Cajkler, 2017).

4.2.2 Universal and differentiated methodology design

The qualitative analyses of post-LS interview transcripts showed that LS seems to have improved participants' (PS1, IS1, IM3, IM1, IM4) perceived instructional design skills, encompassing detailed lesson planning, blackboard planning, and classroom management. These results establish LS as an integrated and crucial component for both preservice teacher preparation and in-service continuing professional development. Scholars (McMahon et al., 2010; Wolthuis et al., 2020) widely concur that teacher collaboration is invaluable for teachers, directly enhancing their lesson planning skills, enabling the immediate assessment of instructional quality, and providing essential peer recognition for expertise. Additionally, the structured LS planning phase provided opportunities for participants (IS1, PS1, PS3) to re-evaluate their lesson planning and structure to ensure all students can succeed when teaching diverse student populations. This shows that the LS practice appears to have fostered skills in differentiated instruction by compelling teachers to gain a deeper understanding of their students' diverse needs and explore innovative teaching methods. Previous studies also reveal that the LS form of collaboration is crucial for teacher development, impacting student learning and providing new pedagogical skills, along with increased confidence and a better understanding of culturally diverse students (Cajkler et al., 2013; Cohan and Honigsfeld, 2007). Furthermore, the authentic exposure provided by LS gave opportunities for both pre-service and in-service teachers to collaboratively develop and validate innovative teaching strategies designed specifically for diverse student populations, thereby embedding universal design for learning as a core skill. The LS cyclical nature ensures that planning enables learning about teaching, and teaching informs planning (Dibaba et al., 2024; Mutton et al., 2011). This professional learning mechanism operates as an innovation-driven community, fostering creativity and new ideas through continuous inquiry, rather than merely transmitting existing knowledge (Wong, 2010).

4.2.3 Integration of support services expertise

The structured interactions within LS seem to have improved the perceived professional knowledge of both preservice and in-service mathematics and inclusive education teachers. Crucially, the LS cycles foster the essential recognition and integration of support-teachers' functions, such as SPED teachers, within the general education classroom. This recognition is an indication that the specialized knowledge and skills required to address the specific needs of CSEs are valued and utilized by general education mathematics teachers (e.g., IM3, IM1). These results underscore the vital role of the LS form of collaboration in facilitating enhanced pedagogical and content knowledge through the integration of specialized expertise. This claim is

supported by the literature, which emphasizes the benefits of diverse professional collaboration. Vangrieken et al. (2015) highlighted that teacher collaborations increase motivation, improve efficiency, enhance technological skills, and result in the design of more student-centered lessons. The socialization and cultivation of preservice teachers' professional identities as both teachers and continuous learners is also facilitated by collaborating with experienced in-service teachers (Elipane, 2017; Jimenez-Silva and Olson, 2012). Additionally, engaging preservice teachers in communities of practice alongside experienced in-service teachers has been shown to develop a better understanding of the relationship between theory and practice (Baptista et al., 2025; Schipper et al., 2020). This commitment to transdisciplinary collaboration reinforces the commitment to equitable and appropriate instruction. The success of integrating CSEs into regular classrooms largely depends on the expertise of the support teacher, whose involvement is critical for facilitating the selection, analysis, and sharing of successful educational experiences tailored for CSEs (Voinea and Topalá, 2018). Acknowledging and accurately understanding how every member of the team plays a vital role in ensuring an inclusive learning environment is fundamental to sustaining a collaborative practice such as LS (Fasting and Breilid, 2023).

4.2.4 Distributed leadership and design responsibility

The LS structure functioned as the primary mechanism for neutralizing the inherent power asymmetries between in-service and pre-service teachers. Data from the initial LS cycles revealed a 'hesitancy threshold' among pre-service participants (PM1, PM3), who initially deferred to the pedagogical wisdom of in-service teachers. However, the model addressed this imbalance by attributing pre-service teachers the role of technology and analytics leads. By positioning pre-service teachers as experts in digital fluency and real-time data collection, the framework catalyzed a process of 'pedagogical unlearning' for in-service teachers. In this role-reversal, in-service teachers moved from a position of authority to a learner's stance, discarding outdated 'one-size-fits-all' practices in favor of the innovative, inclusive strategies proposed by their younger colleagues. This shift was further solidified by a structured turn-taking protocol during post-lesson conferences, where pre-service teachers presented their observations and reflections first. This ensured that the dialogue was grounded in objective student data rather than hierarchical seniority, transforming the collaboration from a top-down mentorship into a transdisciplinary synergy.

The LS structure fundamentally supports distributed leadership by relying on interactions where every member respects the individual abilities and contributions of their peers. As specifically shared during post-LS interviews, participants perceived that this supportive environment nurtures self-esteem (PM1, PM3), increasing team members' active engagement because their inclusion and abilities are valued (IM3, IS3, IM2). The resulting combination of self-confidence and collaboration actively drives the team toward achieving shared objectives (Flanagan et al., 2024; Gómez-Jorge and Díaz-Garrido, 2023). This confidence, in turn, fosters increased motivation and belief

in one's capacity to contribute, ultimately amplifying collective achievement. Additionally, participants' post-LS interviews (IM4, IM2) showed that the promotion of open and regular communication during LS is critical, contributing to productive engagement. Studies consistently confirm that open communication positively affects team performance by facilitating relationships, establishing a supportive environment that encourages work engagement, knowledge sharing, and innovative behavior (Escribá-Carda et al., 2023; Koo et al., 2022). Crucially, regular communication also enables teams to constructively identify and resolve differences and potential conflicts, maintaining team cohesion (Johnson and Johnson, 2009).

4.3 Collaboration, inclusion, and educational innovations

The subsequent sections offer a comprehensive analysis of the educational innovations identified throughout the LS cycles, specifically involving student-centered pedagogies, integration of technology, and the adaptation of physical learning environments. A deeper evaluation of the preceding data illustrates how the collaborative framework of LS, shown in Figure 4, not only inspires innovative behavior but also plays a critical role in establishing accessible and equitable learning environments.

4.3.1 Student-centred pedagogies

The various lessons delivered during the LS cycles—such as explicit instruction, gamification, problem posing, and arts integration—highlight how student-centred principles lead to differentiated instruction and innovative design. During LS implementations, four separate lesson deliveries demonstrated a clear application of explicit instructional techniques, specifically through the utilization of the CRA approach. During lesson observations, the LS team highlighted how the CRA approach benefited students by using stimulating resources to maintain focus (IM1). Furthermore, this method allowed learners to navigate complex tasks with greater ease and clarity (IS2). Consistent with the findings of previous studies (McElroy et al., 2024; Yakubova et al., 2024), the use of explicit instruction leverages learners' strengths through varied modalities and breaks down complex tasks into manageable parts, directly addressing gaps in prerequisite knowledge required for inclusion. The integration of arts was also observed during LS cycles, specifically appearing in two of the sixteen lessons. This approach serves as a form of embodied learning, a strategy that the OECD (2016) suggests prioritizes the physical and emotional dimensions of the educational experience over purely cognitive processes. The LS team noted that student engagement and creativity flourished when lessons included arts-based activities such as singing and dancing (PS2, PM2). These improvements were largely attributed to the diverse composition of the LS team; SPED teachers contributed unique methods for addressing learner variability (PS2), and in-service teachers provided seasoned perspectives that helped innovate instructional delivery (PM2). In line with Pan et al. (2024), the results underscore

how collaborative efforts foster an environment conducive to teacher-led innovation. The data further reinforces the necessity of interdisciplinary cooperation, particularly between regular and special educators, as a cornerstone for strengthening inclusive pedagogical practices (Paulsrud and Nilholm, 2023).

Game-based pedagogy was featured in six research lessons during LS implementations, with participants noting that the use of vibrant, interactive, and tactile materials successfully captured student attention (IS1, PM2). These elements were vital for boosting learner engagement (PS1, PM2), reinforcing existing literature which suggests that gamification fosters essential skills such as self-regulation, teamwork, and creative exploration (Tomé Klock et al., 2024). Additionally, three lessons utilized a problem-posing strategy, where students were tasked with constructing their own word problems from given data. This approach was found to stimulate higher-order cognition (IM2) and serve as a diagnostic tool for identifying student misconceptions (IM1). As a form of differentiated instruction, problem-posing allows for the customization of content to fit various learning profiles (Gheysens et al., 2023) while providing educators with clear insights into student conceptual mastery, enabling the delivery of targeted support (Basister and Kawai, 2018). The shift toward student-centered pedagogies was the result of the collaborative intervention negotiated between pre-service teachers' digital fluency and in-service teachers' pedagogical experience. For example, during the LS planning phase, the team engaged in joint-sense-making to ensure that gamified elements were not just engaging, but specifically calibrated for the diverse learning profiles in the classroom. This collaborative filtering allowed the team to 'unlearn' traditional lecturing in favor of a gamified structure that provided real-time inclusion data.

4.3.2 Technology integration

Instructional innovation was further evidenced by the prevalent use of digital tools and data analytics within the classroom. Technological integration was observed in over 60% of the lessons during LS cycles, featuring hardware and software such as LCD projectors, multimedia presentations, and mobile devices. These tools were reported to have heightened student focus and enthusiasm (PM1). Simultaneously, the application of learning analytics streamlined the data collection process, empowering educators to offer more immediate and precise feedback (IS1). Such findings mirror the conclusions of Bešić et al. (2024) and Paolucci et al. (2024), who argue that educational technology is a vital instrument for optimizing learning outcomes and guiding evidence-based teaching practices. Technological innovation in education not only clarifies individual learning trajectories but also serves as a vehicle for social inclusion (Khalil et al., 2024). This was demonstrated in two research lessons where the LS team proactively mitigated the digital divide. By opting for paper-based QR card systems (PS1, IM1), the educators bypassed barriers related to internet connectivity and hardware affordability (Lythreitis et al., 2022). This was consistent with the concerns-based adoption model for innovations (Hall, 1979), emphasizing the crucial roles of teachers in the successful implementation of innovations in the classrooms (Stevens et al.,

2024). Moreover, while veteran educators often lead collaborative efforts (Coenders and Verhoef, 2019), the involvement of pre-service and early-career teachers was instrumental in optimizing classroom technology (IM1, IM2). These interactions underscore how LS acts as a bridge between theoretical knowledge and practical application, fostering pedagogical expertise and sharper observational skills in novice teachers.

4.3.3 Learning space modifications

Contextualization of instruction and resources was a prominent feature in the majority of observed sessions, occurring in 11 of the 16 lessons during LS cycles. The LS teams adapted these materials not only to meet individualized student requirements (IS3, IS4) but also to comply with institutional mandates concerning cultural, linguistic, and socioeconomic diversity (DM No. 008, 2023). By aligning curriculum content with the lived experiences of the students, educators successfully increased learner motivation and participation (IM3). As noted by Page et al. (2024), pedagogical flexibility that accounts for group dynamics and relevant environmental contexts strengthens the bond between students, their curriculum, and their community. The strategic reconfiguration of classroom seating and student grouping served as another key spatial innovation observed during LS cycles. Adaptable seating arrangements and varied grouping strategies were observed as alternative methods for fostering a safe, collaborative learning environment (Grannäs et al., 2025). These social configurations promote empathy among students, which Rutland et al. (2005) identify as a pillar of successful teaching. Moreover, the habit of explicitly stating goals and summarizing key takeaways shifted the classroom focus from mere content delivery to student understanding. Consistent with the idea of UDL (Almeqdad et al., 2023; Karisa, 2023), this structured approach helps learners track their own progress and is particularly helpful for those with special educational needs, as it clarifies conceptual relationships and aids in the retention of information. The transformation of the classroom into a 'fluid learning hub' was driven by the collective analysis of spatial observation maps. Rather than a top-down mandate, the spatial reconfigurations were the result of the team's shared reflection on where students experienced barriers to engagement. By collaboratively 'reading' the classroom's physical flow during the LS post-lesson discussion, the participants co-constructed a layout that maximized proximity between support staff and CSEs, thereby manifesting 'inclusion' through a shared spatial agency.

5 Conclusion

As illustrated in Figure 4, this research demonstrates how the LS cycles implemented in this study can serve as a powerful catalyst for transformative teacher collaboration, driving both educational innovation and inclusive practice. The shift from traditional, intradisciplinary models toward a transdisciplinary structure of collaboration is fundamental to this transformation, as it provided opportunities for the integration of the specialized expertise of the involved mathematics, SPED, in-service, and

preservice teachers. This collaborative synergy not only bridged the gap between theoretical knowledge and classroom practice but also fostered a culture of collective ownership and systemic equity. The systematic, sustained, and iterative nature of the LS cycle provided the necessary framework for these innovations to take root. Theoretically, this study reinforces socio-cultural theory (Vygostky, 1978) by illustrating how transdisciplinary LS collaboration improved professional practice through social interaction as a primary mechanism for refinement. By engaging in this continuous process, the LS process inherently embeds Universal Design for Learning principles (Almeqdad et al., 2023; Karisa, 2023) into teacher preparation and development, ensuring that pedagogical innovations are systematically designed for accessibility from the outset. Furthermore, the student-centered focus of this collaboration was enhanced by a nuanced understanding of how educators navigate the complexities of instructional change. As supported by the concerns-based adoption model for innovation (Hall, 1979), LS activities addressed specific stages of teacher concern—ranging from personal apprehensions regarding new technology to the refinement of its instructional impact. This transition is further supported by cross-generational dialogue between preservice and in-service teachers, which could help practitioners “unlearn” outdated routines while fostering distributed leadership and a sense of collective accountability (Basister et al., 2025b; Coenders and Verhoef, 2019). Consequently, these findings advance the understanding of teacher professional development through both theoretical and practical lenses.

Figure 4 further identifies other key design principles for collaboration that can facilitate innovations and inclusion. First is the careful consideration of the educational context and content diversity. Engaging in LS increases teachers' awareness of and concern for the diverse needs of their students. This foundational understanding is critical for promoting inclusive education, as it can shape the creation of responsive materials and inclusive practices (Basister et al., 2025a). Second, the cyclical nature of LS supports universal and differentiated methodology design. Specifically, the structured planning phase empowers teachers to re-evaluate lesson structures and develop sophisticated instructional design skills. This process compels educators to explore innovative methods, ensuring that all students can succeed regardless of their background or learning needs (Cajkler et al., 2013; Cohan and Honigsfeld, 2007). Third, crucial to the success of collaboration is the integration of support services expertise. LS cycles in this study fostered the essential recognition and utilization of support teachers, such as SPED professionals, within the general education classroom. This integration of specialized expertise is vital for selecting, analyzing, and sharing successful educational experiences specifically tailored for learners with additional needs (Voinea and Topalã, 2018). Finally, collaboration is sustained by distributed leadership and design responsibility. The LS structure supported this by fostering an environment where every member's unique ability and contribution are respected and valued. This inclusive atmosphere can nurture self-esteem and self-confidence among collaborating teachers (Flanagan et al., 2024; Gómez-Jorge and Díaz-Garrido, 2023), which in turn can amplify collective achievement and actively drive innovative behavior within the teaching community (Escribá-Carda et al., 2023; Koo et al., 2022).

The study further identified three critical dimensions of innovative and inclusive practices facilitated through the cyclical process of LS. First, the implementation of student-centered pedagogies was developed through collaborative planning and reflection. This enabled educators to utilize diverse strategies such as the CRA approach, problem-posing, game-based, and embodied learning. These instructional methods provided opportunities for differentiation, empowering learners to navigate complex tasks while simultaneously deepening their creative and cognitive engagement. Second, the integration of technology and data served as a cornerstone for innovation, where the strategic application of digital tools and learning analytics supported more precise, evidence-based instructional decisions. Notably, the collaborative teams demonstrated a commitment to equity by proactively mitigating the digital divide; they adopted low-tech, inclusive alternatives, such as paper-based QR cards, to ensure that socioeconomic barriers regarding device access did not hinder student participation. Finally, strategic modifications to the learning space played a vital role in fostering an inclusive atmosphere. By reconfiguring the physical environment through flexible seating and varied grouping, educators promoted a sense of security and empathy among a diverse student body. This spatial innovation was further supported by a focus on structured and clear lesson framing, which provided essential cognitive scaffolding to assist struggling learners.

6 Limitations and future directions

Despite positive outcomes from this study, certain limitations must be acknowledged. The transition to a transdisciplinary model required challenging established institutional guidelines and discipline-specific routines, which may present barriers to scaling this model in different contexts. Furthermore, while the study captured shifts in teacher competencies, the long-term sustainability of these innovations beyond the research cycle remains to be explored. Building on these insights, future inquiries may employ longitudinal designs to evaluate the long-term academic and social-emotional benefits for students as they transition through grade levels taught by LS-trained educators. While this research established the success of collaboration between preservice, in-service, mathematics, and SPED teachers, further inquiry is needed to determine how this cross-generational and transdisciplinary LS model adapts to other disciplines to ensure its scalability as a universal design principle. Additionally, future research may also explore how emerging technologies and advanced learning analytics can be ethically integrated into the LS cycle to further personalize instruction. Investigating the correlation between participation in transdisciplinary LS communities and the long-term retention of novice teachers will also be essential for maintaining the innovative momentum revealed in this study. Finally, a notable limitation of this research is the exclusion of formal post-lesson pupil interviews, often referred to as ‘learner voice’ in modern LS adaptations (Dudley et al., 2019). Consequently, while the spatial observation maps and teacher reflections offer robust evidence of engagement in this study, the subjective perspective of the learners themselves remains an area for future inquiry.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the University of the Philippines Los Baños Research Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MB: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JP: Supervision, Writing – original draft, Writing – review & editing. RB: Supervision, Writing – original draft, Writing – review & editing.

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References

- Acton, K. S. (2020). School leaders as change agents: do principals have the tools they need? *Manag. Educ.* 35 (1), 43–51. doi: 10.1177/0892020620927415
- Al-Eisawi, D. (2022). A design framework for novice using grounded theory methodology and coding in qualitative research: organisational absorptive capacity and knowledge management. *Int. J. Qual. Methods.* 21, doi: 10.1177/16094069221113551
- Aldridge, J. M., and McLure, F. I. (2024). Preparing schools for educational change: barriers and supports—a systematic literature review. *Leadersh. Policy. Sch.* 23 (3), 486–511. doi: 10.1080/15700763.2023.2171439
- Almeqdad, Q. I., Alodat, A. M., Alquraan, M. F., Mohaidat, M. A., and Al-Makhzoomy, A. K. (2023). The effectiveness of universal design for learning: a systematic review of the literature and meta-analysis. *Cogent Educ.* 10 (1), 2218191. doi: 10.1080/2331186X.2023.2218191
- Almumen, H. A. (2020). Universal design for learning (UDL) across cultures: the application of UDL in Kuwaiti inclusive classrooms. *Sage. Open.* 10 (4), 2158244020969674. doi: 10.1177/2158244020969674
- Alzoraiki, M., Ahmad, A. R., Ateeq, A., and Milhem, M. (2024). The role of transformational leadership in enhancing school culture and teaching performance in Yemeni public schools. *Front. Educ.* 9, 1413607. doi: 10.3389/feduc.2024.1413607
- Andrés, J., Alejandro, D., and Eduardo, D. (2025). Inclusive education through technology: a systematic review of types, tools and characteristics. *Front. Educ.* 10, 1527851. doi: 10.3389/feduc.2025.1527851
- Atanasova, D., and Papen, U. (2025). UK University teachers on inclusive education: conceptualizations, practices, opportunities and challenges. *Stud. High. Educ.*, 51 (1), 54–65. doi: 10.1080/03075079.2025.2455431
- Baena, S., Collet-Sabé, J., Garcia-Molsosa, M., and Manzano, M. (2022). More innovation, less inclusion? Debates and discussions regarding the intersectionality of innovation and inclusion in the Catalan school system: a position paper. *Int. J. Inclusion. Educ.* 26 (9), 865–877. doi: 10.1080/13603116.2020.1736653
- Quezon City, Philippines (grant numbers OILCOOP-2024-11 and OILCOOP-2024-12) and the Faculty of Education and Society, Malmö University, Malmö, Sweden.
- Bakoč, A., Brojčin, B., Banković, S., Glumbić, N., and Đorđević, M. (2025). Academic outcomes of inclusive education in typically developing children. *Front. Psychol.* 15, 1448935. doi: 10.3389/fpsyg.2024.1448935
- Baptista, M., Conceição, T., and Filipe, J. (2025). Lesson study enhancing pre-service teachers' learning in STEM education. *Int. J. Lesson Learn. Stud.*, doi: 10.1108/IJLLS-08-2024-0172
- Basister, M. P., and Kawai, N. (2018). Japan's educational practices for mathematically gifted students. *Int. J. Incl. Educ.* 22 (11), 1213–1241. doi: 10.1080/13603116.2017.1420252
- Basister, M. P., Petersson, J., and Bacongus, R. D. (2025a). Educational innovations for an inclusive learning environment: insights from the teachers' collaboration through lesson study. *Front. Educ.* 10, 1610749. doi: 10.3389/feduc.2025.1610749
- Basister, M. P., Petersson, J., and Bacongus, R. D. T. (2025b). Effects of lesson study on the perceived teaching competencies of mathematics and special education teachers. *Sage. Open.* 15(3), 21582440251365692. doi: 10.1177/21582440251365692
- Basister, M., Petersson, J., and Bacongus, R. (2026). Deconstructing teachers' mental models of collaboration through lesson study toward inclusive mathematics education. *Front. Educ.* doi: 10.3389/feduc.2026.1723824
- Baumfield, V., Bethel, A., Boyle, C., Katene, W., Knowler, H., Koutsouris, G., et al. (2022). How lesson study is used in initial teacher education: an international review of literature. *Teach. Dev.* 26 (3), 356–372. doi: 10.1080/13664530.2022.2063937
- Bešić, E., Frizzarin, A., and Todorova, K. (2024). Digital technology use in inclusive schools in four European countries: within- and between-school differences. *J. Res. Technol. Educ.*, 57 (1), 142–155. doi: 10.1080/15391523.2024.2378084
- Bruer, J. T. (2005). "Cognitive science: interdisciplinary and intradisciplinary collaboration," in *Interdisciplinary Collaboration: An Emerging Cognitive Science*. 1st ed, eds. S.J. Derry, C.D. Schunn, and M.A. Gernsbacher (New York, NY: Psychology Press). doi: 10.4324/9781410613073

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- Cajkler, W., Wood, P., Norton, J., and Pedder, D. (2013). Lesson study: towards a collaborative approach to learning in initial teacher education? *Camb. J. Educ.* 43 (4), 537–554. doi: 10.1080/0305764X.2013.834037
- Charmaz, K. (2014). Grounded theory in global perspective: reviews by international researchers. *Qual. Inq.* 20 (9), 1074–1084. doi: 10.1177/1077800414545235
- Charmaz, K., and Thornberg, R. (2021). The pursuit of quality in grounded theory. *Qual. Res. Psychol.* 18 (3), 305–327. doi: 10.1080/14780887.2020.1780357
- Cheung, W., and Wong, W. (2014). Does lesson study work?: a systematic review on the effects of lesson study and learning study on teachers and students. *Int. J. Lesson Learn. Stud.* 3 (2), 137–149. doi: 10.1108/IJLLS-05-2013-0024
- Coenders, F., and Verhoef, N. (2019). Lesson study: professional development (PD) for beginning and experienced teachers. *Prof. Dev. Educ.* 45 (2), 217–230. doi: 10.1080/19415257.2018.1430050
- Coffey, A., and Atkinson, P. (1996). *Making Sense of Qualitative Data. Complementary Research Strategies*. London: Sage.
- Cohan, A., and Honigsfeld, A. (2007). Incorporating 'lesson study' in teacher preparation. *Educ. Forum.* 71 (1), 81–92. doi: 10.1080/00131720608984570
- Conde, M.Á., and Rodríguez-Sedano, F. J. (2024). Is learning analytics applicable and applied to education of students with intellectual/developmental disabilities? A systematic literature review. *Comput. Human. Behav.* 155, 108184. doi: 10.1016/j.chb.2024.108184
- Daneshpour, H., and Kwegyir-Afful, E. (2022). Analysing transdisciplinary education: a scoping review. *Sci Educ.* 31, 1047–1074. doi: 10.1007/s11191-021-00277-0
- de Jong, L., Vaessen, A., Admiraal, W., and Schenke, W. (2025). The sustainable development of schools as professional learning communities: educators' views. *Educ. Res.* 67 (3), 309–328. doi: 10.1080/00131881.2025.2519579
- Debasu, H., and Yitayew, A. (2024). Examining elements of designing and managing of creating inclusive learning environment: systematic literature review. *Int. J. Spec. Educ.* 39 (1), 33–43. doi: 10.52291/ijse.2024.39.4
- Dell'Anna, S., Pellegrini, M., Ianes, D., and Vivanet, G. (2020). Learning, social, and psychological outcomes of students with moderate, severe, and complex disabilities in inclusive education: a systematic review. *Int. J. Disabil. Dev. Educ.* 69 (6), 2025–2041. doi: 10.1080/1034912X.2020.1843143
- DeMatthews, D., Billingsley, B., McLeskey, J., and Sharma, U. (2020). Principal leadership for students with disabilities in effective inclusive schools. *J. Educ. Adm.* 58 (5), 539–554. doi: 10.1108/JEA-10-2019-0177
- Dibaba, T. Y., Lemma, A., Faith, M., and Hunde, A. B. (2024). The potential of lesson study in enhancing secondary school mathematics teachers' pedagogical practices in lesson planning: evidence from Ethiopia. *Int. J. Lesson Learn. Stud.* 13 (4), 233–245. doi: 10.1108/IJLLS-01-2024-0023
- Dubois, A., and Gadde, L. (2002). Systematic combining: an abductive approach to case research. *J. Bus. Res.* 55 (7), 553–560. doi: 10.1016/S0148-2963(00)00195-8
- Dudley, P., Xu, H., Vermunt, J. D., and Lang, J. (2019). Empirical evidence of the impact of lesson study on students' achievement, teachers' professional learning and on institutional and system evolution. *Eur. J. Educ.* 54 (2), 202–217. doi: 10.1111/ejed.12337
- Elipane, L. E. (2017). Introducing lesson study as a professional development model in the islands of the Philippines. *Adv. Sci. Lett.* 23, 1126–1129. doi: 10.1166/asl.2017.7514
- Escribá-Carda, N., Canet-Giner, T., and Balbastre-Benavent, F. (2023). The role of engagement and knowledge-sharing in the high-performance work systems-innovative behaviour relationship. *Eur. J. Manag. Bus. Econ.*, 33 (1), 19–37. doi: 10.1108/EJMBE-07-2022-0206
- Everatt, J., Fletcher, J., and Fickel, L. (2019). School leaders' perceptions on Reading, writing and mathematics in innovative learning environments. *Educ. 3-13* 47 (8), 906–919. doi: 10.1080/03004279.2018.1538256
- Fasting, R. B., and Breilid, N. (2023). Cross-professional collaboration to improve inclusive education. *Scand. J. Educ. Res.* 68 (4), 661–676. doi: 10.1080/00313831.2023.2175248
- Flanagan, B., Hourigan, M., and Leavy, A. (2024). Implementation of lesson study in the context of STEM education in a rural setting in Ireland: challenges and opportunities. *Int. J. Lesson Learn. Stud.* 13 (2), 57–70. doi: 10.1108/IJLLS-11-2023-0162
- Fletcher, J., Everatt, J., Subramaniam, Y. D. B., and Ma, T. (2023). About innovative and traditional learning spaces: teachers and students in New Zealand primary schools. *N. Z. J. Educ. Stud.* 58, 133–151. doi: 10.1007/s40841-023-00280-9
- Georgiou, Y., and Ioannou, A. (2019). Teachers' concerns about adopting technology-enhanced embodied learning and their mitigation through professional development. *J. Technol. Teach. Educ.* 27 (3), 335–371. Waynesville, NC USA: Society for Information Technology & Teacher Education. doi: 10.70725/777910ngamnp
- Ghedin, E. (2021). "Social innovation through collaboration for enabling educational inclusive EcoSystems: following Italy's lead," in *Instructional Collaboration in International Inclusive Education Contexts (International Perspectives on Inclusive Education, Vol. 17)*, eds. S.R. Semon, D. Lane, and P. Jones (Leeds: Emerald Publishing Limited), 71–96. doi: 10.1108/S1479-363620210000017008
- Gheysens, E., Grifol-Freixenet, J., and Struyven, K. (2023). "Differentiated instruction as an approach to establish effective teaching in inclusive classrooms," in *Effective Teaching Around the World*, eds. R. Maulana, M. Helms-Lorenz, and R.M. Klassen (Cham: Springer), 723–747. doi: 10.1007/978-3-031-31678-4_30
- Gómez-Jorge, F., and Díaz-Garrido, E. (2023). The relation between self-esteem and productivity: an analysis in higher education institutions. *Front. Psychol.* 13, 1112437. doi: 10.3389/fpsyg.2022.1112437
- Grannäs, J., Frelin, A., and Östlin, T. (2025). Unpacking flexibility in innovative learning environments—teachers' experiences in practice. *Educ. Stud.*, 52 (1), 88–104. doi: 10.1080/03055698.2024.2448781
- Gräsel, C., Fußangel, K., and Pröbstel, C. (2006). Lehrkräfte zur Kooperation anregende aufgabe für sisyphos? *Zeitschrift Pädagogik* 52 (2), 205–219.
- Green, L. (2024). Teacher collaboration for student-centered project-based curriculum development in the supplementary school: what do teachers need? *J. Jewish Educ.* 90 (4), 330–346. doi: 10.1080/15244113.2024.2415085
- Gurin, P., Dey, E. L., Hurtado, S., and Gurin, G. (2002). Diversity and higher education: theory and impact on educational outcomes. *Harv. Educ. Rev.* 72 (3), 330–366. doi: 10.17763/haer.72.3.01151786u134n051
- Hall, G. E. (1979). The concerns-based approach to facilitating change. *Educ. Horiz.* 57 (4), 202–208.
- Hannafin, M. J., and Land, S. M. (1997). The foundations and assumptions of technology-enhanced student-centered learning environments. *Instr. Sci.* 25 (3), 167–202. doi: 10.1023/A:1002997414652
- Hargreaves, A. (1994). *Changing Teachers, Changing Times: Teachers' Work and Culture in the Postmodern Age*. London: Cassell.
- Hargreaves, A., and O'Connor, M. T. (2018). *Collaborative Professionalism: When Teaching Together Means Learning for all*. Corwin: a SAGE Company.
- Hernandez, S. (2013). Collaboration in special education: its history, evolution, and critical factors necessary for successful implementation. *US-China Educ. Rev.* 3 (6), 480–498.
- Hornstra, L., van der Veen, I., Peetsma, T., and Volman, M. (2014). Innovative learning and developments in motivation and achievement in upper primary school. *Educ. Psychol. (Lond)* 35 (5), 598–633. doi: 10.1080/01443410.2014.922164
- Jimenez-Silva, M., and Olson, K. (2012). A community of practice in teacher education: insights and perceptions. *Int. J. Teach. Learn. Higher Educ.* 24 (3), 335–348.
- Johnson, B. (2003). Teacher collaboration: good for some, not so good for others. *Educ. Stud.* 29 (4), 337–350. doi: 10.1080/0305569032000159651
- Johnson, D. W., and Johnson, R. T. (2009). An educational psychology success story: social interdependence theory and cooperative learning. *J. Educ. Res.* 38 (5), 365–379. doi: 10.3102/0013189X09339057
- Johnson, I. P. (2025). "Evaluation of the effect of educational innovation on learning outcomes in anatomy: a role for prospective items in assessments," in *International Anatomical Education. Biomedical Visualization, vol 9*, eds. I.D. Keenan, I. Stabile, and A. Venkatesh (Cham: Springer), 89–110. doi: 10.1007/978-3-031-91849-0_5
- Johnson-Harris, K., and Mundschenk, N. (2014). Working effectively with students with BD in general education classroom: the case for universal design for learning. The clearing house: a journal of educational strategies. *Issues and Ideas* 87, 168–174. doi: 10.1080/00098655.2014.897927
- Johnstone, C., and Niad, H. (2022). "Curriculum and inclusive education: universal design for learning as a "traveling" phenomenon," in *International Encyclopedia of Education: Fourth Edition*, eds. R. J. Tierney, F. Rizvi, and K. Ericson (Oxford: Elsevier), 440–446. doi: 10.1016/B978-0-12-818630-5.03076-1
- Kager, K., Kalinowski, E., Jurczok, A., and Vock, M. (2024). A systematic review of transparency in lesson study research: how do we report on the observation and reflection stages? *Front. Educ.* 9, 1322624. doi: 10.3389/feduc.2024.1322624
- Karisa, A. (2023). Universal design for learning: not another slogan on the street of inclusive education. *Disabil. Soc.* 38 (1), 194–200. doi: 10.1080/09687599.2022.2125792
- Kelle, U. (1995). "Theories as heuristic tools in qualitative research," in *Openness in Research. The Tension Between Self and Other*, eds. I. Maso, P.A. Atkinson, S. Delamont, and J.C. Verhoeven (Assen: van Gorcum), 33–50.
- Khalil, M., Slade, S., and Prinsloo, P. (2024). Learning analytics in support of inclusiveness and disabled students: a systematic review. *J. Comput. High. Educ.* 36, 202–219. doi: 10.1007/s12528-023-09363-4
- Klein, J. T. (2018). "Learning in transdisciplinary collaborations: a conceptual vocabulary," in *Transdisciplinary Theory, Practice and Education*, eds. D. Fam, L. Neuhauser, and P. Gibbs (Cham: Springer), 11–23. doi: 10.1007/978-3-319-93743-4_2
- Koo, Y., Kim, S. J., and Song, J. H. (2022). The moderating effect of communication on congruence and incongruence of openness to change: is communication always beneficial for learning organization culture and knowledge sharing? *Learn. Organ.* 29 (2), 172–190. doi: 10.1108/TLO-02-2021-0025
- Koon, V. Y., Yeng, S. K., Meng, C. S., and Chuen, P. W. (2025). Transformative trends and challenges: navigating disruptive innovation in higher education through bibliometric insights. *Innov. Educ. Teach. Int.*, 63 (1), 112–125. doi: 10.1080/14703297.2025.2469080

- Korthals Altes, T., Willemse, M., Goei, S. L., and Ehren, M. (2024). Higher education teachers' understandings of and challenges for inclusion and inclusive learning environments: a systematic literature review. *Educ. Res. Rev.* 43, 100605. doi: 10.1016/j.edurev.2024.100605
- Lewis, C., Perry, R., and Murata, A. (2006). How should research contribute to instructional improvement? *The Case of Lesson Study. Educational Researcher* 35 (3), 3–14. doi: 10.3102/0013189X035003003
- Liu, Q., and Sun, Y. (2025). The impact of collaborative atmosphere on innovative work behavior of college teachers, north China. *Front. Psychol.* 15, 1497503. doi: 10.3389/fpsyg.2024.1497503
- Lu, S. C. Y., and Liu, A. (2011). Abductive reasoning for design synthesis. *CIRP Annals* 61 (1), 143–146. doi: 10.1016/j.cirp.2012.03.062
- Lythreath, S., Singh, S. K., and El-Kassar, A.-N. (2022). The digital divide: a review and future research agenda. *Technol. Forecast. Soc. Change.* 175, 121359. doi: 10.1016/j.techfore.2021.121359
- Mahat, M., Bradbeer, C., Byers, T., and Imms, W. (2018). *Innovative Learning Environments and Teacher Change: Defining Key Concepts*. Melbourne: University of Melbourne, LEARN. Available online at: <http://www.ilet.com.au/publications/reports> (Accessed January 15, 2026).
- Masters, C., O'Toole Baker, V., and Jodon, H. (2013). Multidisciplinary, team-based learning: the simulated interdisciplinary to multidisciplinary progressive-level education (SIMPLE©) approach. *Clin. Simul. Nurs.* 9 (5), e171–e178. doi: 10.1016/j.ecns.2011.11.007
- McElroy, A. R., Van Stratton, J. E., and Sherlund-Pelfrey, P. (2024). A systematic review of explicit instruction and frequency building interventions to teach students to write. *Educ. Treat. Child.* 47 (2), 165–181. doi: 10.1007/s43494-024-00125-0
- McMahon, M., Forde, C., and Martin, M. (2010). *Contemporary Issues in Learning and Teaching*. London: SAGE Publication, 119.
- Methlagl, M. (2021). Patterns of teacher collaboration, professional development, and teaching practices: a multiple correspondence analysis of TALIS 2018. *Int. J. Educ. Res. Open* 3, 100137. doi: 10.1016/j.ijedro.2022.100137
- Miller-Young, J., and Yeo, J. (2015). Conceptualizing and communicating SoTL: a framework for the field. *Teach. Learn. Inq.* 3 (2), 37–53. doi: 10.20343/teachlearninqu.3.2.37
- Mutton, T., Hagger, H., and Burn, K. (2011). Learning to plan, planning to learn: the developing expertise of beginning teachers. *Teach. Teach.* 17 (4), 399–416. doi: 10.1080/13540602.2011.580516
- Mydin, A. A., Anoar, A., and Romly, R. (2025). Driving educational innovation: the role of transformational leadership and professional learning community in Malaysian vocational college. *Innov. Educ. Teach. Int.*, 63 (2), 215–231. doi: 10.1080/14703297.2025.2471978
- Norwich, B., and Ylonen, A. (2015). Lesson study practices in the development of secondary teaching of students with moderate learning difficulties: a systematic qualitative analysis in relation to context and outcomes. *Br. Educ. Res. J.* 41, 629–649. doi: 10.1002/berj.3167
- OECD (2015a). *Innovation Policies for Inclusive Growth*. Paris: OECD Publishing.
- OECD (2015b). *Students with Disabilities, Learning Difficulties and Disadvantages: Policies, Statistics and Indicators*. Paris: OECD Publishing.
- OECD (2016). *Innovating Education and Educating for Innovation: The Power of Digital Technologies and Skills*. Paris: OECD Publishing. doi: 10.1787/9789264265097-en
- Ozdemir, S., Carlos Fernandez de Arroyabe, J., Sena, V., and Gupta, S. (2023). Stakeholder diversity and collaborative innovation: integrating the resource-based view with stakeholder theory. *J. Bus. Res.* 164, 113955. doi: 10.1016/j.jbusres.2023.113955
- Page, A., Anderson, J., and Charteris, J. (2024). Innovative learning environments and spaces of belonging for students with disability in mainstream settings. *Camb. J. Educ.* 54 (5), 607–626. doi: 10.1080/0305764X.2024.2397398
- Page, A., and Davis, A. (2023). The alignment of innovative learning environments and inclusive education: how effective is the new learning environment in meeting the needs of special education learners? teachers'. *Work* 20 (2), 316–333. doi: 10.24135/teacherswork.v20i2.612
- Pan, H., Lin, Y., and Chung, C. (2024). Teacher collaboration, school innovativeness, and innovative teaching in Taiwan: evidence from TALIS. *Int. J. Educ. Res.* 127, 102383. doi: 10.1016/j.ijer.2024.102383
- Paolucci, C., Vancini, S., Bex, R. T. II, Cavanaugh, C., Salama, C., and De Araujo, Z. (2024). A review of learning analytics opportunities and challenges for K-12 education. *Heliyon* 10 (4), e25767. doi: 10.1016/j.heliyon.2024.e25767
- Paulsrud, D., and Nilholm, C. (2023). Teaching for inclusion—a review of research on the cooperation between regular teachers and special educators in the work with students in need of special support. *Int. J. Inclusion Educ.* 27 (4), 541–555. doi: 10.1080/13603116.2020.1846799
- Peter, F. (2013). Principles of good practice in SoTL. *Teach. Learn. Inquiry ISSOTL J.* 1 (1), 121–125. doi: 10.20343/teachlearninqu.1.1.121
- Pimmer, C., Pachler, N., Nierle, J., and Genewein, U. (2012). Learning through inter- and intradisciplinary problem solving: using cognitive apprenticeship to analyse doctor-to-doctor consultation. *Adv. Health Sci. Educ.* 17 (5), 759–778. doi: 10.1007/s10459-012-9350-7
- Rainforth, B., and England, J. (1997). Collaboration for inclusion. *Educ. Treat. Child.* 20 (1), 85.
- Rao, K., and Meo, G. (2016). Using universal design for learning to design standards-based lessons. *Sage. Open.* 6 (4), 2158244016680688. doi: 10.1177/2158244016680688
- Reigeluth, C. M., Beatty, B. J., and Myers, R. D. (Eds.). (2016). *Instructional-Design Theories and Models, Volume IV: The Learner-Centered Paradigm of Education*, 1st Edn. (Oxford: Routledge), 5–32. doi: 10.4324/9781315795478
- Richardson, R., and Kramer, E. H. (2006). Abduction as the type of inference that characterizes the development of a grounded theory. *Qual. Res.* 6 (4), 497–513. doi: 10.1177/1468794106068019
- Rogers, E. M. (2003). *Diffusion of Innovations*. 5th ed. New York, NY: Free Press.
- Rutland, A., Cameron, L., Milne, A., and McGeorge, P. (2005). Social norms and self-presentation: children's implicit and explicit intergroup attitudes. *Child. Dev.* 76 (2), 451–466. doi: 10.1111/j.1467-8624.2005.00856.x
- Schipper, T. M., Goei, S. L., Van Joolingen, W. R., Willemse, T. M., and Van Geffen, E. C. (2020). Lesson study in Dutch initial teacher education explored: its potential and pitfalls. *Int. J. Lesson Learn. Stud.* 9 (4), 351–365. doi: 10.1108/ijlls-04-2020-0018
- Stephanie, L. M. (2010). Implications of collaboration in education. *Acad. Leadersh.* 8, 35. doi: 10.58809/OULX4484
- Stevens, T. M., Day, I. N. Z., den Brok, P. J., Prins, F. J., Assen, H. J. H. E., ter Beek, M., et al. (2024). Teacher professional learning and development in the context of educational innovations in higher education: a typology of practices. *High. Educ. Res. Dev.* 43 (2), 437–454. doi: 10.1080/07294360.2023.2246412
- Strachan, S., Logan, L., Willison, D., Bain, R., Roberts, J., Mitchell, I., et al. (2023). Reflections on developing a collaborative multi-disciplinary approach to embedding education for sustainable development into higher education curricula. *Emerald Open Res.* 1 9. doi: 10.1108/EOR-09-2023-0007
- Thornberg, R. (2012). Informed grounded theory. *Scand. J. Educ. Res.* 56 (3), 243–259. doi: 10.1080/00313831.2011.581686
- Tie, Y. C., Birks, M., and Francis, K. (2019). Grounded theory research: a design framework for novice researchers. *SAGE. Open. Med.*, doi: 10.1177/2050312118822927
- Timmermans, S., and Tavory, I. (2012). Theory construction in qualitative research: from grounded theory to abductive analysis. *Sociol. Theory* 30 (3), 167–186. doi: 10.1177/0735275112457914
- Tomé Klock, A. C., Palomino, P. T., Lima Rodrigues, L. A., Toda, A. M., Simanke, S., Spors, V., et al. (2024). Gamification towards and alongside equity, diversity and inclusion: looking back to move forward. *New Media Soc.* 27 (1), 142–168. doi: 10.1177/1461448241254028
- UNESCO (2019). *Inclusive Education: The Way of the Future*. Paris: UNESCO. Available online at: <https://en.unesco.org/themes/inclusion-in-education> (Accessed January 15, 2026).
- Utley, B., and Rapport, M. (2002). Essential elements of effective teamwork: shared understanding and differences between special educators and related service providers. *Phys. Disabil. Educ. Related Serv.* 20 (2), 9–47.
- Vangrieken, K., Dochy, F., Raes, E., and Kyndt, E. (2015). Teacher collaboration: a systematic review. *Educ. Res. Rev.* 15, 17–40. doi: 10.1016/j.edurev.2015.04.002
- Verhoef, N., Tall, D., Coenders, F., and Smaalem, D. V. (2014). The complexities of a lesson study in a Dutch situation: mathematics teacher learning. *Int. J. Sci. Math. Educ.* 12, 859–881. doi: 10.1007/s10763-013-9436-6
- Voinea, M., and Topală, I. R. (2018). Support teacher as key factor of integration children with special education needs in mainstream school. *Eur. J. Soc. Sci. Educ. Res.* 5 (3), 166–171. Revistia Research and Publishing. doi: 10.2478/ejser-2018-0058
- Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.
- Welch, M., and Tulbert, B. (2000). Practitioners' perspectives of collaboration: a social validation and factor analysis. *J. Educ. Psychol. Consult.* 11 (3), 357–378. doi: 10.1207/S1532768XJEP113&4_05
- White, S. W., Scchill, L., and Ollendick, T. H. (2016). "Multimodal treatment for anxiety and social skills difficulties in adolescents on the autism Spectrum," in *CBT for Children and Adolescents with High-Functioning Autism Spectrum Disorders*, eds. A. Scarpa, S. White, and T. Attwood (New York, NY: Guilford Press), 123–132.
- Wolthuis, F., van Veen, K., de Vries, S., and Hubers, M. (2020). Between lethal and local adaptation: lesson study as an organizational routine. *Int. J. Educ. Res.* 100, 101534. doi: 10.1016/j.ijer.2020.101534

Wong, J. L. N. (2010). Searching for good practice in teaching: a comparison of two subject-based professional learning communities in a secondary school in Shanghai. *Compare* 40 (5), 623–639. doi: 10.1080/03057920903553308

Wood, P., and Cajkler, W. (2017). Lesson study: a collaborative approach to scholarship for teaching and learning in higher education. *J. Furth. High. Educ.* 42 (3), 313–326. doi: 10.1080/0309877X.2016.1261093

Wullschleger, A., Vörös, A., Rechsteiner, B., Rickenbacher, A., and Maag Merki, K. (2022). Improving teaching, teamwork, and school organization: collaboration networks in school teams. *Teach. Teach. Educ.* 121, 103909. doi: 10.1016/j.tate.2022.103909

Yakubova, G., Nozari, M., and Lee, Y. (2024). A systematic review of evidence-based instruction for developing fraction concepts of autistic students and those with intellectual and developmental disabilities. *Rev J Autism Dev Disord.* 12 (1), 156–172. doi: 10.1007/s40489-024-00473-y

Appendix A

Theoretic-Analytic mapping.

Theoretical Framework	Generative concept	Sample Transcript	Categorical Theme	Final design principle
Sociocultural Theory	Zone of Proximal Development/More Knowledgeable Other	<p><i>“the active participation of SPED teachers offered the team additional insights on how to tailor math lesson materials and strategies for CSENs.” (PM1)</i></p> <p><i>“as an in-service teacher, I can say that the involvement of preservice teachers helped the team in discussing age-appropriate ideas, strategies, and learning resources for the effective delivery of our research lessons.” (IM2)</i></p>	Structure of collaboration	<p>Transdisciplinary structure</p> <ul style="list-style-type: none"> - The transdisciplinary form of LS collaboration improves professional knowledge and practice
Concerns-based Adoption Model	Stages of Concern	<p><i>“First, I was hesitant to share my ideas during LS sessions since I am aware that the other participants are of veteran status and hold leadership roles.” (PM1)</i></p> <p><i>“Having pre-service and younger teachers in the team was instrumental in incorporating technology into the research lessons.” IS3</i></p>	Community engagement	<p>Student-centered pedagogies</p> <ul style="list-style-type: none"> - LS activities addressed specific stages of teacher concern—ranging from personal apprehensions (i.e., career stage, new technology) to the refinement of lessons
Universal Design for Learning	Multiple Means of Engagement	<p><i>“my participation in LS cycles enhanced my knowledge and skills related to designing lessons catering to the diverse needs of learners.” (PM1)</i></p> <p><i>“After participating in the series of LS activities, I realized that CSENs can successfully engage in classroom activities when provided with appropriate support and materials.” (IM4)</i></p>	Understanding diversity	<p>Systematic, sustained, and iterative activities</p> <ul style="list-style-type: none"> - The cyclical structure of LS evolves collaboration from superficial sharing into sustained, evidence-based development, ensuring pedagogical innovations are systematically designed for accessibility from the outset.