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Educational innovations for an inclusive learning environment: insights from the teachers' collaboration through lesson study

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Lesson Study (LS) is one of the collaborative practices that fosters deep interdependence among teachers. This deeper level of collaboration is vital in producing educational innovations that can lead to a more inclusive learning environment. Thus, this paper describes specific educational innovations that could promote inclusive learning environments developed and implemented by teachers during LS implementations. Using phenomenography, this study found various educational innovations emphasizing student-centered pedagogies, technology integration, and learning space modifications designed to address students' diverse needs during the teaching and learning process. Further data analyses also showed that the collaborations through LS fostered teachers' awareness of diverse learner needs, promoted student-centered planning, and encouraged input from veteran, novice, and special education teachers. These features of LS collaborations are crucial in developing inclusive and innovative practices. The findings from this study can help decision-makers optimize interventions, allocate resources strategically, and gain timely feedback on the impact of educational initiatives, such as LS, on the teaching and learning processes.

KEYWORDS

lesson study, teachers' collaboration, educational innovations, inclusive learning environment, inclusive practices

1 Introduction

In today's rapidly changing world, education must adapt by embracing innovative practices to meet the evolving needs of the teaching and learning processes. International comparative studies highlight the urgent need for innovation to improve student outcomes in critical thinking, literacy, numeracy, and science (OECD, 2023; Reynolds et al., 2024, 2022). Currently, various definitions of innovation are grounded in different contexts and disciplines. Innovation typically involves a deliberate effort to introduce change beyond incremental improvements (Cain et al., 2024; Carvalho et al., 2021). Thus, it usually requires a departure from routine practices and often entails the creation of something novel, such as a new idea, method, or product (Kopcha et al., 2016; Leron and Baconguis, 2021; Stevens et al., 2023). While innovation can encompass various aspects, such as new

processes or organizational structures, it primarily focuses on the generation of novel ideas and inventions (Littlejohn et al., 2019; Perren and Sapsed, 2013; Tassone et al., 2021).

In the education sector, previous scholars tried to describe the concept of educational innovation as the creation and dissemination of new educational tools (Walder, 2014). It also refers to contemporary practices of organizational and technological education capable of changing processes and techniques to improve the quality and productivity of educational services (Foray and Raffo, 2014). However, the work of Krstikj et al. (2022) highlights the lack of consensus on definitions within educational innovation, a challenge that resonates with the varied interpretations and adaptations of innovations across different educational contexts. Nevertheless, various studies claimed that innovations in education, whether implemented individually or collectively, are essential for ensuring quality learning experiences for all students (Laszlo et al., 2017; Vincent-Lancrin et al., 2017, 2019).

While there is no single definition of educational innovation, scholars generally agree that it necessitates deliberate changes within the learning environment (Krstikj et al., 2022; Stevens et al., 2023). This may involve the generation, introduction, or implementation of new processes, ideas, or materials aimed at enhancing educational outcomes (Zeb et al., 2020). Previous studies identified several key elements of educational innovations, including student-centered pedagogy, extending learning beyond the classroom, and the effective integration of technology (Bernard and Langworthy, 2011; Kalyani and Rajasekaran, 2018). These innovative practices often involve activities that encourage students to explore, brainstorm, collaborate with peers, engage with the community, and even seek expertise from professionals in a specific field (Sias et al., 2016; Vincent-Lancrin et al., 2019). Additionally, these educational innovations are considered to have a positive impact on students' learning outcomes by cultivating their creativity, critical thinking, problem-solving skills, and self-evaluation of ability (Ainley and Carstens, 2018; Le Donné et al., 2016).

Studies also established that collaborations between education stakeholders are vital in producing educational innovations that can lead to a more inclusive learning environment (DeMatthews et al., 2020; Ghedin, 2021). Thus, academic institutions should nurture interactions and collaborations between and among education stakeholders since these are vital for planning, implementing, and evaluating innovative educational programs and projects (Kunnari and Ilomäki, 2014; Leron and Baconguis, 2021; Liu and Sun, 2025; Miles, 2021). Additionally, these institutions also need to develop strategies for improving the mindset and perceptions of teachers about innovations since it could promote improvement in the quality of education services for diverse learners (Baena et al., 2020). Other scholars further claimed that collaborations (Fasting and Breilid, 2023; Ní Bhroin and King, 2019) and innovations (Baena et al., 2020; Page et al., 2024) are crucial tools for education professionals to achieve a more comprehensive view of the diverse needs of learners and promote a more inclusive learning environment.

2 Teachers' collaboration nurtures educational innovations

Implementing innovations in education often requires teachers to adopt new roles and tasks, including modifications of their behaviors (Littlejohn et al., 2019). This also necessitates the ability to generate and execute new ideas, which is crucial for the success of any innovative approach in education. Scholars refer to these abilities as "innovative behavior," emphasizing that educators must be willing to exert effort, remain focused, and possess the energy to develop and implement their novel ideas (Escribá-Carda et al., 2023; Zeb et al., 2020). Furthermore, a supportive work environment, such as a culture of collaboration, is also essential for successfully flourishing innovative practices. Several studies established that teachers' collaboration is one of the factors that could drive teachers' innovative behavior (Methlagl, 2021; Pan et al., 2024; Ronfeldt et al., 2015; Sargent, 2015).

Various scholars also argue that teachers' collaborations, such as sharing information and benchmarking teaching practices, are non-hierarchical (De Jong et al., 2019; Van Gasse et al., 2017). However, other studies classified teachers' collaborative activities, suggesting varying degrees of interdependency and collegiality (Gräsel et al., 2006; Kelchtermans, 2006; OECD, 2020; Pan et al., 2024). These classifications range from the aggregation of individual activities into cohesive and unified group actions. For example, Gräsel et al. (2006) revealed that teachers' collaboration progresses from "exchange," where information is shared, to "division of work" with joint goals and shared tasks, culminating in "co-construction," where partners work together concurrently until task completion. On the other hand, recent studies used two categories in assessing teachers' collaborative activities (OECD, 2020; Pan et al., 2024). One category, "professional collaboration," emphasizes collaborative practices such as co-teaching, peer observation with feedback, joint activities, and collaborative professional development (OECD, 2020). The other category, "exchange and coordination for teaching," focuses on activities such as sharing teaching resources, discussing student learning outcomes, and working with colleagues to establish common assessment standards for students (Pan et al., 2024).

Collaborative activities have been shown to increase individual motivation and engagement (Escribá-Carda et al., 2023). Recent studies (Liu and Sun, 2025; Pan et al., 2024) suggest that deeper levels of collaboration, particularly "professional collaboration" as defined by OECD (2020), are more strongly associated with the adoption of innovative practices compared to surface-level interactions such as information exchange and coordination. Indeed, teachers' collaborative practices—such as teamwork, networks, and learning communities—all contribute to a climate conducive to educational innovations. Specifically, teachers' collaboration is essential for consolidating individual initiatives, building a shared knowledge base, and facilitating the wider implementation of educational innovations (Stevens et al., 2023). Further, in a positive collaborative environment, educators are more receptive to new ideas and knowledge, fostering a cycle of innovations in the teaching and learning processes (Liu and Sun, 2025).

2.1 Educational innovations that contribute to an inclusive learning environment

Creating an inclusive learning environment requires careful consideration of its physical, academic, behavioral, and social aspects to foster engagement and inclusion for all learners. Scholars highlight the need for teachers to adapt their teaching strategies to meet diverse learning needs, taking into account the broader learning environment (Atanasova and Papen, 2025; Debasu and Yitayew, 2024; Korthals Altes et al., 2024). Inclusive learning environments enhance academic performance (OECD, 2015b) and foster diversity, equity, and inclusion in education (UNESCO, 2019). It also enriches learning by promoting critical thinking, creativity, and problem-solving skills (Gurin et al., 2002). Furthermore, an inclusive learning environment allows students to interact with individuals from diverse backgrounds, fostering empathy and understanding (Rutland et al., 2005). While educational innovation is often viewed as a pathway to creating more inclusive learning environments (OECD, 2015a; Page and Davis, 2023), some scholars caution that certain innovations may inadvertently exclude vulnerable learners, particularly those with special educational needs (Baena et al., 2020; Everatt et al., 2019). For instance, innovative pedagogies often emphasize collaboration, inquiry-based learning, and self-regulation (Hornstra et al., 2014), skills that can be challenging for students with cognitive, emotional, and behavioral disorders (White et al., 2016). Therefore, it is crucial for teachers to be knowledgeable about innovative practices that can effectively address the diverse needs of all learners.

Some of the key dimensions of educational innovations include student-centered pedagogy, technology integration, and learning space modification (Grannäs et al., 2025; Fletcher et al., 2023; OECD, 2016; Page et al., 2024). Several studies have examined specific innovative strategies (explicit instruction, gamification, differentiated instruction, embodied learning) classified as student-centered pedagogies while also documenting their contributions to inclusive learning. Specifically, explicit instruction, such as the concrete-representation-abstract (CRA) approach, accommodates diverse needs by utilizing students' strengths through varied modalities (models, objects, visuals) and breaking down complex tasks to address prerequisite knowledge gaps (Yakubova et al., 2024). Gamification or game-based learning benefits diverse learners through tailored experiences that cater to varied abilities and needs (Jadán-Guerrero et al., 2023; Tomé Klock et al., 2024). Differentiated instruction (e.g., problem posing) personalizes content, activities, and assessments to meet diverse student needs, interests, and learning styles (Gheyssens et al., 2023). Lastly, embodied learning emphasizes the non-mental aspects of learning, recognizing the importance of the body and feelings (Macedonia, 2019). For example, through arts-integrated lessons, this approach helps learners recognize and manage emotions, resolve conflicts, solve interpersonal problems, empathize with others, and develop positive relationships (OECD, 2016).

Various studies also highlight technology integration in teaching and learning as educational innovation, documenting its potential to improve education outcomes. Specific examples include using educational technologies and applying learning analytics to inform educational decisions and practices. Particularly, the use of educational technology facilitates learning by providing tools and systems that support preparation, instruction, and assessment (Bešić et al., 2024). It can also increase access to materials, personalize learning, and offer alternative task formats, allowing students to capitalize on their strengths and overcome challenges (Andrés et al., 2025). Further, the application of learning analytics involves the utilization of various tools to collect, analyse, and report data on learning. These innovative approaches, through the integration of technology, enhance student outcomes and inform educational decisions and practices (Paolucci et al., 2024). Overall, these educational innovations through technology integrations facilitate understanding of individual learning processes and foster inclusivity by reducing discrimination (Khalil et al., 2024). These technology integrations in the classrooms also improve the retention of disadvantaged students and validate effective learning designs for marginalized groups (Conde and Rodríguez-Sedano, 2024).

Modifying learning spaces to optimize educational outcomes is also considered an innovative education practice. As emphasized by Mahat et al. (2018), an innovative learning environment refers to the merging of innovative space designs and pedagogies. Various scholars (Grannäs et al., 2025; Page et al., 2024) have examined several aspects of innovative learning environments. One of these is the flexibility of pedagogical spaces, which entails adapting pedagogies to improve student outcomes. An example of this is the contextualization of lesson materials, enhancing students' connection to their learning materials, environment, and community (Page et al., 2024). Another innovative practice is the flexibility of class structures, especially modifying the class organization based on group dynamics and individual needs. These flexible class structures improve learner interaction and foster a supportive, safe learning environment for diverse learners (Grannäs et al., 2025).

2.2 Lesson study: an opportunity for teachers' collaborative, innovative, and inclusive practices

Lesson Study (LS) is a collaborative practice that fosters deep interdependence among teachers. It involves joint lesson planning, peer observation, and individual or collective reflection to improve specific lesson outcomes. These activities align with "professional collaboration," a higher level of collaboration that is strongly linked to the adoption of educational innovations (Liu and Sun, 2025; Pan et al., 2024). Corollary to this, implementing educational innovations is crucial for teachers to understand diverse learner needs and create inclusive learning environments (Baena et al., 2020; Page et al., 2024). However, there is limited research on how teacher collaboration through LS facilitates the development and implementation of educational innovations that promote an inclusive learning environment. Hence, this study aimed to address this research question: what specific educational innovations that could promote inclusive learning environments were developed and implemented by teachers during LS implementations? Examining these educational innovations that

emerged during LS implementations provides valuable insights into how teacher collaboration can foster both innovative practices and inclusive learning environments. Additionally, information from this examination enables decision-makers to optimize interventions, allocate resources strategically, and gain timely feedback on the impact of educational initiatives, such as LS, on the teaching and learning processes.

3 Methods

This study examined how collaboration through LS enabled mathematics and special education (SPED) teachers to develop and implement educational innovations promoting an inclusive learning environment. The first author attended as a participant observer in the four LS cycles conducted by the two LS groups. These LS groups were formed through a larger study (Basister et al., in review) that investigated the collaboration between preservice and in-service teachers specializing either in mathematics or SPED. Grounding on phenomenography (Alhazmi and Kaufmann, 2022; Harris, 2010), the following subsections outline how the qualitative data were collected and analyzed to describe how the teachers' collaboration through the LS process fostered educational innovations promoting an inclusive learning environment.

3.1 Data collection

Researchers utilized a multi-step process for nominating and screening study sites. Key criteria for site selection included schools that: supported children with special education needs, had SPED teachers on staff, had maintained inclusion programs for more than a year, and exhibited at least three years of adequate yearly progress in student math performance based on Philippine National Achievement Test scores. University professors and education supervisors in mathematics or special education provided initial recommendations for potential sites, ensuring these recommendations met the outlined criteria. Teachers participating in the study were deliberately chosen to provide essential information pertinent to the research question. These participants were situated within the study's specific context and were selected intentionally to address the research objective. The studied groups consisted of both in-service and preservice teachers specializing in either mathematics or SPED. In-service teachers had a minimum of 5 years of teaching experience at the selected locations. Conversely, the chosen preservice teachers were from a teacher education institution in Naga City, Philippines, offering both mathematics and SPED programs. In the Philippines, discipline-specific teachers are not mandated to take SPED courses during their preservice education, nor are SPED teachers required to take discipline-specific courses at the preservice level.

A total of sixteen (16) preservice and in-service teachers participated in this study as members of the two LS groups formed. Each group consisted of two (2) preservice math, two (2) preservice SPED, two (2) in-service math, and two (2) in-service SPED teachers. Both groups implemented LS cycles that involved working together to plan lessons, observing lesson delivery, revising lessons based on post-lesson conferences, and re-implementing the revised lessons. Each group implemented four LS cycles in diverse middle school classrooms (years 7 to 10), comprising students with a wide range of abilities and educational needs. Specifically, students with identified special educational needs such as deafness, visual impairments, autism, learning disabilities, and intellectual disabilities were present in these classrooms. Additionally, these LS implementations addressed a range of mathematical topics, such as mathematical variations, radicals, exponent laws, circles, permutations, quadrilaterals, and statistical concepts. Before collecting data, written informed consent was secured from each participant after discussing the nature of their participation, the ethical measures observed, the purpose of the study, and the dissemination of results.

Each LS cycle involved two collaborative lesson-planning sessions, two jointly prepared lesson plans, two lesson deliveries, two lesson observation opportunities, and two post-lesson conferences. Both LS groups completed four LS cycles from January to April 2024. With participant permission, all collaborative lesson planning, lesson deliveries, and post-lesson conferences were recorded and transcribed. During lesson observations, the participants used observation forms to record their comments and suggestions on the teaching and learning process. Aside from observing the conduct of all LS cycles, the first author also secured copies of the jointly prepared lesson plans and conducted post-LS interviews with each participant. Therefore, the data sources for this study included eight collaborative lesson planning transcripts, eight jointly prepared lesson plans, 48 completed observation forms from LS members, 16 post-lesson conference transcripts, 16 post-LS interview transcripts, and the research diary of the first author.

3.2 Data analysis

The collected data from the identified data sources were anonymized and analyzed using a thematic inductive approach (Vears and Gillam, 2022). This approach followed three phases of data-driven analyses. The first phase involved familiarizing researchers with the data to inductively identify the main categories and subcategories. Specifically, researchers in this phase familiarized themselves with all collected data by reading and re-reading it to gain an overall understanding and note preliminary impressions. The sensitizing concepts (Bowen, 2006) of educational innovations and inclusive learning environments guided the researchers' exploration and interpretation of the data. The second phase involved the development of codes to identify specific themes relevant to the identified categories and subcategories. During this phase, the data was broken down into preliminary codes, with each distinct idea or concept, often a sentence or paragraph, assigned a descriptive code. For instance, statements such as "the presence of SPED teachers helped the LS team to become more focused on how the lesson would accommodate and engage diverse learners" was coded as "SPED teacher impact on modification of learning materials and activities," while "interactive games and colorful activity materials" was coded as "engaging materials." This initial coding was conducted line-by-line to ensure comprehensive data coverage.

In the final phase, which involved axial and selective coding, researchers reviewed the preliminary codes to identify similarities, differences, and relationships, grouping them into broader categories or emergent themes (Hallberg, 2006). For example, codes related to "SPED teacher impact on modification of learning materials and activities," "desks and seating arrangements," and "teaching strategies that respond to the needs of learners" were clustered under a theme "learning space modifications" while "engaging materials," "mobile application for assessment," and "digital presentations" were grouped under "technology integration in pedagogy." This stage also included refining code definitions and identifying sub-themes. The identified categories and themes then underwent rigorous review against the original data to ensure accurate representation of participants' perspectives and observed phenomena. Themes were defined, named, and supported with exemplary quotes, with any coding or interpretation discrepancies discussed among the research team until consensus was reached to enhance trustworthiness. This iterative process of moving between data, codes, and themes continued until thematic saturation was achieved (Rahimi and Khatooni, 2024), meaning no new themes or significant insights emerged, leading to a rich and nuanced understanding of the identified educational innovations.

Indeed, emphasizing the phenomenography principle (Alhazmi and Kaufmann, 2022), the themes and categories identified in this study emerged from the analysis of the collected data. This whole process aimed to describe educational innovations produced through teachers' collaborations that could potentially promote a more inclusive learning environment. Specifically, educational innovations that emerged during LS implementations include student-centered pedagogies, technology integration, and learning space modifications. Further, an inclusive learning environment in this study refers to a learning environment that considers learners' physical, academic, behavioral, and social needs to ensure engagement and inclusion.

4 Results

The analyses of collaborative lesson planning sessions, co-designed lesson plans, lesson deliveries, observation notes, post-lesson conference proceedings, post-LS interview transcripts, and the participant researcher's journal were instrumental in documenting educational innovations that emerged during the four LS cycles. The following subsections use relevant data extracts to describe the identified educational innovations, emphasizing how these innovations were developed and utilized to promote an inclusive learning environment. These subsections also focus on three key dimensions of educational innovation: student-centered pedagogies, technology integration, and learning space modifications.

4.1 Student-centered pedagogy

Table 1 describes the innovative student-centered pedagogies that emerged during the four LS cycles. The first column reflects the specific strategies for innovative student-centered pedagogies. This includes the concrete-representation-abstract (CRA) approach, game-based learning, problem posing, and arts-integrated learning.

TABLE 1 Educational innovations in terms of student-centered pedagogy.

Innovative strategies	Frequency ($n = 16$)	Exemplar during LS implementations
CRA approach	4	To teach circular permutations, the teacher used three differently colored objects. Students were given the opportunity to physically arrange these objects in a circle to find all unique arrangements. The teacher then assigned symbols (A, B, C) to each object. Students used these symbols to list the possible arrangements. Finally, the teacher introduced the formula for circular permutations. Students compared their answers obtained through the formula with their manual lists. *(Research diary, 19 March 2024 Lesson implementation)*
Game-based learning	6	The lesson on parallelograms began with a motivational activity: the teacher divided the class into six groups and provided each with jigsaw puzzle pieces. Upon completion, each group described the shape they formed from solving the puzzles, focusing on its sides, angles, corners, and name. *(Research diary, 27 February 2024 Lesson implementation)*
Problem posing	3	As an assessment exercise for zero and negative exponents lesson, students were tasked with formulating word problems using specific data. *(Research diary, 09 January 2024 Lesson implementation)*
Arts-integrated learning	2	To motivate students on the lesson about zero and negative exponents, the teacher presented a song and dance routine with lyrics incorporating exponent concepts. The specific terms in the lyrics were designed to reinforce concepts from the previous lesson and to provide a foundation for discussing zero and negative exponents. *(Research diary, 11 January 2024 Lesson implementation)*

The second column of the table reflects the number of lessons where these innovative pedagogies were observed, and the last column describes the exemplar for each strategy.

4.1.1 CRA approach

One of the innovative pedagogies implemented by the LS team was the CRA approach during the lesson on circular permutations. Through collaborative lesson planning, lesson observation, and post-lesson conferences, the LS team designed lesson activities and materials to sustain student interest, engage students throughout the lesson, and improve lesson implementation. Below are specific excerpts of idea exchanges between in-service mathematics teachers (IM) and special education teachers (IS) for the circular permutation lesson:

> IM1: *I observed that the use of concrete and colorful materials caught the attention of the students.*
>
> IS2: *Assigning letter symbols to real objects was very helpful to the students, especially to the slow learners. They were able*

> *to follow the movement of the objects during the different arrangements made.*
>
> IS1: *I appreciate the use of real objects during the activities. However, the objects we used were quite small.*
>
> IM2: *I suggest, instead of using objects, we can have selected students represent the objects.*
>
> (Post-lesson conference transcript, 19 March 2024)

A preservice math teacher (PM) and preservice SPED teacher (PS) from the LS team shared their experiences with their LS participation.

> *"In every collaborative lesson planning, I became more focused on how the lesson would accommodate and engage the students with special needs."* (PS1, post-LS interview)
>
> *"The suggestions from veteran math teachers and SPED teachers during collaborative lesson planning and post-lesson conferences were very helpful in improving the overall design and delivery of the lessons."* (PM2, post-LS interview).

4.1.2 Game-based learning

Another innovative pedagogy observed was the use of games during lesson implementations. Out of 16 lessons, six utilized game-based learning. Below is an excerpt of conversations between members of the LS team:

> IM1: *I observed that the students were not engaged during the first run of the lesson. Thus, I suggest we utilize exciting games and other interactive activities.*
>
> IS1: *If we introduce games, it would be better if the materials we use are attractive and the students can manipulate these materials.*
>
> (Collaborative lesson planning transcript, 08 February 2024)

The LS team revised the lesson plan based on the suggestions during the post-lesson conference and collaborative lesson planning for the parallelogram session. Then, one member of the LS team delivered the second run of the lesson while the rest of the members observed its implementation. Below is an extract from the completed observation forms of the team members during the second run of the lesson:

> *"The students, especially those with special needs, showed interest."* (PS1, observation form notes)
>
> *"The students became more engaged when the implementing teacher introduced interactive games and colorful activity materials."* (PM1, observation form notes).

4.1.3 Problem posing

One strategy for differentiated instruction is the use of problem posing. This was evident in three out of 16 lessons implemented during the four LS cycles. Specifically, during the lesson on zero and negative exponents, the way the teacher assessed students' understanding was contextualized based on students' abilities. Based on the excerpts below, the strategy was established during the collaborative lesson planning.

> IM1: *Instead of letting students solve word problems, can we try asking them to create word problems involving laws of exponents?*
>
> IM2: *I agree with this since it can be considered as a form of higher-order thinking skills activity and, at the same time, differentiated instruction.*
>
> PM2: *I think it is a good idea. However, I suggest we ask them to create just one word problem.*
>
> (Collaborative lesson planning transcript, 04 January 2024)

When the implementing teacher was asked about her experience in implementing the strategy, she disclosed that:

> *"It helped assess student learning by revealing common errors and learning barriers."* (IM1, post-LS interview)

4.1.4 Arts-integrated learning

Embodied learning was also evident in two lessons implemented during the LS cycles. One of the collaboratively planned lessons specifically involved song and dance routines to help students recall concepts related to the topic. The terms used in the song lyrics were designed to reinforce concepts from the previous lesson and to provide a foundation for discussing zero and negative exponents. Below are some of the extracts from the completed observation forms of the LS team members during the second run of the lesson:

> *"The singing and dancing part of the lesson made the students more engaged since its lyrics were related to mathematical concepts."* (PM2, observation form notes)
>
> *"The use of arts-related activity helped enhance the motivation and creativity of the students. It also presents a unique opportunity to apply previously mastered skills."* (PS2, observation form notes).

4.2 Technology integration

Table 2 details the educational innovations involving technology integration that emerged during the LS implementations. This includes the use of educational technology and learning analytics during lesson deliveries. Table 2 also indicates the number of lessons where technology integration was observed and provides examples.

4.2.1 Use of educational technology

Most of the lessons delivered during LS cycles utilized available educational technologies, specifically TV screens, LCD projectors, digital presentations, and mobile phones. As described in Table 2, one example of this educational innovation is the use of QR cards during lesson delivery. The LS team members were asked to

TABLE 2 Educational innovations in terms of technology integration.

Innovative strategies	Frequency ($n = 16$)	Exemplar during LS implementations
Use of educational technology	10	The teacher used a paper-based version of the Quizizz mobile application. Printed quick response (QR) Cards, each with a unique participant number, were distributed to students for easy identification during evaluation. Questions were displayed on a TV screen, and students selected their answers using their QR-Cards. After the allotted time, students held their QR-Cards upright, ensuring they were not blocked or tilted. The teacher then scanned the QR-Cards with a mobile phone to record the answers. *(Research diary, 12 April 2024 Lesson implementation)*
Use of learning analytics	2	The Quizizz mobile application was used to facilitate the assessment of students' understanding of quartiles in ungrouped data. Specifically, it collected and recorded student answers to questions about measures of position. A mobile phone application generated real-time scores, which were displayed on a TV screen for the class. The screen showed the number of students who selected each answer choice for every question. *(Research diary, 17 April 2024 Lesson implementation)*

identify the educational innovations they observed during the LS implementations. Below are some of the participants' responses.

> *"The technology integration, especially the scanning of QR cards without requiring the students to log in with their devices."* (PS1, post-LS interview)
>
> *"The activity using QR cards. It made the students more engaged, interested, and excited since it was more relevant to the generation of our students."* (PM1, post-LS interview)

Below are the other comments of the participants about their LS experiences:

> *"Since not all students have mobile phones, we used the paper mode QR code. It only requires an internet connection on the part of the teacher."* (IM1, post-LS interview)
>
> *"The participation of preservice teachers during collaborative lesson planning helped us develop additional ideas for integrating technology into our lessons."* (IM2, post-LS interview)

4.2.2 Use of learning analytics

Only two out of 16 lesson deliveries during LS cycles involved using learning analytics in its implementation. In these lessons, the Quizizz mobile application was used to assess students' understanding of quartiles in ungrouped data. It collected answers to questions on measures of position, generated real-time scores, and displayed student responses on a TV screen for the class.

TABLE 3 Educational innovations in terms of learning space modifications.

Innovative strategies	Frequency ($n = 16$)	Exemplar during LS implementations
Contextualization of lesson materials	11	The school is in a typhoon-prone province. During a lesson on graphing circles in a coordinate plane, the teacher used a map of the province plotted on a Cartesian coordinate system. The class was divided into ten groups, each given an equation of a circle representing a specific municipality's location. The teacher then provided an equation describing the location and size of a typhoon, along with its movement data (3 units left, 2 units down). Using the Cartesian coordinate system displayed on the board, one group plotted the typhoon's initial location and its movement. The remaining groups determined if their assigned municipality was in the typhoon's path. *(Research diary, 01 April 2024 Lesson implementation)*
Flexible class structure	10	In one observed class, students with diverse learning needs, including high-performing, low-performing, and learners with special educational needs, participated in a group activity. The teacher determined the composition of each group, ensuring a mix of these diverse learners in each. *(Research diary, 05 April 2024 Lesson implementation)*

Below are some of the notes written by the participants in their observation forms during the delivery of these lessons:

> *"Collecting and analyzing student responses during informal assessment became more efficient using the Quizizz mobile application."* (IS1, observation form notes)
>
> *"Students were engaged in the class discussion, and they showed interest in the subject matter."* (IS2, observation form notes)

Other participants also shared that:

> *"The ideas coming from younger teachers were different compared to ideas from veteran teachers like me."* (IM2, post-LS interview)
>
> *"Younger teachers helped us how to maximize the benefits of using technology inside the classroom."* (IM1, post-LS interview).

4.3 Learning space modification

Another form of educational innovation is the flexibility of pedagogical spaces. Specifically, this involves the transformation of teacher-student roles, enhancing students' connection to their learning materials, environment, and peers. Shown in Table 3 are the number of lessons where modifications of learning spaces

through contextualization of lesson materials and flexibility of class structures were observed. Table 3 also describes specific innovative strategies during the LS implementations.

4.3.1 Contextualization of lesson materials

Eleven of the sixteen observed lessons during the LS cycles employed contextualization, integrating local products, traditions, places, and materials into the lesson deliveries. The exemplar shown in Table 3 connected the real-life experiences and situations encountered by students in discussing how to graph circles in a coordinate plane. During collaborative lesson planning, accommodation of the diverse needs of students was also considered, as shown by the excerpts below:

> IS3: *I suggest we use different activities and learning materials since the class is composed of diverse learners.*
>
> IS4: *To support students with visual impairments, we provide handouts and worksheets in a larger font.*
>
> (Collaborative lesson planning transcript, 31 March 2024)

In the second run of the lesson about graphing circles, an extract from the completed observation form of one participant stated that:

> *"When the lesson was contextualized on the experiences and situations of students, they became more active and interested during the lesson."* (IM3, observation form notes)

Additionally, most of the lesson plans implemented during LS cycles include parts specifying the following key results areas (KRA) based on the Philippine Professional Standards for Teachers:

> KRA2: *Established a learner-centered culture by using teaching strategies and materials that respond to their linguistic, cultural, socio-economic, and religious backgrounds.*
>
> KRA3: *Selected, developed, organized, and used appropriate teaching resources to address learners' goals and needs.*
>
> (Lesson plan, 17 April 2024)

4.3.2 Flexible class structure

Another form of learning space modification is the flexibility of class structures. This was observed in 10 out of 16 lessons throughout the four LS cycles. In one of the sessions for collaborative lesson planning, the teachers discussed how they could further improve class structures such as seating and grouping arrangements. Below are some of the extracts from the conversations between LS team members:

> IM3: *I noticed that the visual materials we used were not visible, especially to those students who are visually impaired and who are seated at the back.*
>
> IS3: *Aside from using larger font sizes for our visual materials, I think it would be better if we ensure that the visually impaired students are seated in the first row of the class.*
>
> IM4: *May I also suggest changing the individual activity to a pair activity? I observed that students felt pressured during the individual activity. Specifically, I saw some students who did not write any response. It would be better if we let the students work in pairs.*
>
> (Collaborative lesson planning transcript, 01 April 2024)

From the lesson observations, classrooms typically contained at least two chalkboards, all containing individual desks for each student. However, the arrangement of desks varies, such as desks arranged in rows facing the front, desks arranged in groups, and desks arranged in a U-shaped configuration, with the open end of the U facing the front. Some of the teachers also recounted that:

> *"We arranged the seats in such a way that students could easily discuss with each other during class activities and discussions."* (IM4, post-LS interview)
>
> *"In some activities, we purposely let high-performing students sit beside or group with struggling students. This is to provide opportunities for cooperative learning among students."* (IM3, post-LS interview)

In several observed classes, teachers began discussions by clearly stating the learning objective for the day, either by writing or posting it in the upper right corner of the board. They introduced the topic using students' experiences whenever possible. At the end of the lesson, selected students summarized the discussion. This practice provided students with a clear understanding of the expected learning outcomes for the session. One participating teacher also shared that:

> *"Our main goal for students is learning, thus, if students don't know what they should be able to do at the end of the class, then it will not be easy for them to reach that goal."* (IM2, post-LS interview)

In another collaborative lesson planning session, the teachers focused on how they could improve the board structure as well as the interactions between teachers, students, and learning materials during lesson implementation. This was evident in the excerpts below:

> IM4: *We should plan the blackboard structure from the beginning to the end of the lesson. We need to decide what materials to place, when to place them, and where to place them on the board. This way, at the end of the lesson, students can see and reflect on what transpired.*
>
> IS3: *I also suggest that we maintain and sustain interactions among students in addition to teacher-student interactions. I observed that throughout the lesson, the interactions were primarily between teachers and students.*
>
> IM3: *It is also essential to consider how students interact with the learning materials during lesson implementation.*
>
> (Collaborative lesson planning transcript, 31 March 2024)

5 Discussion

Focusing on student-centered pedagogies, technology integration, and learning space modifications, the following

subsections provide detailed analyses of the educational innovations observed during LS implementations. Further examination of data presented in the previous section suggested insights into how teacher collaboration through LS can foster educational innovations and promote inclusive learning environments.

5.1 Student-centered pedagogies

Various lessons delivered during the four LS cycles employed student-centered pedagogies. As described in Table 1, the implementation of these lessons showed specific attributes of innovative strategies for explicit instruction, gamification, differentiated instruction, and embodied learning. Evidence of explicit instruction was observed in four lesson implementations, particularly applying the CRA approach. The LS team members noted its positive effects on learners during lesson implementations. Specifically, through the CRA approach, the utilized learning materials caught learners' attention (IM1) and let them easily follow the lesson activities (IS2). Scholars previously established that lessons employing explicit instruction, such as the CRA approach, leveraged learners' strengths through varied modalities, such as models, objects, and visuals, and broke down complex tasks into manageable parts, thus addressing gaps in prerequisite knowledge (Flores and Hinton, 2022; McElroy et al., 2024; Yakubova et al., 2024).

Game-based learning was also evident in six lessons implemented during the LS cycles. The participants (IS1, PM2) agreed that the materials used in this innovative pedagogy were colorful, attractive, manipulative, and interactive. These materials and strategies were instrumental in enhancing students' interest and engagement (PS1, PM2). Consistent with previous studies (Jadán-Guerrero et al., 2023; Paniagua and Istance, 2018; Tomé Klock et al., 2024), this research confirms that gamification or game-based learning enhances learning experiences and cultivates self-regulation, collaboration, exploration, and creativity. On the other hand, three lessons during LS cycles showed evidence of a problem posing strategy. From the observed lessons, this strategy required students to formulate a word problem from the set of information available to them. The participants believed that this strategy helped develop higher-order thinking skills (IM2) and was also valuable in identifying common errors and learning barriers of students (IM1). Problem posing is a form of differentiated instruction that personalizes content, activities, and assessments to meet diverse student needs, interests, and learning styles (Gheyssens et al., 2023). Furthermore, this technique offers teachers a valuable opportunity to observe students' comprehension of mathematical concepts and processes, leading to the identification and implementation of appropriate supplemental support (Basister and Kawai, 2018).

Arts-integrated learning was also evident in a small number of lessons (2 out of 16) observed during LS cycles. This embodied learning strategy emphasizes the non-mental aspects of learning, recognizing the importance of the body and feelings (OECD, 2016). During lesson implementation, the LS team observed that arts-related activities, such as singing and dancing, enhanced student engagement, motivation, and creativity (PS2, PM2). In general, post-lesson interviews also revealed that the LS process and the team's composition were instrumental in improving the lesson deliveries. Specifically, the involvement of SPED teachers provided innovative ideas on how to accommodate the diverse needs of students (PS2). Additionally, the suggestions from participating veteran teachers were also useful in innovating lesson designs and implementations (PM2). This is consistent with previous studies establishing that teachers' collaboration is one of the factors that could drive teachers' innovative behavior (Pan et al., 2024). Furthermore, other scholars also emphasized that collaborations between regular education and SPED teachers are crucial in supporting and enhancing inclusive practices (Paulsrud and Nilholm, 2023).

5.2 Technology integration

Deeper levels of collaboration, such as LS processes, are associated with the adoption of innovative practices (Liu and Sun, 2025; Pan et al., 2024). One indication of these innovative practices involves the use of technology and learning analytics inside the classrooms. Table 2 reflects that the majority (10 out of 16) of the lessons implemented during LS cycles utilized various educational technologies such as TV screens, LCD projectors, digital presentations, and mobile phones. The integration of these educational technologies showed that the students became more engaged, attentive, and motivated during lesson deliveries (PM1). From the perspective of the teachers, the utilization of learning analytics during lesson implementations helped them become more efficient in collecting and analyzing data to provide timely feedback to their students (IS1). This is consistent with previous studies claiming that the use of educational technology facilitates learning, enhances student outcomes, and informs educational decisions and practices (Bešić et al., 2024; Paolucci et al., 2024).

Additionally, educational innovations through technology integrations facilitate understanding of individual learning processes and foster inclusivity (Khalil et al., 2024). This was evident in two implemented lessons where the LS team addressed issues of the digital divide. Specifically, the decision of the group to use the paper mode of a QR card (PS1, IM1) addressed the socioeconomic issue of device access and internet penetration (Lythreatis et al., 2022). However, the observed minimal application of learning analytics (only 2 out of 16 lessons) manifests a digital divide among teachers in terms of their algorithmic awareness. Gran et al. (2021) claimed that a gap in awareness and conscious navigation of the internet and algorithmic systems constitutes a new and reinforced digital divide. Furthermore, while experienced teachers are better positioned to contribute to collaborative activities (Coenders and Verhoef, 2018), the presence of preservice and younger teachers also assisted the LS team in maximizing the benefits of using technology inside the classroom (IM1, IM2). This clearly showed that LS experiences facilitate the integration of theory and practice for pre-service and novice teachers, resulting in greater pedagogical mastery and improved critical observation skills.

5.3 Learning space modifications

The data in Table 3 showed that a significant number of observed lessons (11 out of 16) during the LS cycles applied contextualization of materials and learning activities. The LS team contextualized activities and materials both to address specific students' learning needs (IS3, IS4) and to align with the education department's guidelines regarding learners' linguistic, cultural, socioeconomic, and religious backgrounds (KRA2, KRA3). These modifications of learning materials to accommodate student needs and align the lesson with their experiences enhanced their motivation and engagement (IM3). Indeed, the flexibility of pedagogies based on group dynamics, individual needs, and relevant materials enhances students' connection to their surroundings, learning materials, and peer relationships as they explore diverse learning environments (Page et al., 2024).

Another learning space modification observed during lesson implementations was the flexible arrangement of class seating and grouping. Consistent with Grannäs et al. (2025), this flexible class structure created a supportive and safe learning environment, fostering commitment and strong relationships among learners. Diverse class groupings also cultivate empathy and understanding, which are crucial for effective teaching and learning processes (Rutland et al., 2005). Previous research supports the view that attending to learners' emotional development is as vital as enhancing their cognitive and academic proficiencies (Basister, 2013). Additionally, the practice of stating learning objectives at the beginning and summarizing discussions at the end of class shifted the focus from content to students. This can allow both students and teachers to monitor comprehension and understand the overall structure of the lessons. This can be particularly beneficial for students with educational needs since it can reinforce key points, highlight relationships between concepts, and aid information recall.

During collaborative lesson planning, the LS team also emphasized the importance of well-structured blackboard materials (IM4) and the sustained interactions between teachers, students, and learning resources (IS3, IM3). During lesson implementations, the blackboard served as a reflection of these interactions, showcasing: (i) students' ideas, questions, and answers; (ii) lesson theme details; and (iii) other relevant lesson development data. This practice can be particularly helpful for struggling learners who require additional processing time. Furthermore, students can absorb blackboard material more effectively when presented with less information at any given time. Previous studies established that organized lesson information presented using a blackboard provides a crucial resource for both students and teachers (Blondeau and Van Nieuwenhoven, 2025).

6 Conclusion

This study demonstrated that teacher collaboration through LS processes was crucial in developing educational innovations that promote inclusive learning environments. Specifically, collaborative lesson planning, lesson observations, and post-lesson conferences provided opportunities for LS team members to deepen their collaboration by consolidating ideas to jointly create and evaluate innovative educational strategies and materials. Furthermore, the composition of LS teams—which included preservice, in-service, mathematics, and SPED teachers—was instrumental in strengthening ideas tailored to young learners, including those with special educational needs. Specifically, preservice and younger teachers brought innovative approaches to lesson design by leveraging educational technologies, including gamified learning platforms, learning analytics, and appropriate online tools, to enhance student engagement and understanding. SPED teachers shared their expertise on fostering inclusive practices within diverse classrooms, providing guidance on creating a supportive and accessible learning environment for all students. The collaboration with veteran mathematics teachers proved invaluable, as their experience further enhanced lesson implementation. Their contributions included refining lesson sequencing, identifying key areas of focus, and ensuring alignment with established educational standards. Consistent with Pan et al. (2024), this study confirms that teacher collaboration is a significant catalyst for innovative teaching. Additionally, it supports the previous assertion that collaboration between regular education and SPED teachers is essential for developing and improving inclusive educational practices (Paulsrud and Nilholm, 2023).

To effectively address the diverse needs of all learners, teachers must be well-versed in innovative practices. Research highlights the importance of innovative educational practices considering the broader learning environment (Atanasova and Papen, 2025; Debasu and Yitayew, 2024; Korthals Altes et al., 2024). Beyond enhancing academic performance, creating an innovative and inclusive learning environment also fosters diversity, equity, and inclusion by developing critical thinking and empathy (Gurin et al., 2002; OECD, 2015b; Rutland et al., 2005; UNESCO, 2019). The educational innovations stemming from the LS collaborations showcased a diverse array of student-centered pedagogies, technology integration, and learning space modifications. The detailed accounts provided by the LS team members revealed that these innovations had a profound impact on student learning. Specifically, they significantly boosted learners' engagement, maintained their attention, and amplified their motivation during mathematics lessons. These innovations also fostered a deeper sense of empathy and understanding among students. This was achieved through the (i) implementation of collaborative activities that encouraged teamwork and peer learning, (ii) the use of peer teaching strategies that empowered students to take ownership of their learning, and (iii) engaging discussions that provided a platform for students to voice their perspectives and learn from the diverse experiences of their classmates. These innovative strategies went beyond traditional instruction, actively encouraging students to share their unique viewpoints and build upon each other's knowledge. By doing so, they created a more supportive, safe, and inclusive learning environment where students can feel valued, respected, and empowered to learn.

Additionally, the frequency with which specific educational innovations are observed in lessons serves as a barometer for teachers' professional development needs. A low occurrence of certain strategies, such as embodied learning and learning

analytics, suggests a potential gap in teacher training or confidence. For example, if embodied learning, which emphasizes physical engagement in the learning process, is rarely seen, it might indicate that teachers lack the knowledge or resources to implement it effectively. Similarly, a scarcity of lessons utilizing learning analytics, which involves using data to inform instructional decisions, points to a need for professional development focused on data literacy and its pedagogical applications. Gran et al. (2021) argue that a lack of awareness and conscious navigation of the internet and algorithms creates a new, intensified digital divide. Therefore, future research should delve deeper into teachers' perceptions of these innovative approaches. Specifically, future studies may explore teachers' familiarity with these methods, their level of apprehension about using them, their willingness to adopt them, or whether they hold neutral, skeptical, or critical views. Understanding these perspectives is crucial for designing targeted professional development that empowers teachers to effectively integrate innovative strategies into their practice and ultimately enhance student learning.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by 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, Validation, Visualization, Writing – original draft, Writing – review & editing. JP: Writing – original draft, Writing – review & editing. RB: Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Gen AI was used in the creation of this manuscript.

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References

Ainley, J., and Carstens, R. (2018). *Teaching and Learning International Survey (TALIS) 2018 Conceptual Framework. OECD Education Working Papers, No. 187*. Paris: OECD Publishing.

Alhazmi, A. A., and Kaufmann, A. (2022). Phenomenological qualitative methods applied to the analysis of cross-cultural experience in novel educational social contexts. *Front. Psychol.* 13:785134. doi: 10.3389/fpsyg.2022.785134

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.* 1–12. doi: 10.1080/03075079.2025.2455431

Baena, S., Collet-Sabé, J., Garcia-Molsosa, M., and Manzano, M. (2020). More innovation, less inclusion? Debates and discussions regarding the intersectionality of innovation and inclusion in the Catalan school system: a position paper. *Int. J. Inclusive Educ.* 26, 865–877. doi: 10.1080/13603116.2020.1736653

Basister, M. (2013). "Cross-age tutoring: Its effects on high performing students and students at-risk with learning disabilities in mathematics," in *International Conference Proceedings of the 5th Asian Conference on Education* (Nagaya: International Academic Forum).

Basister, M., Petersson, J., and Baconguis, R. (in review). *Effects of Lesson Study on the Perceived Teaching Competencies of Mathematics and Special Needs Education Teachers*. Thousand Oaks: SAGE Open.

Basister, M. P., and Kawai, N. (2018). Japan's educational practices for mathematically gifted students. *Int. J. Inclusive Educ.* 22, 1213–1241. doi: 10.1080/13603116.2017.1420252

Bernard, J., and Langworthy, M. (2011). *Innovative teaching and learning research: 2011 findings and implications*. Available online at: https://www.european-agency.org/sites/default/files/itlresearh2011findings.pdf (Accessed February 3, 2025).

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.* 1–14. doi: 10.1080/15391523.2024.2378084

Blondeau, M., and Van Nieuwenhoven, C. (2025). Learning to use the blackboard during the correction, discussion and recap phase: a challenge for preservice teachers during practicum. *Teach. Teach. Educ.* 157:104940. doi: 10.1016/j.tate.2025.104940

Bowen, G. A. (2006). Grounded theory and sensitizing concepts. *Int. J. Qual. Methods*, 5, 12–23. doi: 10.1177/160940690600500304

Cain, M., Campbell, C., and Fanshawe, M. (2024). What's an innovation? Capitalising on disruptive innovation in higher education. *Teach. Teach.* 30, 684–700. doi: 10.1080/13540602.2024.2365141

Carvalho, A., Teixeira, S. J., Olim, L., de Campanella, S., and Costa, S. T. (2021). Pedagogical innovation in higher education and active learning methodologies-a case study. *Educ. Train.* 63, 195–213. doi: 10.1108/ET-05-2020-0141

Coenders, F., and Verhoef, N. (2018). Lesson Study: professional development (PD) for beginning and experienced teachers. *Profess. Dev. Educ.* 45, 217–230. doi: 10.1080/19415257.2018.1430050

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. *Comp. Hum. Behav.* 155:108184. doi: 10.1016/j.chb.2024.108184

De Jong, L., Meirink, J., and Admiraal, W. (2019). School-based teacher collaboration: Different learning opportunities across various contexts. *Teach. Teach. Educ.* 86:102925. doi: 10.1016/j.tate.2019.102925

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, 33–43. doi: 10.52291/ijse.2024.39.4

DeMatthews, D., Billingsley, B., and McLeskey, J. Sharma, U. (2020). Principal leadership for students with disabilities in effective inclusive schools. *J. Educ. Adm.* 58, 539–554. doi: 10.1108/JEA-10-2019-0177

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. Manage. Bus. Econ*. doi: 10.1108/EJMBE-07-2022-0206. [Epub ahead of print].

Everatt, J., Fletcher, J., and Fickel, L. (2019). School leaders' perceptions on reading, writing and mathematics in innovative learning environments. *Education* 47, 906–919. doi: 10.1080/03004279.2018.1538256

Fasting, R. B., and Breilid, N. (2023). Cross-professional collaboration to improve inclusive education. *Scan. J. Educ. Res.* 68, 661–676. doi: 10.1080/00313831.2023.2175248

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

Flores, M. M., and Hinton, V. M. (2022). Use of the concrete-representational-abstract instructional sequence to improve mathematical outcomes for elementary students with EBD. *Beyond Behav.* 31, 16–28. doi: 10.1177/10742956211072421

Foray, D., and Raffo, J. D. (2014). The emergence of an educational tool industry: Opportunities and challenges for innovation in education. *Res. Policy*. 43, 1707–1715. doi: 10.1016/j.respol.2014.07.010

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 (Bingley: Emerald Publishing Limited), 71–96. doi: 10.1108/S1479-3636202100000 17008

Gheyssens, E., Griful-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, R. M. Klassen (Cham: Springer). doi: 10.1007/978-3-031-31678-4_30

Gran, A. B., Booth, P., and Bucher, T. (2021). To be or not to be algorithm aware: a question of a new digital divide? *Inf. Commun. Soc.* 24, 1779–1796. doi: 10.1080/1369118X.2020.1736124

Grannäs, J., Frelin, A., and Östlin, T. (2025). Unpacking flexibility in innovative learning environments - teachers' experiences in practice. *Educ. Stud*. 1–17. doi: 10.1080/03055698.2024.2448781

Gräsel, C., Fußangel, K., and Pröbstel, C. (2006). Lehrkräfte zur kooperation anregen-eine aufgabe für sisyphos?. *Zeitschrift für Pädagogik*, 52, 205–219. doi: 10.25656/01:4453

Gurin, P., Dey, E. L., Hurtado, S., and Gurin, G. (2002). Diversity and higher education: theory and impact on educational outcomes. *Harvard Educ. Rev.* 72, 330–366. doi: 10.17763/haer.72.3.01151786u134n051

Hallberg, L. R. M. (2006). The "core category" of grounded theory: making constant comparisons. *Int. J. Qual. Stud. Health Well-Being* 1, 141–148. doi: 10.1080/17482620600858399

Harris, L. R. (2010). Phenomenographic perspectives on the structure of conceptions: the origins, purposes, strengths, and limitations of the what/how and referential/structural frameworks. *Educ. Res. Rev.* 6, 109–124. doi: 10.1016/j.edurev.2011.01.002

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.* 35, 598–633. doi: 10.1080/01443410.2014.922164

Jadán-Guerrero, J., Avilés-Castillo, F., Buele, J., and Palacios-Navarro, G. (2023). "Gamification in Inclusive education for children with disabilities: global trends and approaches - a bibliometric review," in *Computational Science and Its Applications - ICCSA 2023 Workshops. ICCSA 2023. Lecture Notes in Computer Science, vol 14104*, eds. O. Gervasi (Cham: Springer). doi: 10.1007/978-3-031-37105-9_31

Kalyani, D., and Rajasekaran, K. (2018). Innovative teaching and learning. *J. Appl. Adv. Res.* 3, 23–25. doi: 10.21839/jaar.2018.v3iS1.162

Kelchtermans, G. (2006). Teacher collaboration and collegiality as workplace conditions. A review. *Zeitschrift für Pädagogik* 52, 220–237. doi: 10.25656/01:4454

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

Kopcha, T. J., Rieber, L. P., and Walker, B. B. (2016). Understanding university faculty perceptions about innovation in teaching and technology. *Brit. J. Educ. Technol.* 47, 945–957. doi: 10.1111/bjet.12361

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

Krstikj, A., Godina, J. S., Bauelos, L. G., Pea, O. I. G., Milin, H. N. Q., Coronado, P. D. U., et al. (2022). Analysis of competency assessment of educational innovation in upper secondary school and higher education: a mapping review. *Sustainability* 14:8089. doi: 10.3390/su14138089

Kunnari, I., and Ilomäki, L. (2014). Reframing teachers' work for educational innovation. *Innovations Educ. Teach. Int.* 53, 167–178. doi: 10.1080/14703297.2014.978351

Laszlo, A., Luksha, P., and Karabeg, D. (2017). Systemic innovation, education, and the social impact of the systems sciences. *Syst. Res. Behav. Sci.* 34, 601–608. doi: 10.1002/sres.2492

Le Donné, N., Fraser, P. G., and Bousquet. (2016). *Teaching Strategies for Instructional Quality: Insights from the TALIS-PISA Link Data. OECD Education Working Papers, No. 148*. Paris: OECD Publishing.

Leron, P. J. G., and Baconguis, R. dT. (2021). Elements of innovation culture influencing individual research and development (RD) performance in public higher education institutions in the Philippines. *Asia-Pacific J. Manage. Res. Innovation* 17, 137–151. doi: 10.1177/2319510X221135662

Littlejohn, A., Jaldemark, J., Vrieling-Teunter, E., and Nijland, F. (2019). "Networked professional learning: an introduction," in *Networked Professional Learning. Research in Networked Learning*, eds. A. Littlejohn, J. Jaldemark, E. Vrieling-Teunter, and F. Nijland (Cham: Springer). doi: 10.1007/978-3-030-18030-0

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

Lythreatis, S., Singh, S. K., and El-Kassar, A. (2022). The digital divide: a review and future research agenda. *Technol. Forecasting Soc. Change* 175:121359. doi: 10.1016/j.techfore.2021.121359

Macedonia, M. (2019). Embodied learning: why at school the mind needs the body. *Front. Psychol.* 10:467787. doi: 10.3389/fpsyg.2019.02098

Mahat, M., Bradbeer, C., and Byers, T. Imms, W. (2018). *Innovative Learning Environments and Teacher Change: Defining Key Concepts*. Melbourne: University of Melbourne, LEaRN.

McElroy, A. R., and 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, 165–181. doi: 10.1007/s43494-024-00125-0

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

Miles, P. (2021). Innovation through co-creation: lessons from an Australian broadcaster and teachers' collaboration in designing engaging multiplatform education resources. *Media Pract. Educ.* 23, 1–19. doi: 10.1080/25741136.2021.1993436

Ní Bhroin, Ó., and King, F. (2019). Teacher education for inclusive education: a framework for developing collaboration for the inclusion of students with support plans. *Eur. J. Teach. Educ.* 43, 38–63. doi: 10.1080/02619768.2019.1691993

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.

OECD (2020). *TALIS 2018 Results (Volume II): Teachers and School Leaders as Valued Professionals, TALIS*. Paris: OECD Publishing.

OECD (2023). *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. Paris: PISA; OECD Publishing. doi: 10.1787/53f23881-en

Page, A., Anderson, J., and Charteris, J. (2024). Innovative learning environments and spaces of belonging for students with disability in mainstream settings. *Cambridge J. Educ.* 54, 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, 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

Paniagua, A., and Istance, D. (2018). *Teachers as Designers of Learning Environments: The Importance of Innovative Pedagogies, Educational Research and Innovation*. Paris: OECD Publishing. doi: 10.1787/9789264085374-en

Paolucci, C., Vancini, S., Bex, I. I., Cavanaugh, R. T., Salama, C., De Araujo, C., et al. Z. (2024). A review of learning analytics opportunities and challenges for K-12 education. *Heliyon* 10: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. Inclusive Educ.* 27, 541–555. doi: 10.1080/13603116.2020.1846799

Perren, L., and Sapsed, J. (2013). Innovation as politics: the rise and reshaping of innovation in UK parliamentary discourse 1960–2005. *Res. Policy* 42, 1815–1828. doi: 10.1016/j.respol.2013.08.012

Rahimi, S., and Khatooni, M. (2024). Saturation in qualitative research: an evolutionary concept analysis. *Int. J. Nurs. Stud. Adv.* 6:100174. doi: 10.1016/j.ijnsa.2024.100174

Reynolds, K. A., Aldrich, C. E. A., Bookbinder, A., Gallo, A., von Davier, M., and Kennedy, A. (eds.) (2024). *TIMSS 2023 Encyclopedia: Education Policy and Curriculum in Mathematics and Science*. Boston College; TIMSS & PIRLS International Study Center. doi: 10.6017/lse.tpisc.timss.rs5882

Reynolds, K. A., Wry, E., Mullis, I. V. S., and von Davier, M. (2022). *PIRLS 2021 Encyclopedia: Education Policy and Curriculum in Reading*. Boston College; TIMSS & PIRLS International Study Center. Available online at: https://pirls2021.org/encyclopedia (Accessed February 3, 2025).

Ronfeldt, M., Farmer, S. O., McQueen, K., and Grissom, J. A. (2015). Teacher collaboration in instructional teams and student achievement. *Am. Educ. Res. J.* 52, 475–514. doi: 10.3102/0002831215585562

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, 451–466. doi: 10.1111/j.1467-8624.2005.00856.x

Sargent, T. C. (2015). Professional learning communities and the diffusion of pedagogical innovation in the chinese education system. *Comp. Educ. Rev.* 59, 102–132. doi: 10.1086/678358

Sias, C. M., Nadelson, L. S., Juth, S. M., and Seifert, A. L. (2016). The best laid plans: educational innovation in elementary teacher generated integrated STEM lesson plans. *J. Educ. Res.* 110, 227–238. doi: 10.1080/00220671.2016.1253539

Stevens, T. M., Day, I. N. Z., den Brok, P. J., Prins, F. J., Assen, H. J. H. E., ter Beek, M., et al. (2023). Teacher professional learning and development in the context of educational innovations in higher education: a typology of practices. *High. Educ. Res. Dev.* 43, 437–454. doi: 10.1080/07294360.2023.2246412

Tassone, V. C., Biemans, H. J. A., den Brok, P., and Runhaar, P. (2021). Mapping course innovation in higher education: a multi-faceted analytical framework. *High. Educ. Res. Dev.* 41, 2458–2472. doi: 10.1080/07294360.2021.1985089

Tomé Klock, A. C., Palomino, P. T. 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*. 1–26. doi: 10.1177/14614448241254028

UNESCO (2019). *Inclusive Education: The Way of the Future*. Paris: UNESCO.

Van Gasse, R., Vanlommel, K., Vanhoof, J., and Van Petegem, P. (2017). Unravelling data use in teacher teams: how network patterns and interactive learning activities change across different data use phases. *Teach. Teach. Educ.* 67, 550–560. doi: 10.1016/j.tate.2017.08.002

Vears, D. F., and Gillam, L. (2022). Inductive content analysis: A guide for beginning qualitative researchers. *Focus Health Prof. Educ. Multi-Prof. J.* 23, 111–127. doi: 10.11157/fohpe.v23i1.544

Vincent-Lancrin, S., Jacotin, G., Urgel, J., Kar, S., and González-Sancho, C. (2017). *Measuring Innovation in Education: A Journey to the Future*. Paris: OECD Publishing.

Vincent-Lancrin, S., Urgel, J., Kar, S., and Jacotin, G. (2019). *Measuring Innovation in Education 2019: What has Changed in the Classroom?* Paris: OECD Publishing. doi: 10.1787/62212c37-en

Walder, A. M. (2014). The concept of pedagogical innovation in higher education. *Educ. J.* 3, 195–202.

White, S. W., Scahill, 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.

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 disability. *Rev. J. Autism Dev. Disord.* doi: 10.1007/s40489-024-00473-y

Zeb, A., Abdullah, N. H., Hussain, A., and Safi, A. (2020). Authentic leadership, knowledge sharing, and employees' creativity. *Manage. Res. Rev.* 43, 669–690. doi: 10.1108/MRR-04-2019-0164