



PROMOTING SUSTAINABLE TEACHER DEVELOPMENT: THE IMPACT OF ONLINE LESSON STUDIES ON REFLECTIVE PRACTICES

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Abstract

Reflective practice is essential in teacher education, enabling pre-service teachers to engage in meaningful professional development and continuously improve their teaching skills. However, barriers such as time constraints, geographic isolation, and crises like COVID-19 often hinder consistent engagement in reflective practices. This study developed and evaluated an online lesson study platform within a university-based teacher education program to address these challenges and support pre-service teachers' professional growth. Using a mixed-methods approach, the study analyzed reflective engagement among 115 pre-service teachers in the Faculty of Education through reflection reports and surveys. The theoretical framework, based on Darling-Hammond's reflective perspective, focused on student learning processes, teaching effectiveness, classroom atmosphere, personal educational philosophy, and continuous growth through reflective dialogue. Qualitative analysis revealed varying levels of engagement in reflective practices, with significant improvements in reflections on teaching methods and student learning. However, challenges remained in reflecting on students' cognitive processes. Quantitative analysis using the McNemar test confirmed statistically significant increases in reflective practice engagement. These findings suggested that online lesson study platforms can provide accessible and practical opportunities for pre-service teacher professional development, overcoming barriers related to location and logistics and supporting global educational goals, particularly Sustainable Development Goals 4 (Quality Education) and 10 (Reduced Inequalities).

Keywords: lesson study, peer collaboration, professional development, reflective practices, teacher education

Introduction

The Necessity of Online Lesson Study

The pursuit of Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities), emphasizes the critical need for equitable opportunities for effective teacher education. The Global Education Monitoring Report (UNESCO, 2020) has underscored that achieving these goals requires comprehensive and inclusive teacher training strategies that address educational opportunity disparities. Tikly and Barrett (2011) have highlighted that educational systems must ensure that pre-service teachers are equipped not only with pedagogical knowledge but also with the ability to adapt and respond to diverse learning environments. However, despite significant global efforts, educational

inequality persists, particularly in regions with limited access to resources and training. This underscores the need for innovative models that align with the principles of sustainability and equity, providing all pre-service teachers with the necessary skills and opportunities for professional growth (Aikman & Unterhalter, 2005; Unterhalter, 2017).

Teacher education is vital for fostering the development of high-quality educators capable of navigating complex and evolving classroom environments. Guskey (2002) and Desimone (2009) have emphasized that effective teacher professional development must be ongoing, involve active learning, and include collaborative elements that reinforce practical application. Opfer and Pedder (2011) have argued that teacher learning is an iterative process that requires continuous reflection and adaptation. However, current teacher training programs often face limitations in scope and sustainability, primarily focusing on short-term outcomes (Hargreaves & Fullan, 2012). This presents a significant challenge in structuring teacher education programs to ensure sustained professional growth while addressing the diverse needs of future educators (Knight, 2007; Stoll et al., 2006).

Collaborative lesson study has emerged as a promising approach that integrates reflective practice with professional development, providing pre-service teachers with the opportunity to engage in collaborative planning, observation, and reflection (Lewis, 2002; Stigler & Hiebert, 1999). Dudley (2014) has noted that lesson study encourages a culture of shared inquiry, where teachers collectively analyze lessons, identify strengths and weaknesses, and refine their teaching strategies based on peer feedback. Takahashi and McDougal (2016) have added that this method supports a cycle of continuous improvement, allowing educators to deepen their understanding of instructional techniques and student learning processes. Perry and Lewis (2009) and Fernandez and Yoshida (2004) have emphasized that when implemented effectively, lesson study can bridge the gap between theoretical knowledge and practical application, fostering a deeper connection between pedagogical principles and real-world teaching.

Despite the documented benefits, implementing collaborative lesson study in teacher education faces challenges. Groth (2011) has pointed out that logistical issues such as time constraints and the availability of trained facilitators can hinder the integration of lesson study into university curricula. Additionally, Murata (2011) and Hiebert and Morris (2012) have stressed that while lesson study promotes reflective practice, aligning these activities with broader educational standards and curricula remains challenging. Coenders and Verhoef (2019) have highlighted the need for sustained institutional support to ensure that lesson study can be effectively embedded in teacher training programs. These findings underscore a critical research gap: How can lesson study be adapted and scaled to fit various educational contexts, particularly in higher education, where resources and time are often limited?

Moreover, the importance of reflection within collaborative lesson study cannot be overstated. Schön (1983) first introduced the concept of reflective practice as a means for professionals to analyze and improve their work, a principle that has been foundational in teacher education. Brookfield (1995) has reinforced the idea that reflection should involve both self-assessment and peer feedback to be truly effective. In the context of lesson study, reflective practices enable pre-service teachers to evaluate their teaching methods critically, learn from their peers, and make informed changes to their instructional approaches (Zeichner & Liston, 1996; Hatton & Smith, 1995). Day (1999) and Rodgers (2002) have noted that structured reflection contributes to more profound professional growth, yet practical implementation within teacher training programs remains underexplored. This indicates a need for research into scalable models that integrate structured reflection as an essential component of teacher education (Farrell, 2013; Killion & Todnem, 1991).

The integration of lesson study into university-based teacher education programs is particularly significant. Perry and Lewis (2009) have found that pre-service teachers who participated in lesson studies were better equipped to apply their theoretical knowledge in

practical settings, enhancing their understanding of instructional design and student learning processes. Fernandez and Yoshida (2004) and Takahashi (2014) have argued that lesson study in university settings supports the development of essential teaching skills, such as lesson planning and anticipating student misunderstandings. However, limited faculty expertise and insufficient time for in-depth lesson study sessions can restrict its effectiveness (Coenders & Verhoef, 2019; Groth, 2011). Rock and Wilson (2005) have noted that while lesson study encourages reflective thinking, universities must overcome logistical and resource-related barriers to maximize its potential impact.

The benefits of lesson study are further amplified when combined with the advantages of online learning platforms. Bozkurt and Sharma (2020) and Hodges et al. (2020) have highlighted how digital technologies became essential during the COVID-19 pandemic, maintaining educational continuity and facilitating collaborative learning. Online platforms offer a way to scale collaborative lesson study, making it accessible to pre-service teachers regardless of location (Means et al., 2009; Murphy, 2020). However, the digital platform presents a significant challenge, with disparities in access to technology impacting the effectiveness of online learning (Tikly & Barrett, 2011; UNESCO, 2020). This calls for developing robust online lesson study platforms designed to be inclusive and adaptive, supporting sustained professional growth and reflective practices across diverse educational contexts.

In response to these challenges and gaps in the literature, the current study seeks to develop and evaluate an online lesson study platform tailored for university-based teacher education programs. By leveraging the strengths of both lesson study and digital learning, this platform seeks to provide pre-service teachers with the tools to engage in reflective, collaborative learning that aligns with SDG 4 and SDG 10, ultimately contributing to a more equitable and effective model of teacher training.

Theoretical Framework of Lesson Study

This study proposes a theoretical model integrating teacher growth, lesson study, and reflective practice. Designed to facilitate continuous professional development, this model elucidates how these elements interact to create a synergistic process that supports teacher growth and addresses the goals of Sustainable Development Goal 4 (SDG 4: Quality Education) and SDG 10 (Reduced Inequalities), as highlighted by UNESCO (2020) and Tikly & Barrett (2011).

Teacher Growth

Teacher growth is conceptualized as the ongoing enhancement of professional abilities and knowledge. This process includes a deepening of subject-specific expertise (Shulman, 1987), the refinement of teaching skills (Hattie, 2009), and the diversification of instructional approaches (Cochran-Smith & Lytle, 1999). Continuous professional growth is essential for educators to respond effectively to students' evolving needs and the educational environment's complexities. Guskey (2002) and Desimone (2009) have emphasized that impactful professional development must be iterative and practical, integrating active learning and collaborative elements that reinforce real-world application. Opfer and Pedder (2011) further argue that teacher growth requires sustained engagement in reflective and adaptive practices, ensuring that professional development remains responsive and contextually relevant.

Lesson study provides a collaborative structure through which teachers collectively plan, observe, and reflect on lessons (Lewis, 2002). This approach promotes a culture of cooperation, as Stenhouse (1975) noted, where educators share insights, conduct practical research, and continuously implement feedback to enhance their teaching (Schön, 1983). Initially established in Japan, lesson study has been widely recognized for its efficacy in fostering reflective practice and improving instructional quality, garnering support from researchers such as Perry and Lewis (2009) and Fernandez and Yoshida (2004). Takahashi and McDougal (2016) have highlighted that lesson study supports a cyclical improvement process, enabling educators to deepen their understanding of pedagogical strategies and student learning dynamics. This collaborative reflection contributes to a more refined and adaptable teaching approach, aligning with Dudley's (2014) findings on the value of shared inquiry in professional development.

Reflective Practice

Reflective practice is characterized by three key features that are essential for the professional growth of teachers:

Multiple Perspectives: Reflective practice encourages educators to examine their teaching through various perspectives, incorporating feedback from colleagues, students, and self-reflection (Brookfield, 1995; Zeichner & Liston, 1996). This multi-dimensional approach allows teachers to assess their instructional methods comprehensively, facilitating a balanced and nuanced understanding of teaching effectiveness.

Continuous Improvement: As Day (1999) and Rodgers (2002) have highlighted, reflective practice supports an ongoing refinement process. Reflection should be embedded as a continuous activity, enabling teachers to iteratively adapt their strategies to meet diverse learning needs and optimize educational outcomes.

Concrete Methodologies: Reflective practice is grounded in actionable methodologies that guide teachers in implementing reflective insights directly within their classrooms (Killion & Todnem, 1991). By providing specific tools and strategies, this approach ensures that reflection is not merely theoretical but practical and directly applicable, enhancing the overall impact on teaching practices.

By integrating these dimensions, the theoretical model used in this study aims to promote a reflective environment where teachers systematically analyze and improve upon their instructional methods, fostering a culture of continuous professional growth and collaborative learning.

Theoretical Framework of Teacher Reflection

This study constructs a teacher reflection model grounded in the reflective practice framework proposed by Linda Darling-Hammond (1997, 2006), which is widely acknowledged for its effectiveness in fostering professional growth among educators. Darling-Hammond's framework emphasizes a structured, multi-perspective approach to self-evaluation, encouraging teachers to continuously refine their instructional practices in response to objective and systematic analysis. This reflective model aims to enhance the quality of education by promoting an evidence-based and responsive approach to teaching.

The proposed model aligns with a broader body of research that has underscored the importance of reflection in teacher education. Reflective practice, introduced by Schön (1983), supports a process in which teachers critically examine their actions, question assumptions, and derive insights that contribute to improved educational outcomes. Brookfield (1995) has

similarly emphasized critical reflection, urging teachers to consider their beliefs and the impact of their practices within a larger educational context. These foundational theories provide a compelling rationale for adopting a structured reflection model that prioritizes continuous self-improvement and professional growth in educational settings (Lewis, 2002; Rodgers, 2002).

The analytical framework in this study aims to incorporate five essential perspectives articulated by Darling-Hammond (2006), each developed to support teachers in systematically evaluating and enhancing their instructional approaches:

Student Learning Processes and Outcomes: This perspective directs teachers' attention to understanding students' cognitive and developmental progress. By observing and analyzing student behaviors, participation, and performance, teachers can identify unique learning needs and adapt their instructional methods to foster optimal learning outcomes. This reflective approach aligns with research by Zeichner and Liston (1996), which has advocated for structured reflection on PST learning as an essential component of teacher education.

Effectiveness of Teaching Methods on Student Impact: This dimension emphasizes evaluating the efficacy of various instructional approaches in promoting student engagement and understanding. Teachers are encouraged to assess the impact of different pedagogical strategies, incorporating innovative techniques such as digital tools and actively seeking feedback from students to refine their practice. Studies by Guskey (2002) and Desimone (2009) have demonstrated that a focus on the effectiveness of instructional methods is central to impactful professional development.

Classroom Environment and Atmosphere: Recognizing that a supportive learning atmosphere is critical to student success, this perspective urges teachers to consider the classroom environment's role in facilitating positive learning interactions. Teachers are prompted to reflect on the physical setup, emotional climate, and quality of student-teacher interactions within the classroom. A conducive classroom environment has been identified as a critical factor in motivating students and enhancing academic achievement (Hargreaves & Fullan, 2012; Stoll et al., 2006).

Personal Educational Philosophy and Its Practice: This perspective guides teachers in aligning their instructional decisions with their educational beliefs, ensuring that personal values resonate through professional practice. By reflecting on how personal philosophy manifests in the classroom, teachers cultivate integrity and authenticity, fostering a more meaningful educational experience for both themselves and their students. Brookfield (1995) and Knight (2007) have emphasized that alignment between beliefs and actions is essential for developing a consistent and impactful teaching approach.

Continuous Growth through Reflective Dialogue: The final perspective stresses the significance of reflective dialogue for ongoing professional development. Engaging in discussions with colleagues, students, and other stakeholders provides teachers with diverse perspectives and constructive feedback, promoting a culture of shared learning and continuous improvement. As Lewis (2002) and Takahashi and McDougal (2016) highlighted, collaborative reflection is essential in lesson study practices and contributes to the enhancement of teaching quality across educational contexts.

Through these five perspectives, the proposed model used in this study facilitates a systematic process by which teachers critically analyze and refine their instructional practices. This multi-dimensional approach to reflection not only supports individual professional growth but also aligns with broader educational goals, such as fostering a culture of reflective practice and continuous improvement within the teaching profession. By drawing on established theories and evidence-based frameworks, this model is positioned to contribute meaningfully to developing reflective, adaptive, and effective educators, thereby enhancing the quality of education in alignment with SDG 4 and SDG 10.

Online Lesson Study Program

In this study, an online lesson study platform was developed and integrated into a university-based teacher education program to enhance the practical teaching skills of pre-service teachers (PSTs). This platform was specifically designed to allow PSTs to engage in the lesson study process without time and location constraints, thereby facilitating a more flexible and accessible learning environment. Consistent with findings by Bozkurt and Sharma (2020) and Hodges et al. (2020) regarding the effectiveness of digital learning platforms, the online lesson study platform could offer PSTs the opportunity to engage with the latest technologies and methodologies, enriching their educational experiences and fostering innovation in teaching practices.

The structure of this online lesson study program is grounded in the traditional Japanese lesson study model, widely recognized for its effectiveness in teacher professional development (Lewis, 2002; Stigler & Hiebert, 1999). The traditional model typically consists of three key phases: preparation, lesson observation, and post-lesson discussion (Takahashi & McDougal, 2016). In the preparation phase, teachers conduct in-depth research on teaching materials and analyze the characteristics and needs of their students, crafting a detailed lesson plan based on these insights. The lesson observation phase then allows a teacher to deliver the lesson while colleagues observe, focusing on both instructional techniques and student engagement. Finally, in the post-lesson discussion, teachers engage in reflective dialogues, examining the lessons' strengths and areas for improvement. This iterative process has been shown to contribute significantly to continuously enhancing lesson quality, as highlighted by Perry and Lewis (2009) and Dudley (2014). In adapting this structure to an online platform, this study retained the traditional phases while offering pre-service teachers a flexible and accessible format. PSTs were asked to participate in all stages of the lesson study process, including material research, lesson planning, lesson implementation, self-evaluation, and reflective discussion. By engaging in these activities through the online platform, PSTs were assumed to eventually bridge the gap between theory and practice, gaining practical experience in systematically refining lesson quality. This approach aligns with Zeichner and Liston's (1996) call for connecting theoretical learning with practical application in teacher education while also expanding Schön's (1983) model of reflective practice into digital environments.

The implementation of the online lesson study program in this study began with a series of foundational lectures covering essential topics, such as effective teaching methodologies, lesson design principles, and various evaluation techniques. These lectures aimed to equip PSTs with a solid theoretical foundation, ensuring they understood the principles behind effective lesson design and could apply them in practice. This approach follows Guskey's (2002) recommendation for professional development programs to balance theoretical understanding with practical application. Additionally, the lectures were implemented to guide PSTs in understanding essential methods for assessing student comprehension and delivering constructive feedback on critical skills within the lesson study process that contribute to professional growth (Day, 1999; Hattie, 2009).

After completing the instructional phase, PSTs were organized into small teams, typically consisting of three to four members, to develop lesson plans collaboratively. Collaborative reflection is essential in lesson study, and research by Stenhouse (1975) and Knight (2007) has highlighted the importance of peer feedback in fostering professional growth. Thus, this team-based structure in this study allowed PSTs to share ideas, critique each other's lesson plans, and iteratively refine their designs, fostering a culture of mutual learning and professional growth. Even without direct supervision, this peer feedback mechanism could provide a vital avenue for constructive critique, supporting ongoing lesson improvement and reinforcing a collaborative learning environment (Brookfield, 1995).

In this study, Microsoft Teams and Microsoft Stream were selected as the primary digital tools to support the lesson study process due to their suitability for supporting real-time communication and collaboration among participants in the context of the teacher education program. Microsoft Teams facilitated interactive discussions and document sharing, allowing PSTs to collaborate on lesson planning and reflection from anywhere. Microsoft Stream enabled the recording and sharing of lesson observations, providing PSTs with opportunities to review their teaching practices, engage in self-reflection, and integrate feedback at their convenience. This digital infrastructure aligns with findings by Means et al. (2009) on the potential of technology to support effective collaborative learning and continuous reflection, particularly in remote or resource-limited settings.

Through this online platform, PSTs engaged in a continuous cycle of lesson study, receiving timely feedback and iteratively enhancing their teaching practices. This approach not only improved the quality of their lesson plans but also prepared them to become reflective practitioners capable of contributing to the ongoing advancement of educational practices. By offering a flexible, accessible model that can be implemented across varied educational contexts, this study provides an innovative approach to lesson study that aligns with the goals of Sustainable Development Goal 4 (SDG 4) and addresses the broader need for equitable access to quality teacher development, as emphasized in international educational research (Tikly & Barrett, 2011; UNESCO, 2020).

Research Aim and Objectives

The primary aim of this study was to develop, implement, and evaluate a novel online lesson study platform within a university-based teacher education program, contributing to a flexible and scalable model for teacher professional development. Traditional lesson study has proven effective in fostering reflective practices (Brookfield, 1995; Lewis, 2002); however, this study uniquely adapts lesson study to an online environment, broadening access to professional development for pre-service teachers across varied contexts. By offering opportunities for reflective dialogue and peer feedback in a digital format, this platform addresses challenges associated with geographical barriers and limited resources, aligning with global efforts to enhance educational equity and quality (SDG 4; UNESCO, 2020).

To achieve this aim, the study set three primary objectives:

1) to examine the effectiveness of the online lesson study platform by analyzing the depth and breadth of reflective practices among participating pre-service teachers. Reflective practice is essential to teacher growth, enabling educators to assess and refine instructional methods critically. The online format in this study facilitated continuous reflection and iterative improvement, extending Schön's (1983) concept of reflective practice into digital spaces, an area not fully explored in previous research (Guskey, 2002; Opfer & Pedder, 2011).

2) to evaluate the platform's capability to foster meaningful peer feedback and collaborative learning, central elements in lesson study that have been shown to enhance reflective depth (Dudley, 2014; Takahashi & McDougal, 2016). By investigating how pre-service teachers incorporated peer feedback to refine lesson plans and instructional strategies, this study offers new insights into how digital lesson study can promote reflective practice and professional growth, particularly in contexts where traditional face-to-face collaboration may be challenging.

3) to establish a framework that supports continuous teacher growth by integrating lesson study and reflective practice within a flexible, online format. This framework is based on principles of multi-perspective analysis and iterative self-improvement, as articulated by Darling-Hammond (2006) and Brookfield (1995). Embedding structured reflection and collaborative inquiry online, this framework provides an adaptable professional development

model that can be applied in diverse international settings to promote continuous improvement and reflective teaching practices (Perry & Lewis, 2009; Hargreaves & Fullan, 2012).

In summary, this study contributes to the existing literature by presenting a unique, scalable approach to lesson study that extends beyond traditional, location-bound methods. The platform addresses critical challenges in teacher education by offering an innovative model that enhances reflective practices and peer collaboration within an accessible digital environment. This approach not only supports the development of reflective, adaptive educators but also aligns with international objectives of improving teacher quality and advancing equitable access to professional development across varied educational contexts.

Research Methodology

General Background

This study employed a mixed-methods research design, integrating both qualitative and quantitative approaches to assess the effectiveness of an online lesson study platform developed within a university-based teacher education program. Conducted over one academic semester, from April to July 2024, this exploratory study aimed to evaluate the program's impact on pre-service teachers' reflective practices and professional growth. The design addressed common challenges in traditional lesson study, such as time and location constraints, by incorporating digital tools that support continuous reflection and collaboration, particularly in settings where in-person interaction may not be feasible.

The theoretical framework combines principles of reflective practice with the lesson study model, emphasizing iterative cycles of planning, observation, and reflection. This approach was chosen to replicate the collaborative nature of lesson study while utilizing online platforms to expand its applicability across diverse educational contexts. By aligning with broader educational goals, such as enhancing teacher quality and promoting equitable access to professional development, this study contributes to more inclusive approaches in teacher education.

This research analyzed how an online lesson study platform can improve teaching quality and foster a culture of continuous learning among pre-service teachers. The following sections outline participant selection, instruments and procedures, and data analysis methods to evaluate program outcomes.

Participants

This study involved 115 PSTs enrolled in the online lesson study program as part of their university coursework in teacher education. The sample size of approximately 100 participants was determined based on established recommendations for the McNemar test, ensuring sufficient statistical power for reliable analysis. Fleiss et al. (2003) and Siegfried and Heumann (2005) have suggested that a sample of this size is generally adequate for detecting significant changes in categorical data, particularly in studies focusing on shifts in behavior or perspectives. This appropriately powered sample size could support robust conclusions, especially when investigating changes in reflective practices and assessing program effectiveness.

Among the participants, one was a graduate PST specializing in education, while the remaining 114 were undergraduate PSTs from the Faculty of Education. This participant group was assumed to represent a typical population in teacher education programs, with more than half planning to become teachers in elementary schools, middle schools, or kindergartens upon graduation. The participant difference in the context was assumed to help this study capture a broad spectrum of perspectives relevant to various educational levels and settings by including this diverse group of PSTs.

The analysis in this study focused on changes in the participants' submitted reflection reports and shifts in their perspectives to assess the development and depth of their reflective practices. Specifically, 103 PSTs who completed two reflection reports during the program's final stages were included in the analysis. This approach enabled a thorough evaluation of the program's effectiveness and helped identify key characteristics in the PSTs' reflections, ultimately highlighting future challenges for teacher education.

Instrument

The primary instrument in this study was an online lesson study platform, utilizing Microsoft Teams and Stream to facilitate collaborative reflection and remote engagement in the lesson study process. Microsoft Teams was assumed to support real-time communication and lesson planning discussions, while Microsoft Stream was assumed to enable asynchronous lesson review. This digital setup was expected to ensure participants flexible access to each stage of lesson study—preparation, observation, and reflection.

Participants used a structured reflection template designed based on Darling-Hammond's reflective perspectives to standardize and deepen reflective practices. This template was designed to allow for consistency across reflections, supporting both qualitative and quantitative analysis.

IBM SPSS Statistics (ver26) was used for statistical analysis to conduct the McNemar test, assessing changes in PSTs' reflective practices over time.

Ethics

This study adhered to ethical guidelines to protect participants' privacy and confidentiality. All data collected from the participants was anonymized before analysis. In addition, the purpose and methods of the research were clearly explained to all participants, both verbally and in writing, before the start of the program. Informed consent was obtained from all participants, ensuring they understood the voluntary nature of their participation and the steps taken to safeguard their privacy.

Data Analysis Procedure

This study employed a mixed-methods approach, integrating both qualitative and quantitative research methods to assess the impact and effectiveness of the online lesson study program and to explore the characteristics of PSTs' reflective practices.

Qualitative Analysis

The primary qualitative analysis was conducted on the self-reflection reports that PSTs submitted through Microsoft Teams. Each PST was asked to create and submit reflection reports at two period points during the program, and these reports were anonymized before analysis. The focus of the qualitative analysis was to examine the presence or absence of the five reflective perspectives outlined by Darling-Hammond: (1) student learning processes and outcomes, (2) effectiveness of teaching methods, (3) classroom environment and atmosphere, (4) the teacher's personal educational philosophy and its implementation, and (5) the teacher's continuous growth through reflective dialogue. For each of the 103 PSTs, the perspectives were analyzed for their inclusion in the reflection.

To determine whether each of the five perspectives was present, the reports' content was carefully interpreted. Two co-authors independently evaluated each report to enhance reliability, assessing whether each perspective was reflected. The agreement rate between the evaluators

was 94.6%, indicating a high level of reliability. In cases where discrepancies occurred, the evaluators discussed the points of contention and reached a consensus on the final assessment. This iterative process was essential in ensuring consistency and dependability in the analysis.

Quantitative Analysis

Following the qualitative analysis, the same set of anonymized reflection reports submitted by PSTs via Microsoft Teams was utilized for the quantitative analysis. Recurring themes identified in the qualitative data were quantified, allowing for the identification of common patterns related to the five reflective perspectives outlined by Darling-Hammond. This approach was assumed to enable a comprehensive understanding of the program's impact on PSTs' reflective practices.

To determine whether there was a statistically significant increase in the number of PSTs reflecting on each of the five perspectives between the first and second reflection reports, the McNemar test was applied. This test was selected due to its suitability for analyzing paired categorical data with binary outcomes, where each reflective perspective was coded as either present or absent. The test provided insights into whether the program effectively enhanced the depth and breadth of PSTs' reflective practices over time, offering a rigorous analysis of the program's impact on PST reflection.

Integrated Evaluation

The results of the qualitative and quantitative analyses were integrated to provide an overall assessment of the online lesson study program's effectiveness. This integration offered a detailed understanding of how PSTs engaged with reflective practices and highlighted specific characteristics of their reflections. Based on these findings, key areas for improvement were identified, and strategies for enhancing the program were proposed. These strategies focused on fostering deeper reflection and improving the overall quality of teacher education.

This integrated evaluation clarified the program's effectiveness in promoting teacher growth and reflective practices, offering practical measures to further enhance the development of reflective skills in future teacher education programs.

Research Results

Program Implementation

The online lesson study program with weekly sessions was implemented as scheduled from April to July 2024. The program was incorporated into the faculty of education's curriculum, and the first eight sessions consisted of lectures on educational methods conducted either in person or online. Each session lasted 90 minutes. To foster relationship-building among the PSTs, the first two sessions were held face-to-face in a university classroom, where PSTs attended lectures and worked in small groups to develop lesson plans collaboratively. From the third session onward, PSTs participated in online lectures and engaged in group activities using the breakout feature of Microsoft Teams to practice collaborative lesson planning.

Throughout the study, 13 sessions were conducted weekly at the university. Table 1 summarizes the content and objectives of these 13 sessions. Of the 13 sessions, 7 focused on lectures related to teaching methods, 1 was dedicated to lesson planning, 2 focused on video recording and editing, and the final 2 sessions centered on PST reflections. Each session was designed to build on previous lessons, fostering a deeper understanding of lesson planning, teaching methodologies, and reflective practices accordingly (Table 1).

Table 1

Overview of the Online Lesson Study Program Sessions, Including Content and Objectives

Session	Content	Objective
1	Lecture on lesson planning; collaboratively creating lesson plans (onsite at a university classroom)	To learn how to create lesson plans; to experience collaborative lesson planning
2	Lecture on teaching methods and lesson planning (onsite at a university classroom)	To master the basic model of a 1-hour lesson; to apply the knowledge to lesson planning
3	Lecture on empirically based teaching methods, and lesson planning	To learn to plan multiple lesson hours; to apply the knowledge to lesson planning
4	Lecture on goal setting in lessons, and lesson planning	To master the methods for setting goals for 1-hour lessons; to apply the knowledge to lesson planning
5	Lecture on learning theories, cognitivism, and lesson planning	To learn teaching methods based on cognitivism; to apply this knowledge to lesson planning
6	Lecture on learning theories, sociocultural theories, and lesson planning	To learn teaching methods based on sociocultural theories; to apply this knowledge to lesson planning
7	Lecture on evaluation methods, and lesson planning	To master evaluation methods during and after a 1-hour lesson; to apply this knowledge to lesson planning
8	Independent lesson planning; peer review	To apply what has been learned to create a 1-hour lesson plan; to refine the plan through peer review
9–10	Video recording and editing	To practice delivering the created lesson plan and record it; to observe self-performance
11	Group viewing of videos; peer review	To watch videos of other PSTs to learn diverse teaching methods; to reflect on own video
12	Lecture on reflective perspectives (Darling-Hammond); group viewing of videos; peer review	To collaboratively reflect and discover the diversity of reflections; to deepen personal reflections on own video review
13	Report writing	To deepen personal reflections and write reports on own recorded video

After completing the lectures, PSTs received instructions on the objectives and methods for video recording. They then spent three weeks planning, recording, and editing the content of their lessons, which were later uploaded to Microsoft Stream. The URLs for these videos were shared among all participants to facilitate easy access.

PSTs were assigned to random groups of four, where they watched and reflected on each other's videos in a collaborative setting. For one week, PSTs were asked to comment freely on the videos via Stream. This system allowed PSTs to watch and provide feedback on the videos at their convenience, as long as the URL was accessible. The following week, a lecture was delivered to deepen their reflections further, focusing on theories and methods of teacher reflection.

After this final lecture, PSTs were again grouped randomly into teams of four PSTs to engage in collaborative reflection. They then submitted a second reflection report. These two reflection reports formed the basis for the subsequent analysis.

General Results

The data analysis revealed that the online lesson study program implemented in this study contributed to both positive developments and highlighted areas for improvement in the PSTs' reflective practices. Key findings from the analysis, supported by quantitative data, are as follows:

PST Engagement with Reflective Practices: Many PSTs engaged actively in reflective practices, particularly in their reflections on lesson planning and classroom management. Initial reflection reports focused on immediate, practical concerns, such as lesson delivery quality and levels of student engagement during lessons.

Deepening of Reflective Depth: The second round of reflection reports showed a marked improvement in the depth of reflection. More PSTs expanded their reflections to address broader teaching aspects, including the impact of their teaching methods on student learning outcomes and connections to their personal educational philosophy. This deepening of reflection suggested that the structured lesson study process facilitated meaningful professional growth among the PSTs.

Areas Requiring Further Development: Despite these improvements, some PSTs continued to face challenges in reflecting on students' cognitive processes, such as identifying potential misconceptions or anticipating areas where students might encounter difficulties. This gap indicates a need for additional support to guide students in considering these critical aspects of teaching more effectively.

Qualitative Analysis Results of Reflective Practices

The primary focus of the outcomes analysis was to evaluate the effectiveness of the online lesson study program in fostering deep and meaningful reflection among PSTs. Reflective practices were crucial for teachers' professional development, as they enabled educators to critically examine their teaching methods, student interactions, and personal educational philosophies.

Results of Reflective Content Analysis

The analysis of PSTs' reflection reports revealed varied engagement with the five reflective perspectives proposed by Darling-Hammond: (1) student learning processes and outcomes, (2) the effectiveness of teaching methods on student impact, (3) the classroom environment and atmosphere, (4) personal educational philosophy and its practice, and (5) continuous growth through reflective dialogue. While PSTs demonstrated strong engagement in reflecting on students' learning processes and teaching effectiveness, there was initially less emphasis on reflecting on their personal educational philosophy and continuous professional growth. This disparity suggested that PSTs focused more on immediate, practical concerns rather than broader, long-term professional development.

Results of Reflective Depth and Breadth

To address the initial imbalance in reflective engagement, targeted instructions on incorporating all five reflective perspectives were provided before the second round of reflections. The results indicated a significant increase in the number of PSTs reflecting on their personal educational philosophy and continuous growth through dialogue. This finding suggested that these perspectives were not absent but latent and that explicit guidance helped PSTs deepen and broaden their reflective practices.

Results of Feedback Acceptance and Application

The analysis also highlighted the importance of feedback in shaping reflective practices. PSTs who actively engaged with feedback demonstrated notable improvements in their reflections. However, the level of engagement with feedback varied, with some PSTs exhibiting more superficial interactions. This variability underscores the need for further support to help PSTs effectively integrate feedback into their reflective practices.

Results Indicating Changes in Educational Practices

Although direct observation of changes in teaching practices was beyond the scope of this study, the analysis of reflection reports provided insights into how PSTs planned to implement changes based on their reflections. Many PSTs intended to modify their instructional strategies, classroom management techniques and approaches to student engagement. These planned modifications suggested that the program encouraged PSTs to consider practical applications of their reflections. However, implementing these changes and their long-term impact requires further study.

Results Highlighting Development in Reflective Practice

The analysis focused on three PSTs (A, B, and C) whose second reflection reports showed a significant increase in word count compared to their first reports. These PSTs' first reports reflected on at least three of the five perspectives, while their second reports included all five perspectives. The increased word count and more detailed content illustrate both a broader engagement with the reflective perspectives and a qualitative deepening of their reflections.

Table 2 presents examples from these PSTs' reflection reports, showing how their reflections developed between the first and second reports. The first report primarily focused on practical aspects, such as lesson delivery, whereas the second report expanded to include deeper considerations like personal educational philosophy and students' cognitive processes. These examples highlight the improvement in the depth and quality of the PSTs' reflections, illustrating the program's effectiveness in fostering reflective practice.

Table 2
Examples of Reflection Reports from Three PSTs

1: Student Learning Processes and Outcomes	
First Report	Second Report
A: No description	A: I believe it was adequate to design the lesson so that all the students first confirmed the task together. By incorporating this step before moving on to the main learning activity, I thought it would enhance the students' understanding.
B: No description	B: In my lesson video, I could somewhat utilize students' prior learning as a review, but I overlooked individual students. I proceeded with the lesson assuming that all students had already understood previous content, without considering individual learning processes.
C: I used the method of teaching decimal division, but it seemed that the students had some difficulty understanding how to handle the decimal point.	C: I realized the importance of being aware of the students' comprehension level and adjusting the explanation speed to ensure all students can follow along.

2: Effectiveness of Teaching Methods on Student Impact	
First Report	Second Report
A: I thought it would be beneficial to give students time to confirm their ideas with each other before presenting their thoughts about how to represent the graph.	A: Before presenting their ideas, I would like to give students time to confirm their ideas with each other. Also, I plan to ask more questions or intentionally make a mistake during the lesson to encourage students to think from different perspectives.
B: I did not engage students actively by asking questions or facilitating discussions.	B: I regret leading the lesson without allowing students to confirm their understanding. I should have ensured that students who struggled could still keep up.
C: I want to improve my ability to summarize key points when explaining and make sure that my instructions are clear to the students.	C: I was able to provide time for students to practice solving review problems, and I believe this helped solidify their understanding. I also plan to challenge them with slightly more complex problems to draw out more learning outcomes.
3: Classroom Environment and Atmosphere	
First Report	Second Report
A: My tone of voice tended to drop at the end of sentences. I think I could create a better classroom atmosphere if I spoke more energetically.	A: As a point of improvement, I plan to speak more energetically and smile more often. I also plan to raise my gaze and pay more attention to my tone of voice, especially when emphasizing key points.
B: I was not aware of the classroom atmosphere at all. I should have created a more supportive environment where students can ask each other for help when they do not understand something.	B: I completely overlooked the classroom atmosphere. I will reflect on how to create a more positive learning environment where students can be motivated to engage.
C: It seemed that my lowered gaze and quiet voice made me appear less confident, which may have affected the students' focus.	C: While I believe I generally maintained a supportive atmosphere, I realized I could do more to enhance the students' motivation by providing more positive feedback during the lesson.
4: Personal Educational Philosophy and Its Practice	
First Report	Second Report
A: No description	A: I believe that individualized attention and support are crucial in teaching. I plan to make sure I can observe the whole class and be mindful of students who may struggle to follow along.
B: I did not have a clear educational philosophy or objective in mind during the lesson planning and video recording.	B: I realized I lacked a solid educational philosophy during the lesson preparation. This has been a point of reflection for me.
C: No description	C: In this lesson, I kept my educational philosophy of helping students to be active learners, and I believe I was able to incorporate this into my lesson plan.
5: Continuous Growth through Reflective Dialogue	
First Report	Second Report
A: No description	A: I believe I was able to critically analyze my lesson. For example, I realized that my explanations were too lengthy and difficult for students to grasp.
B: I did not reflect on my lessons from the students' perspective.	B: Through sharing the video with my group, I discovered various ways to improve my teaching. I plan to continue sharing and discussing my lessons with peers and mentors to gain valuable feedback.
C: No description	C: I realized the importance of understanding students' needs first when planning lessons. As a teacher, I need to keep learning and adjusting my teaching strategies based on students' feedback and observations.

Quantitative Analysis of Reflective Practices

A comparative analysis of the first and second reflection reports was quantitatively conducted to assess the program's effectiveness. The data were analyzed using the McNemar test to evaluate the presence or absence of descriptions across each of the five reflective perspectives. The results are summarized in Table 3.

Table 3
Results of McNemar Test for Reflective Perspectives Between First and Second Reports

Perspective	Report Respondents		McNemar Test Statistic (χ^2)
	First (n, %)	Second (n, %)	
1: Student Learning Processes and Outcomes	34 (33)	52 (50)	8.1 *
2: Effectiveness of Teaching Methods on Student Impact	70 (68)	94 (91)	22.15 ***
3: Classroom Environment and Atmosphere	99 (96)	100 (97)	0.2 (ns)
4: Personal Educational Philosophy and Its Practice	8 (8)	85 (83)	75.05 ***
5: Continuous Growth through Reflective Dialogue	19 (18)	83 (81)	64 ***

Note. $N = 103$

* $p < .01$, *** $p < .001$, ns = not significant.

The results showed statistically significant improvements for the “student learning processes and outcomes” perspective at the 1% level, and at the 0.01% level for the “effectiveness of teaching methods on student impact,” “personal educational philosophy and its practice,” and “continuous growth through reflective dialogue” perspectives. These findings suggest that targeted educational interventions can effectively enhance PSTs’ reflective practices.

Results on Reflective Depth and Breadth

To address initial imbalances in reflective engagement, PSTs received targeted guidance on incorporating all five reflective perspectives before the second round of reflections. As shown in Table 3, the number of PSTs reflecting on their personal educational philosophy and continuous growth through dialogue significantly increased in the second report. This outcome suggested that reflective dimensions were not absent initially but rather latent; the additional guidance helped bring these reflections to the forefront, contributing to a notable improvement in both the depth and breadth of PSTs’ reflective practices.

Results on Feedback Acceptance and Application

The analysis also underscored the critical role of feedback in enhancing PSTs’ reflective practices. PSTs who actively engaged with the feedback they received demonstrated substantial improvements, particularly in reflections related to teaching methods and student learning impact. However, the extent of feedback engagement varied among PSTs, with some exhibiting only superficial interaction. This variability suggested a need for further support to help PSTs effectively integrate feedback into their reflective processes.

Reported Changes in Educational Practices

Although direct observation of changes in actual teaching practices was beyond the scope of this study’s scope, the analysis of reflection reports provided insights into PSTs’ intended to apply their reflections to future teaching contexts. Many PSTs reported plans to adjust instructional strategies, classroom management techniques, and approaches to student engagement based on their reflections. These intentions indicate that the program encouraged critical reflection on teaching practices and practical planning for improvement. However, evaluating the long-term impact of these planned changes on teaching practices requires further study.

Reflective Practices on Students' Cognitive Processes

The outcomes analysis revealed that while the online lesson study program was effective in fostering reflective practices, a notable challenge remained in pre-service teachers' ability to reflect on students' cognitive processes. This difficulty was anticipated, as participants did not have the opportunity to teach actual students during the program, limiting their reflections to hypothetical assumptions about how students might respond to their lessons. Additionally, many pre-service teachers had limited or no prior experience with elementary school students, resulting in a restricted understanding of students' developmental characteristics in thinking and emotions.

Given these limitations, it became evident that relying solely on reflective prompts was insufficient to encourage comprehensive reflections on students' cognitive processes. An in-depth analysis of the second reflection reports from the 52 pre-service teachers who specifically addressed Student Learning Processes and Outcomes revealed several strategic focal points that could enhance reflections on students' cognitive processes. The following sections present these focal points, along with examples from pre-service teachers' reflection reports.

Focusing on Students' Learning Goals

Strategy: Encourage pre-service teachers to identify and reflect on students' specific learning goals. By centering their teaching strategies on these goals, they can align their instructional practices to support students' objectives. PST Response Example: "Through reflection, I realized that the students were focused on understanding how to measure angles, but my lesson did not fully address this. I plan to revise my approach to ensure that their goal is the central focus of the lesson."

Addressing Misconceptions

Strategy: Develop sessions where pre-service teachers can explore and reflect on common misconceptions students may have in different subjects. This approach allows them to design lessons that directly address and clarify these misunderstandings. PST Response Example: "I noticed that many students believed that heavier objects fall faster, which is a common misconception. In my next lesson, I will incorporate experiments that clearly demonstrate the concept of gravity to correct this misunderstanding."

Assessing Students' Comprehension

Strategy: Encourage pre-service teachers to regularly assess and reflect on how well students understand the material. This reflection allows them to identify areas of confusion and adjust instructional strategies to meet students' needs more effectively. PST Response Example: "During group work, I realized that several students were confused about the difference between area and perimeter. I will revisit this topic in the next lesson, using more visual aids to reinforce understanding."

Adapting to Students' Learning Pace

Strategy: Guide pre-service teachers to consider whether the pace of their instruction aligns with students' learning pace. Adjusting the instructional speed based on students' needs helps ensure that all students can keep up and fully understand the material. PST Response Example: "Some students struggled with the pace of the lesson on fractions. In future lessons, I will slow down the introduction of new concepts and provide additional practice opportunities to ensure everyone keeps up."

Identifying Potential Stumbling Blocks

Strategy: Encourage pre-service teachers to reflect on potential stumbling blocks students might encounter during learning. Anticipating these challenges allows them to prepare strategies to help students overcome obstacles and improve their learning experience. PST Response Example: "I observed that many students struggled with word problems in math

due to the complexity of the language used. I plan to break down the problems into simpler steps and use more straightforward language in future lessons to reduce these barriers.”

Discussion

The results of this study have shown that an online lesson study platform can foster pre-service teachers’ reflective practices, especially in teaching effectiveness and student learning outcomes. However, challenges persisted in areas such as reflecting on children’s cognitive processes. Only 50% of participants in the second round reflected on student learning processes and outcomes, compared to 33% in the first round (see Table 3). These findings align with Groth’s (2011) observations that limited classroom experience can hinder deeper reflections among pre-service teachers. Based on the study’s findings and existing literature, the following strategies are proposed to enhance the program.

Reflecting on Children’s Cognitive Processes

While there was a marked improvement in PSTs’ reflections on student learning processes by the second round (from 33% to 50%), a need for deeper reflections on cognitive processes remained. Zeichner and Liston (1996) have emphasized the importance of guided instruction for teachers to anticipate and address student misconceptions. Integrating targeted sessions focused on common cognitive challenges could facilitate more profound reflections, demonstrating the adaptability of Darling-Hammond’s reflective framework in digital environments.

Enhancing Peer Feedback Mechanisms

This study shows that peer feedback positively impacted reflection, with a notable increase in teaching effectiveness reflections, rising from 68% in the first round to 91% in the second. However, the depth of engagement with feedback varied among PSTs. Structured feedback mechanisms, including reflection prompts, could standardize reflective depth and ensure alignment with Takahashi and McDougal’s (2016) emphasis on structured inquiry in collaborative learning. The integration of structured peer feedback illustrates how online platforms can cultivate multi-dimensional reflections—a crucial element for sustained teacher growth.

Embedding Personal Educational Philosophy in Reflection

Initially, only 8% of participants reflected on their educational philosophy, but this increased to 83% after guided prompts were introduced (see Table 3). Brookfield (1995) has suggested that personal philosophy is often overlooked in favor of practical aspects; thus, targeted prompts that connect educational beliefs with teaching practices could reinforce a holistic approach to reflection.

Sustained Reflective Practice Support

The findings indicate that continuous prompts and feedback support deeper reflections, with “continuous growth through reflective dialogue” improving from 18% in the first report to 81% in the second. This significant improvement suggests that reflective practices can be effectively sustained in an online environment. Opfer and Pedder (2011) have highlighted the importance of iterative reflection in professional development, which the online format in this study has successfully supported.

Conclusions and Implications

This study demonstrates the potential of an online lesson study platform to support reflective practices among pre-service teachers, enhancing their engagement with teaching methods and student outcomes. With substantial increases in reflection rates across multiple dimensions (e.g., teaching effectiveness from 68% to 91%, student learning processes from 33% to 50%), the platform's structured approach proves effective even in the absence of face-to-face interaction. These findings support Schön's (1983) model of reflective practice and Lewis's (2002) insights on lesson study, indicating that traditional models of reflection and lesson study can be adapted effectively to broader, digital contexts.

Theoretical and Academic Contributions

This research contributes to the academic understanding of reflective practices in online environments. The data have shown that Darling-Hammond's reflective perspectives, traditionally applied in face-to-face settings, can be implemented effectively online, as evidenced by the improvements in reflective engagement across rounds. By demonstrating the effectiveness of structured prompts and feedback in fostering comprehensive reflection, this study offers new insights into the adaptability of reflective practice theories in digital education—a critical consideration as online education continues to expand globally.

The findings also underscore the potential for a sustainable model of teacher growth. With reflection rates on personal educational philosophy and continuous growth improving significantly after targeted prompts, this model aligns with the Sustainable Development Goals (SDG 4 and SDG 10) by illustrating how equitable access to quality teacher training can be facilitated online.

Implications for Future Research and Global Education

This research provides a framework for integrating peer feedback and multi-perspective reflection within an online platform. As seen in this study, peer feedback significantly deepened reflections on teaching effectiveness and classroom environment. By examining these findings, this study advances the theoretical understanding of collaborative reflection as a core component of teacher development. Further research could build upon this framework by investigating long-term impacts on reflective practices and exploring simulated teaching environments to enhance PSTs' ability to reflect on cognitive processes, thereby supporting ongoing, contextually relevant teacher education across diverse educational settings.

Declaration of Interest

The authors declare no competing interest.

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