BECOMING A SCIENCE TEACHER: FOSTERING PRE-SERVICE SCIENCE TEACHERS' SELF-EFFICACY THROUGH LESSON STUDY

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Abstract

Science teaching self-efficacy shapes how pre-service science teachers (PSTs) implement instruction and respond to classroom challenges. This study investigated PSTs' self-efficacy levels and explored how Lesson Study fostered self-efficacy. An embedded mixed methods design was employed across two phases. Phase 1 surveyed 332 fourth-year PSTs from Rajabhat Universities selected via multi-stage random sampling, using the Science Teaching Efficacy Belief Instrument-B (STEBI-B; IOC = 0.80–1.00; α = .91). Phase 2 involved six purposively selected PSTs categorized by initial self-efficacy level (highest, high, medium, low) who completed three Lesson Study cycles with mentor teachers and university supervisors; qualitative data were collected through observation, semi-structured interviews, and reflection logs then analyzed using content analysis. Phase 1 revealed that the overall science teaching self-efficacy of pre-service teachers was at a high level (M = 3.69, SD = 1.02) across both PSTE (M = 3.69, SD = 1.06) and STOE (M = 3.69, SD = 0.98). Phase 2 revealed that Lesson Study explicitly fostered substantial self-efficacy growth across all six participants, most effectively among those who entered with the lowest initial confidence. Through the Lesson Study, participants demonstrated clear behavioral transformations: they overcame instructional anxiety to teach confidently, shifted from script dependency to pedagogical flexibility, and embraced student-centered instruction. Furthermore, they successfully integrated technology, developed a humble approach to assessing their own abilities, and cultivated the capacity to reflection-in-action. Two features drove these transformations: the buddy teacher pairings, which enabled learning from shared classroom experience, and the reteach phase, which turned earlier struggles into purposeful second attempts. These findings suggest that integrating Lesson Study into practicum programs offers a replicable, evidence-based pathway for developing robust and sustainable science teaching self-efficacy in pre-service educators.

Keywords: Science Teaching Self-Efficacy, Pre-Service Science Teachers, lesson study, professional learning community, Rajabhat University

Introduction

Grounded in Bandura's (1997) Social Cognitive Theory, science teaching self-efficacy refers to a teacher's belief in their capacity to organize and execute effective science instruction (Enochs & Riggs, 1990). This belief fundamentally shapes how pre-service science teachers (PSTs) navigate the classroom. For instance, highly efficacious PSTs tend to embrace inquiry-based teaching and manage complex learning environments with confidence. In contrast, those with lower self-efficacy often perceive teaching challenges as personal threats, which can induce anxiety and lead to a reliance on rote instruction (Oppermann et al., 2019). self-efficacy beliefs evolve during practical teaching experiences (Menon & Azam, 2021; Schipper et al., 2018). Most studies continue to focus on correlational variables rather than exploring systematic approaches to developing self-efficacy in authentic classroom settings (Menon & Sadler, 2016; Yerdelen et al., 2024).

This gap is particularly pressing within the context of Thai Rajabhat Universities. Historically, science teacher education programs in Thailand have drawn criticism for a lack of student-centered approaches and limited integration of pedagogical innovations during the teaching practicum (Faikhamta et al., 2018). Drawing on four years of experience as a university instructor working closely with fourth-year PSTs, the researcher observed a recurring pattern: despite possessing strong content knowledge, these students frequently struggled with teaching anxiety, adhered rigidly to lesson plans, and lacked pedagogical flexibility in real classrooms. Such behaviors are classic indicators of fragile teaching self-efficacy. Echoing these observations, recent studies indicate that many Thai pre-service teachers feel apprehensive and underprepared for science instruction, pointing to a critical need for structured pedagogical support and collaborative networks during their practicum (Pinthong et al., 2020).

To address this issue, the present study investigated the current state of science teaching self-efficacy among PSTs across the Rajabhat University network and examined the impact of a Lesson Study intervention—facilitated through a Professional Learning Community (PLC)—as a mechanism to foster it. Rather than solely measuring efficacy levels pre- and post-intervention, this research traces the developmental process and behavioral transformations of PSTs over time. Ultimately, the findings offer empirical evidence and practical guidance for teacher preparation institutions looking to integrate Lesson Study into their practicum programs, ensuring the sustainable development of confident, highly efficacious science teachers.

Research Objectives

1. To examine the level of science teaching self-efficacy among pre-service science teachers.

2. To foster science teaching self-efficacy in pre-service science teachers through Lesson Study

Literature Review

1. Self-Efficacy and Science Teaching Self-Efficacy

Rooted in Bandura's (1997) Social Cognitive Theory, self-efficacy refers to an individual's belief in their capacity to organize and execute actions required to achieve specific goals - defined precisely as "beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments" (Bandura, 1997). It operates through two distinct but interrelated dimensions: outcome expectancy - the belief that a given action will lead to certain outcomes - and self-efficacy expectancy - confidence in one's own ability to perform the behavior required to produce those outcomes (Bandura, 1977; Guskey & Passaro, 1994). This distinction carries direct implications for teacher education; it is actual teaching practice that builds self-efficacy expectancy, suggesting that teacher preparation programs must provide not only content knowledge but also structured opportunities for authentic classroom engagement (Bandura, 1997)

Critically, self-efficacy is not a fixed trait, but a dynamic, context-specific construct shaped by four primary sources: mastery experiences, vicarious experiences, social persuasion, and physiological and affective states (Bandura, 1997) In the context of science education, science teaching self-efficacy has been operationalized through the Science Teaching Efficacy Belief Instrument (STEBI-B), which assesses two subscales: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) (Enochs & Riggs, 1990). Research consistently demonstrates that PSTs with high science teaching self-efficacy are more likely to adopt inquiry-based, student-centered approaches, while those with lower efficacy tend to rely on rote, teacher-centered instruction and disengage when faced with classroom challenges (Oppermann et al., 2019; Yerdelen et al., 2024). However, a large proportion of PSTs enter teacher preparation programs with limited science backgrounds and low confidence, underscoring the need for structured, experience-based interventions that deliberately activate all four sources of efficacy to build robust and sustainable teaching beliefs (Yerdelen et al., 2024; Nafziger et al., 2026).

2. Lesson Study as Professional Development

Situated Learning Theory, proposed by Lave and Wenger (1991), holds that learning is fundamentally a social process embedded in authentic practice rather than an individual cognitive event. Its central concept - Legitimate Peripheral Participation (LPP) - describes how newcomers gradually move from the margins toward full membership in a Community of Practice (CoP) by engaging alongside experienced practitioners in real, meaningful activities. Wenger (1998) extended this framework by arguing that participation in shared practice shapes not only what practitioners know but who they become, encompassing four interrelated dimensions: meaning, practice, community, and identity. In teacher education, this perspective implies that PSTs develop professional knowledge and self-efficacy most effectively through structured participation in authentic teaching communities - not through decontextualized coursework - where observation, practice, reflection, and mentorship unfold together (Lave & Wenger, 1991; Wenger, 1998).

Lesson Study enacts these principles directly. In this study, PSTs collaboratively design lesson plans before one PST teaches the lesson and subsequently shares their classroom experience — including challenges, student responses, and reflective insights — with their buddy partner. The partner then takes the revised plan and reteaches the lesson in their own classroom context. This iterative cycle of shared planning, experiential narration, and reteaching is precisely the kind of authentic, practice-embedded learning that Lave and Wenger (1991) argue is indispensable for professional growth. Each phase of this process corresponds directly to one of Bandura's (1997) four sources of self-efficacy: collaborative planning and peer debriefing provide social persuasion through constructive, collegial feedback; the first teacher's reflective narration offers the partner a sympathetic experience — enabling them to mentally rehearse and reframe the lesson before entering the classroom; and the Reteach phase itself generates the most compelling source of all, mastery experience, as PSTs enact a refined lesson with greater pedagogical confidence and purpose (Bandura, 1997; Cojorn & Seesom, 2025). Research confirms that this kind of iterative, socially embedded practice produces measurable and sustained gains in teaching self-efficacy, particularly among PSTs who begin with the lowest initial confidence (Nafziger et al., 2026; Yerdelen et al., 2024).

In the science education context, Lesson Study has been shown to support the professional development of pre-service science teachers by enhancing collaborative learning, didactic practice, and pedagogical content knowledge (Conceição et al., 2022). In Thailand specifically, Lesson Study has been demonstrated to facilitate pre-service science teachers in transforming traditional pedagogical beliefs toward inquiry-oriented

teaching through critical reflection and collaborative practice (Nawanidbumrung et al., 2024), within a broader landscape of science teacher education that has long recognized the value of reflective, collaborative practice (Faikhamta et al., 2018).

Research Framework

To clearly present the relationship between the theoretical frameworks, the Lesson Study intervention, and the development of science teaching self-efficacy, the conceptual framework is illustrated in Figure 1.

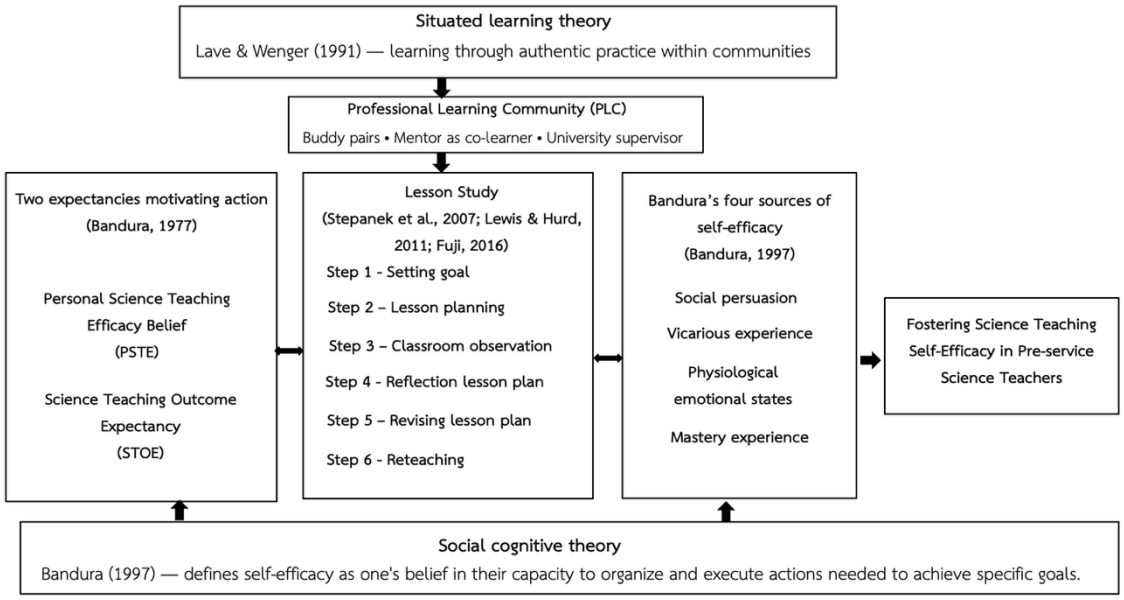


Figure 1 shows the conceptual framework of the research

Research Methodology

Research Design

This study employed an Embedded Mixed Methods Design (Creswell & Plano Clark, 2018) situated within a Pragmatism philosophical paradigm, prioritizing practical problem-solving and real-world applicability. Quantitative data (Phase 1) were embedded within a qualitative interpretive framework (Phase 2), with each phase addressing a distinct research question while collectively contributing to an integrated understanding of pre-service science teacher self-efficacy development.

Phase 1: Quantitative Survey of Current Self-Efficacy State

Population and Sample: The target population comprised all fourth-year pre-service science teachers at the 38 Rajabhat Universities. A sample of 332 participants (86.14% female, 13.86% male) was recruited through multi-stage random sampling combined with proportional quota allocation across university regions.

Instrument: Data were collected using a researcher-modified version of the Science Teaching Efficacy Belief Instrument-B (STEBI-B) (Enochs & Riggs, 1990). The instrument comprised of Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) 23 items rated on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Content validity was established through expert review, yielding an Item-Objective Congruence (IOC) index of 0.80–1.00. Internal consistency reliability was confirmed with a Cronbach's alpha coefficient of .91.

Data Collection and Analysis: Data were collected via an online questionnaire platform. Descriptive statistics—including means, and standard deviations—were computed to characterize the current state of pre-service science teachers' self-efficacy.

Phase 2: Qualitative Investigation of Self-Efficacy Development

Participants: Six pre-service science teachers (PST-1 through PST-6) were purposively selected from the Phase 1 sample based on their STEBI-B scores to represent three self-efficacy strata: Highest (PST-4), High (PST-6), Medium (PST-3), and Low (PST-2, PST-5). Participants were organized into three cross-school buddy pairs (Pairs 1–3) for the duration of the intervention.

Intervention: Six case-study pre-service teachers (PSTs) were organized into three cross-institutional pairs, acting as "Buddy Teachers" from different practicum schools. These team comprising the six PSTs, six mentor teachers, and two university supervisors. Over the course of one semester, each pair completed three cycles of Lesson Study. This three-cycle structure was deliberately designed to provide sufficient iterative opportunities for participants to plan, enact, reflect, and successfully modify their teaching practices, which is necessary to observe meaningful pedagogical transformations and self-efficacy growth. Within each cycle, the paired PSTs collaboratively set learning goals and designed a lesson plan. One PST then taught the initial lesson while mentor teachers, and university supervisors observed. Following the classroom implementation, the team engaged in a collaborative reflection with the mentor teachers and supervisors to critically evaluate and revise the lesson plan. Subsequently, the partner PST reteached the revised version of the lesson in their own classroom, culminating in a final group reflection and a written report.

Data Collection: Prior to data collection, ethical approval was obtained from the relevant institutional ethics committee. Qualitative data were gathered through multiple sources to facilitate methodological triangulation: (a) observation with detailed field notes recorded by the research team (b) semi-structured individual interviews conducted with each pre-service teacher following each Lesson Study cycle; (c) focus group discussions with each buddy pair at the conclusion of the intervention; and (d)

individual reflection logs. Pre- and post-intervention STEBI-B scores were also collected from the six participants to provide quantitative reference points for triangulation.

Data Analysis: Qualitative data were subjected to content analysis following an inductive-deductive approach (Creswell & Plano Clark, 2018). Trustworthiness of qualitative findings was established through multiple procedures aligned with Lincoln and Guba's (1985) criteria: (a) Credibility was enhanced via prolonged engagement throughout the semester-long intervention, peer debriefing among the research team, and member checking whereby participants reviewed and confirmed the accuracy of their interview transcripts; (b) Transferability was supported through thick description of the research context; (c) Dependability was ensured through an audit trail documenting all methodological decisions and data transformation steps; and (d) Confirmability was achieved through spontaneous journaling by the lead researcher to acknowledge and bracket potential researcher bias.

Research Result

1. Current State of Pre-Service Science Teachers' Self-Efficacy

The quantitative results indicated that the overall science teaching self-efficacy among the 332 participants was at a high level (M = 3.69, SD = 1.02). An examination of the two subscale components revealed a consistent pattern, with both Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) receiving correspondingly high ratings (Table 1).

Table 1 Descriptive Statistics of Pre-service Science Teachers' Self-Efficacy Components (N = 332)

Component	M	SD	Level
Personal Science Teaching Efficacy (PSTE)	3.69	1.06	High
Science Teaching Outcome Expectancy (STOE)	3.69	0.98	High
Overall Self-Efficacy	**3.69**	**1.02**	**High**

Despite these high quantitative scores, qualitative analysis of the open-ended responses revealed a more complex pedagogical reality. Regardless of their prior teaching backgrounds, which ranged from a brief two-week practicum placement to over a year of experience as science tutors, the PSTs consistently expressed underlying instructional anxieties. Specifically, their concerns centered on classroom management, time constraints during experiment-based lessons, and the ability to address unexpected

student questions. Consequently, this discrepancy establishes a strong empirical rationale for the Lesson Study intervention investigated in Phase 2.

2. Fostering Self-Efficacy through Cross-School Lesson Study

Pre- and post-intervention STEBI-B scores showed that Lesson Study explicitly fostered substantial growth across all six participants, with the group mean rising from 3.31 (SD = 0.89) to 4.50 (SD = 0.23). Those with the lowest initial confidence exhibited the greatest gains (Table 2).

Table 2 Individual Self-Efficacy Scores and Key Behavioral Transformations

(N = 6)

Participant	Initial Level	Pre-SE	Post-SE	Key Behavioral Transformation
PST-1	Medium	3.38	4.50	Shifted from rigid plan adherence to pedagogical flexibility; integrated Sound Meter app creatively.
PST-2	Low	2.48	4.35	Overcame time management difficulties; developed strong classroom control.
PST-3	Medium	3.43	4.64	Confident use of interactive models and Exit Tickets; cultivated reflect-in-action skills.
PST-4	Highest	4.52	4.88	Transitioned from ego-centric to Humble Confidence; receptive to peer feedback.
PST-5	Low	2.13	4.26	Most dramatic growth; overcame fear of technology; integrated interactive tools confidently.
PST-6	High	3.92	4.39	Resolved administrative anxiety; developed sharp real-time pedagogical decision-making.

Content analysis revealed four interconnected mechanisms through which each Lesson Study step activated a corresponding efficacy source (Bandura, 1997).

Mastery Experience through Reteach (Step 6). The Reteach phase consistently emerged as the most compelling self-efficacy catalyst. Entering reteaching with a revised plan and peer insights already integrated transformed prior struggles into corrective success. PST-2 reflected: “The second time, I felt like I was actually teaching, not just surviving.”

Vicarious Learning through Shared Narratives (Step 3). Vicarious learning operated through symbolic modeling (Bandura, 1997) rather than direct observation. The Buddy Teacher’s structured account of classroom realities served as a relatable coping model. PST-5 reflected after hearing PST-6’s account: “If she could manage the technology in her class, I thought maybe I could try in mine.” This narrative exchange distinguishes the cross-school model from conventional single-school Lesson Study (Cojorn & Seesom, 2025).

Social Persuasion as Collaborative Foundation (Steps 1–2 and 4–5). Collaborative planning and PLC debriefing served as continuous social persuasion. Mentors who reframed setbacks as shared pedagogical challenges consistently reduced anxiety and fostered willingness to experiment. PST-3 reflected: “Receiving positive feedback and support made me feel that this work is valuable and that I do not have to do everything alone.”

Physiological and Affective Regulation (Steps 4–5). Reflection logs revealed a consistent arc across all pairs: elevated anxiety before the initial teach, active processing during debriefing, and calm purposefulness during reteaching mirroring Bandura’s (1997) account of how scaffolded success moderates’ maladaptive arousal. PST-4’s shift from ego-centric confidence to Humble Confidence reflected not a large numerical gain but a qualitative recalibration of professional identity sustained across three cycles.

Discussion

1. Phase 1 results aligned with comparable fourth-year populations (Menon & Sadler, 2016; Yerdelen et al., 2024): PSTs rated their self-efficacy highly across both PSTE and STOE (M = 3.69). This pattern is partly an artifact of the instrument the STEBI-B asks what PSTs expect to do in future classrooms, not what they can do today (Bleicher, 2004; Enochs & Riggs, 1990), so high scores reflect aspiration more than readiness. The qualitative data made this gap visible. Regardless of how much prior teaching experience participants had, the same three anxieties surfaced repeatedly: managing

student behavior during inquiry activities, running out of time in experiments, and not knowing how to handle unexpected questions. These are not minor concerns they are the daily realities of science teaching. Bandura (1997) distinguished between general efficacy beliefs and the context-specific efficacy that governs actual instructional behavior, and classroom management anxiety has been consistently linked to reduced self-efficacy during the practicum (Gorospe, 2022; Yerdelen et al., 2024). Experience alone, it seems, does not close this gap without structured reflection and support (Gorospe, 2022; Yerdelen et al., 2024).

2. Phase 2 demonstrated how Lesson Study explicitly fosters science teaching self-efficacy. The intervention fostered substantial growth by activating all four self-efficacy sources: collaborative planning provided social persuasion, shared narratives offered vicarious learning, structured reflections regulated physiological states, and the Reteach phase generated mastery experiences. This substantial growth was strongest among those who started with the least confidence (Mok et al., 2023; Täschner et al., 2025). The turning point for most participants was the Reteach phase. Having already revised the lesson plan, heard the partner's account of what went wrong, and received mentor feedback, PSTs entered the classroom for the second time in a fundamentally different position. PST-2 described it simply: "The second time, I felt like I was actually teaching, not just surviving." The cross-school design also produced an unexpected finding: because partners taught in different schools and could not observe each other directly, vicarious learning happened through storytelling rather than observation and it worked. When PST-5 heard PST-6 describe managing a digital tool in her classroom, that account was enough: "If she could manage the technology in her class, I thought maybe I could try in mine." Bandura (1997) calls this symbolic modeling, and this study suggests it can be as effective as direct observation in a cross-school context (Cojorn & Seesom, 2025). Throughout all three cycles, structured reflection and lesson revision reframed setbacks as problems the whole team owned rather than failures the individual carried and that shift in framing changed the emotional arc of the experience (Yerdelen et al., 2024). By the final cycle, participants were no longer executing lesson plans; they were reading classrooms in real time and adjusting on the spot, the capacity Schön (1983) calls reflect-in-action, and precisely the outcome that Lesson Study, by activating all four of Bandura's (1997) efficacy sources within a single cycle, is designed to produce.

New Knowledge from the Research

This study generated new knowledge that can be synthesized into the following conceptual model.

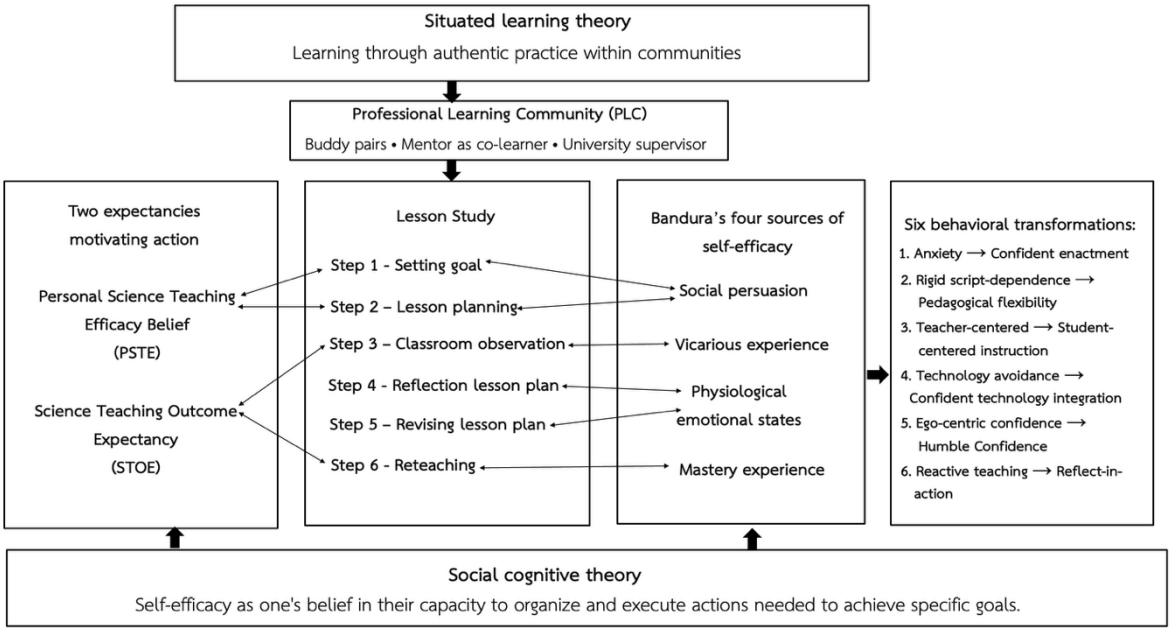


Figure 2 New Knowledge from the Research

Figure 2 presents the body of knowledge derived from this study. Grounded in Situated Learning Theory (Lave & Wenger, 1991) and Social Cognitive Theory (Bandura, 1997), the model demonstrates how the Lesson Study cycle systematically activates sources of self-efficacy within a structured Professional Learning Community (PLC). Although these sources interact dynamically throughout the cycle, specific phases serve as primary catalysts: collaborative planning (Steps 1-2) establishes social persuasion, the Buddy Teacher exchange (Step 3) facilitates vicarious experience through symbolic modeling, structured debriefings (Steps 4–5) regulate physiological and affective states, and the reteach phase (Step 6) delivers the decisive enactive mastery experience. This systematic alignment constitutes the study's primary theoretical contribution. Empirically, the model catalyzed meaningful behavioral changes among pre-service science teachers. Instead of struggling with instructional anxiety and relying rigidly on scripts, participants developed greater pedagogical flexibility and taught with confidence. They also shifted toward student-centered instruction, successfully integrated technology, and developed a humble approach to assessing their own abilities. Finally, they cultivated the capacity to reflect-in-action. Ultimately, these findings confirm that Lesson Study effectively bridges the gap between projected confidence and authentic classroom

readiness across both the PSTE and STOE dimensions. Furthermore, this model provides practical benefits for educational agencies and society. Teacher preparation institutions and school networks can apply this framework to systematically redesign their practicum programs, ensuring the sustainable development of efficacious science teachers. Ultimately, this benefits society by providing classrooms with confident educators who can deliver high-quality science instruction, thereby fostering a future generation of scientifically literate citizens capable of critical thinking and innovation.

Conclusion

This study identified a gap between reported self-efficacy and authentic classroom readiness: PSTs rated their confidence highly on the STEBI-B, but qualitative data revealed persistent anxieties around the very demands that define science teaching. This confirms that quantitative measures alone cannot capture PSTs' actual pedagogical preparedness, and that mixed-methods approaches are essential for a complete picture. Phase 2 demonstrated that Lesson Study closes this gap through intentional structural design rather than additional coursework transforming anxious, script-dependent novices into flexible, reflective practitioners capable of Reflect-in-Action (Schön, 1983). Teacher preparation institutions can replicate this model by embedding Reteach phases and cross-institutional Buddy Teacher pairings into existing practicum frameworks as a sustainable, evidence-based pathway for developing self-efficacious science educators. Regarding theoretical contributions, this study provides a conceptual model illustrating how specific phases of the Lesson Study cycle systematically activate Bandura's sources of self-efficacy.

Recommendation

1. Recommendation for utilizing research findings

1.1 Teacher preparation programs should supplement quantitative surveys (e.g., STEBI-B) with classroom observations and reflective interviews to accurately gauge PSTs' actual readiness.

1.2 Institutions should systematically embed "Reteach" phases and cross-institutional buddy pairings into existing practicums.

1.3 Institutions should invest in developing mentor teachers' capacity for constructive, non-evaluative debriefing facilitation, as mentor quality is as consequential as the teaching experience itself.

2. Recommendation for further research

Future research should longitudinally track whether these efficacy gains persist as PSTs transition into full-time teaching. It would also be valuable to validate this model across different subject areas and investigate how mentor quality impacts the process.

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