frontiers | Frontiers in Education

TYPE Curriculum, Instruction, and Pedagogy
PUBLISHED 30 January 2024
DOI 10.3389/feduc.2024.1331199

OPEN ACCESS

EDITED BY
Carola Manolino,
Università della Valle d'Aosta, Italy

REVIEWED BY
Mario Lepore,
University of Salerno, Italy
Riccardo Minisola,
University of Turin, Italy

*CORRESPONDENCE
Viviane Hummes
✉ vhummes@ub.edu
Maria José Seckel
✉ mseckel@ucsc.cl

RECEIVED 31 October 2023
ACCEPTED 12 January 2024
PUBLISHED 30 January 2024

CITATION
Hummes V and Seckel MJ (2024) Advancing teacher reflective competence: integrating lesson study and didactic suitability criteria in training.
Front. Educ. 9:1331199.
doi: 10.3389/feduc.2024.1331199

Advancing teacher reflective competence: integrating lesson study and didactic suitability criteria in training

Viviane Hummes[1]* and Maria José Seckel[2]*

[1]Department of Linguistic, Scientific, and Mathematical Education, Faculty of Education, Universitat de Barcelona, Barcelona, Spain, [2]Department of Didactics, Faculty of Education, Universidad Católica de la Santísima Concepción, Concepción, Chile

This study examines the impact of combining Lesson Study and the Didactic Suitability Criteria (DSC) for the development of teacher reflective skills. It involves six teachers in an Argentinean training program, spanning 15 virtual sessions over 5 months. Analysis of video recordings indicates significant improvement in reflective abilities, especially when using the DSC for lesson analysis. This approach enhances teaching quality and benefits student learning. The study suggests Lesson Study and the DSC are valuable tools for promoting collaboration and reflection among educators, particularly in math education. Further research with larger samples and long-term follow-up is recommended. This underscores the importance of integrating Lesson Study and the DSC in teacher training to enhance reflective competence and raise education quality.

KEYWORDS

teacher reflexive competence, teacher training, lesson study, didactic suitability criteria, triangle congruence

1 Introduction

Teacher reflective competence is defined as the ability of educators to critically analyze their own performance, identifying both strengths and areas for improvement. It entails a continuous self-assessment and an ongoing commitment to professional development throughout their educational career. Reflective teachers not only review their pedagogical approaches but also make informed decisions and constantly seek ways to enhance the quality of teaching and learning in the classroom (Brown et al., 2021; Pollard et al., 2023).

In the field of teacher education, various theoretical perspectives emphasize the central importance of teacher reflective competence as a fundamental element for advancing and enriching the educational profession (Schön, 1987; Dewey, 1989; Brookfield, 1995; Perrenoud, 2004). To address this need to promote reflection in teaching practice, conceptual approaches have emerged. One of the most notable is Lesson Study (Huang et al., 2019), which involves conducting research in the classroom and provides opportunities to stimulate reflection during teaching. Additionally, we find the Didactic Suitability Criteria (DSC) (Godino et al., 2019), a tool designed to structure and guide teachers' reflection. The central focus of this study revolves around the analysis and description of the indicators present in the DSC, which the participants acquired during the training program. These criteria serve as a reference framework that allows for the evaluation of the didactic adequacy of the conceived and

executed class, encompassing six key dimensions (epistemic, cognitive, interactional, mediational, affective, and ecological).

Although teacher-training courses employing the DSC (Morales-Maure et al., 2019; Seckel and Font, 2020; Esqué and Breda, 2021; Hummes, 2022) offer a comprehensive framework for teacher reflection, there is a recognized need for a space that facilitates more thorough discussion and planning for the implementation of didactic sequences, especially in contexts of practical collaboration. In this sense, Lesson Study could play a significant role in enhancing courses based on the DSC and providing a suitable environment for joint reflection (Hummes, 2022). Therefore, Lesson Study could be conceived as an extension of this approach, creating a favorable context for the reflective process of educators.

Following this line of thought, this study aimed to answer the following question: How does the integration of Lesson Study and the DSC impact the development of reflective competence among participants in a teacher training program? To address this central issue, this work presents the reflections of the participating teachers, in which a collective reflection on a lesson on Triangle Congruence was carried out in a Lesson Study cycle using the DSC as a frame of reference.

In this context, the research aims to thoroughly explore how participants utilize the DSC as a tool for reflection. Furthermore, the objective is to investigate how they effectively transform this reflective tool into a valuable resource, facilitating a process of reevaluation and enhancement of the lessons implemented during the Lesson Study cycle.

2 Pedagogical frameworks

This section addresses the Lesson Study teacher professional development strategy and the Didactic Suitability Criteria, a tool for organizing reflection on teaching practice, providing a pedagogical framework for this investigation. Additionally, a concise review of relevant literature is provided.

2.1 The lesson study professional development strategy

Lesson Study (Lee and Tan, 2020; Da Ponte et al., 2023) is an educational approach based on collaborative inquiry and teaching practice among educators. These activities enhance student learning processes and also elevate the quality of teaching and foster professional development among teachers. Essentially, it involves the joint and detailed creation of a research lesson (class), its execution, direct classroom observation, followed by subsequent analysis (Lewis, 2002; Murata and Takahashi, 2002; Wang-Iverson and Yoshida, 2005; Hart et al., 2011; Fernandez and Yoshida, 2012).

Within the framework of a Lesson Study cycle, a group of teachers comes together to address a challenge related to their students' learning. Together, they develop a research lesson, whether it be an individual class or a series of classes, with the aim of facilitating the students' learning process. They then engage in analyzing and discussing the observations made during the implementation of that lesson. This process provides educators with various opportunities to converse about the students' progress and how teaching influences it.

According to Murata (2011), a Lesson Study cycle encompasses the following phases: curriculum study and goal setting; lesson plan development; implementation and observation; group-based critical reflection using collected data; and design and execution of a tailored new lesson. In a Lesson Study cycle, several criteria must be considered at each stage. The following highlights specific criteria according to Hurd and Lewis (2011) and Lim-Ratnam (2013).

In the curriculum study and goals phase, the inquiry extends beyond conventional curricula, encompassing various instructional materials, expert opinions, and relevant scientific studies. It is recommended to document these discussions, specifying students' prior knowledge and acquisition goals. These analyses serve as the foundation for developing learning objectives in the next stage.

In lesson plan development, specific objectives are developed through the investigation of materials and the formulation of methodologies and assessments. Reactions from students are anticipated, and decisions are made regarding data collection for research purposes.

During the implementation and observation stage, a teacher delivers the lesson while others observe and record. Students actively participate in problem-solving, emphasizing resolution techniques. The teacher guides carefully, fostering the exchange of ideas.

In the critical reflection stage, the group and professionals discuss the lesson's impact on learning. Observers share impressions regarding students' knowledge production. Following reflection, the group makes adjustments for future lessons, marking the beginning of a new cycle with redesign and reimplementation, progressing toward greater maturity.

2.2 Didactic suitability criteria

The Onto-Semiotic Approach to Mathematical Knowledge and Instruction (OSA) according to Godino et al. (2019) considers five distinct ways of examining the processes of teaching and learning mathematics: (1) recognition of mathematical practices; (2) formation of configurations involving mathematical objects and processes; (3) analysis of sequences and educational interactions; (4) identification of the system of norms and metanorms; and (5) evaluation of the didactic adequacy of the teaching process (Font et al., 2010; Breda et al., 2017). The first four types of analysis aim to provide a detailed description and explanation of the process, while the fifth type focuses on evaluating the pedagogical effectiveness of the process through a prior analysis, with the purpose of synthesizing and identifying possible improvements in teaching and learning processes.

The fifth type of didactic analysis proposed by the OSA conceptualizes the didactic suitability of a teaching and learning process as the level at which it exhibits certain characteristics that qualify it as suitable or ideal for facilitating the correspondence between personally acquired meanings in learning and those directed or implemented in institutional contexts (i.e., teaching), considering the circumstances and resources available in the environment. This multidimensional concept is encapsulated in Didactic Suitability Criteria, which can be useful for guiding teaching and learning processes in mathematics and for evaluating their execution (Breda et al., 2018).

OSA considers six DSC, which are as follows: (1) Epistemic Suitability, which evaluates if the mathematics taught are of quality; (2) Cognitive Suitability, which verifies if what is taught is reasonably

close to students' prior knowledge and if the learning obtained is aligned with the expected outcomes; (3) Interactional Suitability, which analyzes if interactions resolve meaning conflicts and students' difficulties; (4) Mediational Suitability, which assesses the adequacy of the contents and temporal resources used throughout the process; (5) Affective Suitability, which examines students' participation (interests and motivations) in the process; (6) Ecological Suitability, which considers, among other aspects, the adequacy of the educational process to the educational project of the institution, curriculum guidelines, and the social and professional environment.

These DSC describe a series of observable components and indicators that serve as a guide for analyzing and evaluating the teaching and learning process at each educational stage (Breda et al., 2017). The components of the DSC are as follows:

1. Epistemic: Errors; Ambiguities; Process richness; Representativeness.
2. Cognitive: Prior knowledge; Curricular adaptation to individual differences; Learning; High cognitive demand.
3. Interactional: Teacher-student interaction; Student–student interaction; Autonomy; Formative assessment.
4. Mediational: Material resources; Number of students, schedule, and classroom conditions; Time.
5. Affective: Interests and needs; Attitudes; Emotions.
6. Ecological: Curriculum adaptation; Intra and interdisciplinary connections; Socio-labor utility; Didactic innovation.

The DSC serves a dual function in the teaching and learning process of mathematics. Before implementation, it serves as a guide to direct how the process should be carried out. Once the implementation is complete, it is used to evaluate the effectiveness of the educational process. The DSC is increasingly being used in training programs as a tool for teachers to reflect on their teaching practice (Esqué and Breda, 2021).

3 Methodology

This study adopted an empirical approach supported by a qualitative methodology (Cohen et al., 2007) with the purpose of investigating and enriching teachers' reflective competence within the context of a case study. It focused on a continuous training program titled "Lesson Study and Didactic Suitability Criteria: a strategy to strengthen teacher reflection," designed to promote the development of teachers' reflective competence.

Six mathematics teachers from an educational institution in Argentina participated in the training course. Three of them taught students in the later years of secondary school (T1, T2, and T3), two taught students of primary school (T4 and T5), and one taught children in early childhood education (T6).

The course spanned 15 weekly sessions, each lasting 1 h and 30 min, covering the period from March to July 2022. The course sessions were conducted virtually using the Zoom platform for training meetings. It is important to note that the sessions with the students (research lesson) were conducted in person. Both the training course sessions and the sessions with the students were recorded with the participants' consent. The first author of this work was the instructor responsible for conducting the course.

3.1 Description of the training course

In session 1 of the course, the objectives and structure of the program were presented, the Lesson Study approach was introduced and explained, the lesson topic was chosen (in this case, Congruence of Triangles), and the teacher who would conduct the research lesson, T1, was assigned.

In session 2, an analysis of Congruence of Triangles in the curriculum was conducted, establishing objectives for the Lesson Study lesson. The examination included how this concept is presented and developed in various materials, considering the school year corresponding to the proposed lesson, which, in this case, was the first year of Secondary Level in Argentina. A detailed evaluation of the institution's curriculum and the national plan was carried out.

During sessions 3 and 4, the group of teachers developed a research lesson specifically relevant to Congruence of Triangles, prioritizing a central or core content.

Between sessions 4 and 5, the research lesson took place in person, was recorded, and later reviewed by the other teachers, as not everyone could be present during the class.

In session 5, the teachers gathered for a collective reflection on the delivered research lesson, highlighting both positive aspects and areas for improvement.

In session 6, the teachers proceeded with the redesign of the class, offering suggestions on aspects to improve and those to retain in the lesson. They focused on optimizing the proposed activities and tasks.

In session 7, the study of Didactic Suitability Criteria (DSC) was introduced. Having completed a full cycle of Lesson Study, the teachers had reflected on the sequence of tasks they proposed. These reflections were used as evidence of the implicit use of some components and indicators of the DSC, leading to an explanation of the concept.

During sessions 8, 9, and 10, the study of DSC took place by presenting each of its components and indicators, as well as carrying out tasks related to each of them.

In sessions 11 and 12, a detailed reflection on the Lesson Study lesson was conducted, using the DSC as an evaluation guide. Each teacher performed an individual analysis from the perspective of one of the DSC (epistemic, cognitive, interactional, mediational, affective, and ecological). During these sessions, reflections were shared, and discussions were promoted about possible adjustments and improvements in the class redesign.

In session 13, the group of teachers redesigned the class considering the DSC.

Between sessions 13 and 14, the redesigned class was implemented with the DSC. The new lesson was implemented by the same teacher, T1, but for a different group of students and took place in person.

In session 14, a reflection and analysis of the second implementation took place, guided by the DSC.

In session 15, a course evaluation questionnaire was filled out, and the course was concluded.

3.2 Data analysis and interpretation

The data analysis employed content analysis technique (Cáceres, 2003) using video recordings of the course sessions. The process consisted of two phases. Phase one involved analyzing the proposed

lesson design in Lesson Study, providing insight into teachers' reflections. Phase two focused on participants' reflections, identifying components and indicators of the DSC that guided the reflection on the implemented lesson. Criteria proposed by Seckel et al. (2022), p.5 were followed:

- The theory of didactic suitability served as the theoretical framework for analysis.
- Content segments (units of analysis) were singled out for categorization based on DSC components.

4 Results

4.1 Lesson study class - triangle congruence

The teachers designed an eighty-minute lesson focused on triangle congruence, aiming for students to recognize congruent triangles and comprehend the necessary and sufficient conditions for arguing about congruence. The activity involved a team competition where each team identified congruent triangles from an envelope with five numbered triangles, employing unique sets for each team.

Afterwards, the teams addressed a hypothetical construction scenario provided by a fictional character, discussing and constructing various triangular window designs based on specific data. Each team presented their constructions on the blackboard, discussing the success or challenges faced.

In the subsequent stage, teams reflected on questions related to the construction process, leading to the development of criteria for triangle congruence: SSS (Side-Side-Side), AAS (Angle-Angle-Side), and SAS (Side-Angle-Side). The entire learning process was observed and recorded for analysis on a tracking sheet.

4.2 DSC implicit in the initial reflection on the lesson study class

Following the planning, implementation, and observation of the Lesson Study class in session 5 of the course, the teachers gathered to reflect on the implemented class. At this point in the course, the participants were not yet familiar with the DSC, so their reflections include comments that are evidence of the validity of the framework for analyzing such situations. Each teacher shared their impressions of what they observed during the Lesson Study class. First, each one presented their observations and then engaged in a brief discussion about the aspects they noticed. Next, the teachers' reflections on the implemented class are presented, organized by each suitability criterion and its components.

4.2.1 DSC epistemic

4.2.1.1 Process richness

Regarding the task sequence involving the execution of relevant processes in mathematical activity, T2 makes the following comment: "I was thinking that the students could have formulated the congruence criteria at the moment when they were measuring their triangles. For example, with the one that did match, ask them: 'What data do you have?' and then record them, like for example, side, angle, side. That way we could keep track, and it would be recorded as their contribution."

4.2.2 DSC cognitive

4.2.2.1 Prior knowledge

Most of the teachers observed that the students lacked clarity regarding the meaning of the word 'congruence'. In other words, they lacked the necessary prior knowledge to address the topic, as noted by T4 in her comment: "In the first exercise, the students did not understand the task because they did not have the concept of congruence. I mean congruence in general terms, not specifically in relation to triangles. They were unfamiliar with the meaning of the word congruent."

4.2.2.2 High cognitive demand

T1 made an observation related to the potential activation of important cognitive processes in the class: "Regarding the congruence criteria, I would have expected them to emerge more naturally from the students. In the end, I felt like I pushed them a bit due to the lack of time and motivation. It would have been enriching if the students could have formulated them on their own, with a little guidance."

4.2.3 DSC interactional

4.2.3.1 Teacher-student interaction

T2 suggested that when students were unsure about the word 'congruence', a question-and-answer game could have been used to address this lack of prior knowledge. This would have helped identify and resolve the students' meaning conflicts. T2 commented: "Perhaps, at the beginning, when that doubt arose, we could have asked everyone: What other word could we use instead of 'congruence'? How else could we express it?"

Regarding facilitating the inclusion of students in the class dynamics instead of excluding them, T5 commented as follows: "When students had doubts, the teacher was present at all times, providing assistance to the groups. She approached the tables, making an effort to reach out to the less engaged students."

4.2.4 DSC mediational

4.2.4.1 Material resources

The teachers expressed criticism regarding the materials used, as seen in T2's comment: "We did not have the opportunity to test the materials. T1 tried them out the day before the class, which was a bit impromptu. We did not have the chance to verify if the assembly was straightforward. We faced difficulties that, perhaps, we could have avoided if we had the opportunity to test them beforehand and realized that it wasn't as simple as it seemed."

4.2.4.2 Number of students, schedule, and classroom conditions

Regarding whether the number and distribution of students allowed for the intended teaching, T1 commented as follows: "Maybe the groups were too large. We could have worked with slightly smaller groups, maybe twice as many groups but with half the number of

members. There were many students who did not have the opportunity to contribute. They found themselves without tasks to do, not even the less participative ones got involved in activities like cutting or measuring. Perhaps this was because the groups were too numerous. If they had been smaller, everyone would have been more engaged in some of the tasks."

Regarding the suitability of the course schedule, T1 noted the following: "On the other hand, we had a small issue with the start of the class, which was a bit later than the usual time they have math classes. Therefore, towards the end of the class, it was noticeable that students asked several times about the need to go play sports, for example. This concerned me a bit because they started to lose interest in the activity, as they were eager to go to the next class. They were focused on the fact that they had to go to another class, especially the boys, who really enjoy sports and did not want to miss it. So in the end, it seemed like they disconnected a bit because they were in a hurry to get to the next class. However, these are things that can happen in a class as well. It was a bit challenging for me to wrap up the class, because it seemed like they got a bit unmotivated towards the end."

4.2.4.3 Time

The teachers expressed concern about the efficiency in the use of the available time. As indicated by T1 in her comment: "I'm not sure if it was too long. Maybe we could adjust it. It lasted 80 min, which is the usual duration of a class, but it was quite intense. The students worked hard throughout that time and it seems like they got a bit tired. […] They were assigned a considerable workload and it seems like they got tired."

4.2.5 DSC affective

4.2.5.1 Attitudes

T4 pointed out that the group size was too large, which affected the participation of many students in the activities. As evidence, she mentioned: "Out of seven members, one or two took the lead, and three, or in the best case, four worked. It seemed like each group could be subdivided and the material could be doubled so that everyone had the challenge of participating, distributing roles, and contributing." Additionally, T2 and T5 also suggested assigning roles to students to encourage their involvement in the activities.

There is no evidence observed regarding the components errors, ambiguities, and representativeness of epistemic suitability; components curricular adaptation to individual differences and learning of the cognitive; components student–student interaction, autonomy, and formative assessment of the interactional; components interests and needs and emotions of the affective; and no component of the ecological.

4.3 DSC in the second reflection on the lesson study class

Following the analysis of the Lesson Study class and the subsequent course adjustments, the participants were introduced to the DSC. In session 11, a fresh reflection on the Lesson Study class was conducted in consideration of these criteria. The results of this reflective process conducted during the analysis phase are presented below, organized by each suitability criterion and its respective components.

4.3.1 DSC epistemic

- Errors: T2 pointed out that "there were misunderstandings in defining the problem, as students lacked a clear grasp of triangle congruence. Furthermore, a procedural mistake occurred because the students could not complete the intended constructions due to the unsuitable materials."
- Ambiguities: T2 noted that "students encountered confusion when defining triangle congruence" due to their prior experience with the concept of congruent sides. They were expecting triangles with two equal sides (isosceles) or three (equilateral). Additionally, they had encountered this concept applied to a different mathematical object, which also involved triangles.
- Process richness: T2 emphasized that "active student engagement in hands-on activities using construction materials and geometric tools. They compared figures, performed constructions through trial and error, and established congruence criteria. Students effectively communicated their procedures and provided reasoning for their conclusions."
- Representativeness: T2 pointed out: "Triangle congruence means that all sides and angles are equal. If congruence is proven for even just one aspect of the triangle (SSS, SAS, ASA), it extends to the entire triangle. This simplifies reproducing the figure, as seen in Juan's problem. However, if we begin with triangle congruence itself, we deduce that all their elements are equal. This enables us to establish congruences in other figures containing these triangles, which can be valuable for proofs. Nonetheless, this level of depth was not the class's objective, as it exceeds the students' current level."

4.3.2 DSC cognitive

- Prior knowledge: T1 noted: "The students showed a solid understanding of fundamental concepts related to triangles and angles, correctly classifying them. However, they faced challenges in areas like comparing triangles and grasping the concept of congruence, resulting in some confusion."
- Curricular adaptation to individual differences: T1 emphasized: "Group work proved effective in diversifying activities and could be tailored to address individual differences in future planning."
- Learning: T1 noted: "Group discussion of conclusions served as an assessment method, fostering team reflection and aiding in error identification. Common mistakes were observed in measurements, with challenges arising in manipulating elements for triangle construction."
- High cognitive demand: T1 emphasized: "The initial activity encouraged intra-mathematical processes, enabling students to infer, conjecture, and generalize through triangle manipulation. Metacognition was stimulated by reviewing instructions and seeking the meaning of congruence for a strategic approach. Processes encompassed schema creation, data interpretation, graphical representation modification, and conclusion argumentation."

4.3.3 DSC interactional

- Teacher-student interaction: T5 observed: "T1 presented the topic clearly, emphasizing the instructions and addressing

students' questions. She monitored the progress of the groups and provided support when needed. Other resources could have been used to explain triangle congruence. She successfully held the students' attention and tried to involve everyone in the class dynamics, challenging them to participate actively."

- Student–student interaction: T5 commented: "There was dialogue and communication among group members. All students participated, although some did not fully engage."
- Autonomy: T5 emphasized: "The students acknowledged their responsibilities. Some took on the challenges of exploration and measurement, while others relied on the group and did not fulfill their assigned tasks."
- Formative assessment: T5 observed: "From the beginning, students were asked to document their activities to assess individual progress and participation. Using a rubric detailing what to document would be an effective option for systematic observation."

4.3.4 DSC mediational

- Material resources: T3 observed: "Students identified two congruent triangles out of five made of cardboard. They then used strips of cardboard and butterfly clips to represent the solution to the problem. However, there were difficulties in joining the strips, which the teacher tried to address verbally, but it complicated and extended the activity."
- Number of students, schedule, and classroom conditions: T3 emphasized: "The class size and the upcoming physical education class caused anxiety among the students at the end of the lesson, affecting the class conclusion. The blackboard was used effectively, visible to all students. Despite limited space due to desk arrangement, there were no complications in the class proceedings."
- Time: T3 observed: "The class did not include a review of prior knowledge. An initial activity to introduce the topic extended due to the students' lack of understanding of congruence. Following this, a contextualized problem was addressed, taking up the majority of the class time. The presentation of the criteria for triangle congruence was brief. Despite its significance, the students did not have the opportunity to discover these criteria themselves, as the class ran over, and they wanted to go to physical education."

4.3.5 DSC affective

- Interests and needs: T4 emphasized: "A practical initial activity with colorful and manipulable material was employed to engage the students. The task presented a challenge that required the application of prior knowledge, promoting cognitive connection. A hypothetical scenario related to real-life needs, such as construction and work, was presented. However, it was observed that a proposal closer to their interests and reality, like creating triangular boxes to form a hexagon and filling them with treats, or designing triangular flower beds or pots, could have had a greater impact."
- Attitudes: T4 pointed out: "The teacher repeatedly encouraged students to collaborate in teams to tackle the challenges. However, it was noted that several students displayed a passive attitude, either not fully engaging or even giving up their attempts. The open expression of arguments was promoted to appreciate everyone's contributions. Some students chose not to participate due to feelings of embarrassment, fear of making mistakes, or insecurity in expressing their ideas. In some cases, they attempted to designate someone they perceived as the "bravest" in the group to speak or present the work."
- Emotions: T4 stated: "Emotions are crucial in development, and emotional learning endures. Providing meaningful environments and activities is crucial. Guiding the development of skills like self-control, empathy, and perseverance is essential. Sharing personal experiences fosters curiosity and identification. Displaying enthusiasm in mathematical activities balances emotion and reason."

4.3.6 DSC ecological

- Curriculum adaptation: T6 noted: "The content on triangle congruence is integrated into the curriculum in Santa Fe, Argentina, for this educational level."
- Intra and interdisciplinary connections: T6 observed: "The class emphasized the importance of establishing intra-mathematical connections, linking compatible mathematical concepts like angle measurement and the use of geometry tools. Additionally, there was an exploration of interdisciplinary connections in an attempt to apply mathematical concepts in non-mathematical contexts. However, it was noted that this application is uncommon and presents challenges, especially in the context of triangle congruence."
- Socio-labor utility: T6 emphasized: "A content with practical applications in the work and social context was taught. Several construction companies were tasked with designing a triangular window with specific reference data. It was emphasized that triangles have a wide range of everyday uses, and their congruence is applied in various fields such as furniture production, manufacturing musical instruments, and household objects. Furthermore, their significance in architecture was highlighted, especially in the construction of triangular trusses used in sloped roofs of homes and similar structures."
- Didactic innovation: T6 noted: "This refers to an innovative practice, where teachers share the class through Classroom for absent students or those who want to review the topic. It creates a kind of open tutorial, allowing students to delve deeper on their own, interact, and share practical experiences through text, photos, or videos."

5 Discussion and conclusions

This research focused on analyzing the resulting impact of integrating Lesson Study and DSC in the development of participants' reflective competence within a teacher training program. This inquiry arises from the crucial importance of teacher reflective competence as an essential component for professional growth, emphasizing the ability to critically assess practice, whether one's own or others', and engage in a continuous development process to provide high-quality education (Prieto et al., 2020; Seckel and Font, 2020).

Richit et al. (2021), in conjunction with Richit and Tomkelski (2020), underscore the significance of cultivating environments that foster in-depth discussions and the meticulous planning of didactic sequences, particularly within collaborative contexts. In this vein, the findings of this research suggest that Lesson Study facilitates collaboration and enables a detailed analysis of lessons. Furthermore,

Colomer et al. (2020) emphasize the evident need to provide structured frameworks for guiding teacher reflection. From this standpoint, the research results indicate that the implementation of DSC offers participants a framework for reflection, providing a profound understanding of six key dimensions encompassing epistemic, cognitive, interactional, mediational, affective, and ecological aspects of the teaching and learning process.

Based on the obtained results, it can be inferred that teachers made notable progress in their ability to reflect on the teaching of Triangle Congruence after completing the training course that integrates Lesson Study and DSC. This progress was even more pronounced when participants used DSC to analyze the lesson implemented during the Lesson Study phase, as evidenced by contrasting it with the initial reflection that lacked the use of DSC.

These findings align with previous research emphasizing the need to equip teachers with tools that focus on teaching and learning processes, allowing these tools to be taught as an integral part of teacher training (Nilssen, 2010; Rubio, 2012; Turner, 2012; Giménez et al., 2013; Sun and van Es, 2015; Seckel, 2016).

The implications derived from the results indicate that the integration of Lesson Study and DSC represents an effective strategy for strengthening teachers' reflective competence, providing meaningful opportunities to enhance the quality of teaching and learning in the classroom. It also underscores the crucial importance of establishing environments that foster reflection and continuous growth in the educational profession, thus contributing to strengthening the overall educational landscape. These findings align with the results obtained by Hummes et al. (2023), who conclude on the potential of the combined use of Lesson Study and DSC for teacher reflection development.

Acknowledging the study's limitations, future research should consider expanding the sample for increased external validity and conducting long-term follow-ups to assess the sustainability of integrating Lesson Study and DSC effects over time. To advance understanding, it is recommended that future research explores the adaptation of these strategies to diverse educational contexts. Long-term studies could offer insights into the duration and maintenance of observed effects. Additionally, investigating the application of Lesson Study and DSC in various subjects and educational levels could further enhance comprehension of their impact.

Data availability statement

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

Ethics statement

Ethical approval was not required for the studies involving humans because The reason why ethical approval was not required is because the study did not involve direct human research. 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

VH: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. MS: Formal analysis, Methodology, Validation, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We thank the teachers who participated in this research and the educational institution that provided the opportunity to carry it out.

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.

Publisher's note

References

Breda, A., Font, V., and Pino-Fan, L. (2018). Evaluative and normative criteria in didactics of mathematics: the case of didactical suitability construct. *Bolema* 32, 255–278. doi: 10.1590/1980-4415v32n60a13

Breda, A., Pino-Fan, L. R., and Font, V. (2017). Meta didactic-mathematical knowledge of teachers: criteria for the reflection and assessment on teaching practice. *EURASIA J. Math. Sci. Tech. Ed.* 13, 1893–1918. doi: 10.12973/eurasia.2017.01207a

Brookfield, S. D. (1995). *Becoming a critically reflective teacher*. Jossey-Bass Publishers. Hoboken.

Brown, C., Poortman, C., Gray, H., Ophoff, J. G., and Wharf, M. M. (2021). Facilitating collaborative reflective inquiry amongst teachers: what do we currently know? *Int. J. Educ. Res.* 105:101695. doi: 10.1016/j.ijer.2020.101695

Cáceres, P. (2003). Análisis cualitativo de contenido: una alternativa metodológica alcanzable. *Psicoperspectivas* 2, 53–82. doi: 10.5027/psicoperspectivas-vol2-issue1-fulltext-3

Cohen, L., Manion, L., and Morrison, K. (2007). *Research methods in education*. London: Routledge.

Colomer, J., Serra, T., Cañabate, D., and Bubnys, R. (2020). Reflective learning in higher education: active methodologies for transformative practices. *Sustainability* 12:3827. doi: 10.3390/su12093827

Da Ponte, J. P., Quaresma, M., and Mata-Pereira, J. (2023). The development of teachers' knowledge in a lesson study. *Int. J. Lesson Learn. Stud.* 12, 78–91. doi: 10.1108/IJLLS-02-2022-0025

Dewey, J. (1989). *Cómo pensamos: Nueva exposición de la relación entre pensamiento y proceso educativo*. Paidós. Mexico City.

Esqué, D., and Breda, A. (2021). Assessment and redesign of a unit on proportionality using the didactical suitability tool. *Uniciencia* 35, 38–54. doi: 10.15359/ru.35-1.3

Fernandez, C., and Yoshida, M. (2012). *Lesson study: a Japanese approach to improving mathematics teaching and learning*. London: Routledge.

Font, V., Planas, N., and Godino, J. D. (2010). Modelo Para el análisis didáctico en educación matemática. *Infanc. APRENDIZ.* 33, 89–105. doi: 10.1174/021037010790317243

Giménez, J., Font, V., and Vanegas, Y. (2013). "Designing professional tasks for didactical analysis as a research process" in *Task Design in Mathematics Education: Proceedings of ICMI study 22*. ed. C. Margolinas (Oxford, England: International Commission on Mathematical Instruction), 579–587.

Godino, J. D., Batanero, C., and Font, V. (2019). The onto-semiotic approach: implications for the prescriptive character of didactics. *Learn. Math.* 39, 38–43.

Hart, L. C., Alston, A. S., and Murata, A. (2011). *Lesson study research and practice in mathematics education*. Dordrecht: Springer.

Huang, R., Takahashi, A., and Da Ponte, J. P. (2019). *Theory and practice of lesson study in mathematics*. Dordrecht: Springer.

Hummes, V. B. (2022). Combined use of the lesson study and the criteria of didactical suitability for the development of the reflection on the own practice in the training of mathematics teachers. *Acta Sci.* 21, 64–82. doi: 10.17648/acta.scientiae.v21iss1id4968

Hummes, V., Breda, A., Font, V., and Seckel, M. J. (2023). Improvement of reflection on teaching practice in a training course that integrates the lesson study and criteria of didactical suitability. *J. High. Educ. Theory Pract.* 23:6395. doi: 10.33423/jhetp.v23i14.6395

Hurd, J., and Lewis, C. (2011). *Lesson study step by step: How teacher learning communities improve instruction*. Portsmouth, NH: Heinemann.

Lee, L. H. J., and Tan, S. C. (2020). Teacher learning in lesson study: affordances, disturbances, contradictions, and implications. *Teach. Teach. Educ.* 89:102986. doi: 10.1016/j.tate.2019.102986

Lewis, C. C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia, PA: Research for Better Schools.

Lim-Ratnam, C. (2013). Lesson study step by step: how teacher learning communities improve instruction. *Int. J. Lesson Learn. Stud.* 2, 304–306. doi: 10.1108/IJLLS-05-2013-0025

Morales-Maure, L., Durán-González, R. E., Pérez-Maya, C., and Bustamante, M. (2019). Hallazgos en la formación de profesores Para la enseñanza de la matemática desde la idoneidad didáctica. Experiencia en cinco regiones educativas de Panamá. *Rev. Incl.* 6, 142–162.

Murata, A. (2011). "Introduction: conceptual overview of lesson study" in *Lesson study research and practice in mathematics education*. eds. L. C. Hart, A. S. Alston and A. Murata (Dordrecht: Springer), 1–12.

Murata, A., and Takahashi, A. (2002). "Vehicle to connect theory, research, and practice: how teacher thinking changes in district-level lesson study in Japan" in *Proceedings of the 24th annual meeting north American chapter of the International Group for the Psychology of mathematics education*. eds. D. S. Mewborn, P. Sztajn, D. Y. White, H. G. Wiegel, R. L. Bryant and K. Nooney (Japan: ERIC/CSMEE).

Nilssen, V. (2010). Encouraging the habit of seeing in student teaching. *Teach. Teach. Educ.* 26, 591–598. doi: 10.1016/j.tate.2009.09.005

Perrenoud, P. (2004). *Diez nuevas competencias Para enseñar: Invitación al viaje*. Barcelona: Graó

Pollard, A., Wyse, D., Craig, A., Daly, C., Harmey, S., and Hayward, L., (2023). *Reflective teaching in primary schools*. London: Bloomsbury Publishing.

Prieto, L. P., Magnuson, P., Dillenbourg, P., and Saar, M. (2020). Reflection for action: designing tools to support teacher reflection on everyday evidence. *Technol. Pedagog. Educ.* 29, 279–295. doi: 10.1080/1475939X.2020.1762721

Richit, A., da Ponte, J. P., and Tomasi, A. P. (2021). Aspects of professional collaboration in a lesson study. *Int. Electron. J. Math. Educ.* 16:em0637. doi: 10.29333/iejme/10904

Richit, A., and Tomkelski, M. L. (2020). Secondary school mathematics teachers? Professional learning in a lesson study. *Acta Sci.* 22, 2–27. doi: 10.17648/acta.scientiae.5067

Rubio, N. (2012). *Teachers' competence in the didactic analysis of mathematical practices, objects and processes*. Barcelona: University of Barcelona.

Schön, D. A. (1987). *Educating the reflective practitioner: toward a new design for teaching and learning in the professions*. Hoboken: Jossey-Bass.

Seckel, M. J. (2016). *Competence in didactic analysis in the initial training of basic general education teachers with a major in mathematics*. Barcelona: University of Barcelona.

Seckel, M. J., Breda, A., Farsani, D., and Parra, J. (2022). Reflections of future kindergarten teachers on the design of a mathematical instruction process didactic sequences with the use of robots. *EURASIA J. Math. Sci. Tech. Ed.* 18:em2163. doi: 10.29333/ejmste/12442

Seckel, M. J., and Font, V. (2020). Reflective competence in mathematics teacher educators. *Mag. Int. J. Res. Edu.* 12, 127–144. doi: 10.11144/Javeriana.m12-25.crfp

Sun, J., and van Es, E. A. (2015). An exploratory study of the influence that analyzing teaching has on preservice teachers classroom practice. *J. Teach. Educ.* 66, 201–214. doi: 10.1177/0022487115574103

Turner, F. (2012). Using the knowledge quartet to develop mathematics content knowledge: the role of reflection on professional development. *Res. Math. Edu.* 14, 253–271. doi: 10.1080/14794802.2012.734972

Wang-Iverson, P., and Yoshida, M. (2005). *Building our understanding of lesson study*. Philadelphia, PA: Research for Better Schools.