Macrothink Institute™

Journal of Studies in Education
ISSN 2162-6952
2025, Vol. 15, No. 3

Teachers' POGIL Professional Development through Lesson Study Approach

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Received: July 1, 2025 Accepted: August 7, 2025 Published: August 7, 2025

doi:10.5296/jse.v15i3.23058 URL: https://doi.org/10.5296/jse.v15i3.23058

Abstract

Cultivating students' competencies in the 5Cs—critical thinking, creativity, communication, collaboration, and complex problem-solving—has become a central goal of 21st-century education. Process-Oriented Guided Inquiry Learning (POGIL) is widely recognized as an effective, student-centered instructional approach for developing these essential skills. To support teachers in implementing POGIL effectively, this study employed the Lesson Study (LS) model to enhance their pedagogical knowledge, instructional beliefs, teaching practices, and professional attitudes. The participants included two school principals and eight natural science teachers. Data were collected through knowledge assessments, belief scales, e-portfolios, and semi-structured interviews. Results revealed significant improvements in participants' post-test scores for both knowledge and beliefs, indicating that LS effectively deepened their understanding of POGIL pedagogy. Moreover, participants demonstrated a notable shift in teaching perspectives—from teacher-centered to student-centered approaches. While teachers expressed highly positive perceptions of POGIL's benefits, they also identified challenges related to adapting to student-centered strategies and managing time constraints in classroom implementation. These findings are further explored in the discussion.

Keywords: Lesson study, process-oriented guided inquiry learning, teachers' professional development

1. Introduction

In today's rapidly evolving and unpredictable global society, schools must prepare students with the essential skills needed for future success. In response, many countries have defined core competencies as key educational priorities. For example, the United States' Partnership for 21st Century Skills (P21) introduced the 4Cs framework in 2002—critical thinking, communication, creativity, and collaboration. Taiwan's Ministry of Education later expanded this model to include complex problem-solving, forming the 5Cs framework. As a result, cultivating students' 5C competencies has become a central objective in 21st-century education.

Traditional, teacher-centered instruction has proven increasingly inadequate for fostering these skills (Bell, 2010). In response, student-centered pedagogies such as Process-Oriented Guided Inquiry Learning (POGIL) have emerged. Grounded in cognitive development theory, cooperative learning, and instructional design, POGIL engages students in a structured learning cycle that promotes the construction of knowledge through guided inquiry and group collaboration (Moog & Spencer, 2008). Teachers act as facilitators, guiding students as they explore, construct, and refine conceptual understanding (Hanson, 2013; Simonson & Shadle, 2013; Trevathan et al., 2014; POGIL Project, 2021). POGIL's emphasis on process skills—such as teamwork, critical thinking, and communication—aligns directly with the 5Cs framework.

Cognitive science research identifies five characteristics of effective learning: (1) building knowledge based on prior experience and beliefs; (2) following structured learning cycles of exploration, concept formation, and application; (3) using multiple representations to visualize ideas; (4) engaging in peer interaction and dialogue; and (5) reflecting on learning processes and outcomes. POGIL inherently incorporates these principles (Hanson, 2013). Empirical evidence confirms its effectiveness in enhancing student engagement, inquiry-based learning, conceptual understanding, and academic achievement (Aiman et al., 2020; Brown, 2010; Hale & Mullen, 2009; Idul & Joevi, 2019; Şen et al., 2016; Vacek, 2011; Villagonzalo, 2014). It also develops key competencies such as argumentation, collaboration, and information processing (Stanford et al., 2016; Andriani et al., 2019; Irwanto et al., 2011).

Science education plays a vital role in helping students apply scientific knowledge and reasoning to real-world challenges. However, disciplines such as physics and chemistry are often perceived as difficult and abstract—especially at the junior high school level in Taiwan—leading to reduced student interest and confidence. A contributing factor is the dominance of lecture-based instruction, which emphasizes content delivery and problem-solving demonstrations over student inquiry and exploration (Moog & Spencer, 2008). Although this approach can effectively transmit knowledge, it often fails to foster deep understanding or process skills. Authentic science learning requires students to reconstruct knowledge through exploration, integration, and reasoning (Hanson, 2013).

To address these limitations, science instruction should begin with student curiosity and promote concept exploration through structured inquiry. POGIL aligns well with this approach, enabling students to explore concepts, reconstruct information, and develop

process skills through active engagement. Studies consistently identify POGIL as an effective method for teaching science, emphasizing guided inquiry as a foundation for deep learning (Hanson, 2013; Lawson et al., 1989). Therefore, this study applies POGIL to junior high school physics and chemistry education to enhance student learning outcomes and develop the 5Cs competencies.

Meaningful instructional reform requires changing teachers' pedagogical practices, as they are central to driving innovation in the classroom. Effective teacher professional development (TPD) must be closely linked to classroom practice to improve instructional quality and student outcomes. Among the various models of TPD, Lesson Study (LS) has emerged as a particularly impactful approach.

Originating in Japan, LS is a collaborative, inquiry-based professional development model that integrates curriculum development, pedagogical innovation, and teacher growth (Özdemir, 2019). The LS cycle typically consists of five stages: (1) identifying learning goals through discussion and literature review; (2) collaboratively designing lessons aligned with these goals; (3) implementing the lesson while others observe student engagement and learning behaviors; (4) analyzing and reflecting on the lesson based on observation data; and (5) refining and theorizing teaching practices through shared feedback (Akiba et al., 2019). The cyclic nature of LS—plan, implement, reflect, revise—supports sustained improvement in teaching practices and professional learning.

Through collaboration, observation, and reflection, LS helps bridge the gap between educational theory and classroom practice, leading to enhanced instructional quality, teacher expertise, and student learning (Jansen et al., 2021; Özdemir, 2019). Numerous studies validate LS as a transformative model for improving lesson design, pedagogical content knowledge, and student-centered instruction, while fostering a culture of professional collaboration (Cheung & Wong, 2014; Lewis & Perry, 2017; Lewis et al., 2009; Godfrey et al., 2018; Murphy et al., 2017; Seleznyov, 2019).

This study integrates Process-Oriented Guided Inquiry Learning (POGIL) into a Teacher Professional Development Program (T-POGILP) using the Lesson Study (LS) framework. The goal is to enhance teachers' knowledge, beliefs, and instructional skills related to POGIL and to support its effective implementation in classroom practice. The study is guided by the following research questions:

1. How does the Lesson Study approach influence teachers' knowledge and perspectives of POGIL?

2. How do teachers perceive the benefits and challenges of implementing POGIL after participating in the Lesson Study process?

3. What are teachers' perspectives on the effectiveness and value of the Lesson Study approach as a model for professional development?

By addressing these questions, the study aims to contribute to research on teacher professional development and support the meaningful integration of POGIL in junior high

school science education.

2. Methodology

2.1 T-POGILP Description

This study developed a framework for enhancing participants' POGIL professional development based on the stages of Lesson Study (LS), as illustrated in Figure 1.

The framework consists of two foundational components:

1. Concept Construction – Participants engaged in various professional development activities to understand the theoretical foundations, core principles, key elements, curriculum design, instructional process, and assessment methods of the POGIL teaching model.

2. Experiential Learning – Participants applied their acquired POGIL knowledge to design a physics and chemistry unit. They then participated in a role-playing exercise, where one acted as the teacher and the others as students. This hands-on experience allowed participants to simulate the POGIL process, reflect on its effectiveness, and discuss potential challenges and limitations in real classroom settings.

Following these initial stages, the LS cycle model was implemented to develop a POGIL-based learning program for eighth graders, consisting of four iterative phases:

1. Design – Participants collaboratively developed a unit lesson plan, including lesson objectives, instructional activities, assessment methods, and evaluation criteria.

2. Implementation – A designated teacher conducted the lesson in their classroom, while other participants observed and recorded students' learning progress.

3. Reflection and Dialogue – After the lesson, participants engaged in critical discussions to evaluate the effectiveness of the POGIL approach, identify strengths and limitations, and propose improvement strategies.

4. Documentation – The entire process was compiled into a comprehensive report, serving as a reference for refining future lesson designs.

This cyclical process was repeated across multiple units until participants completed a one-semester learning program for students.

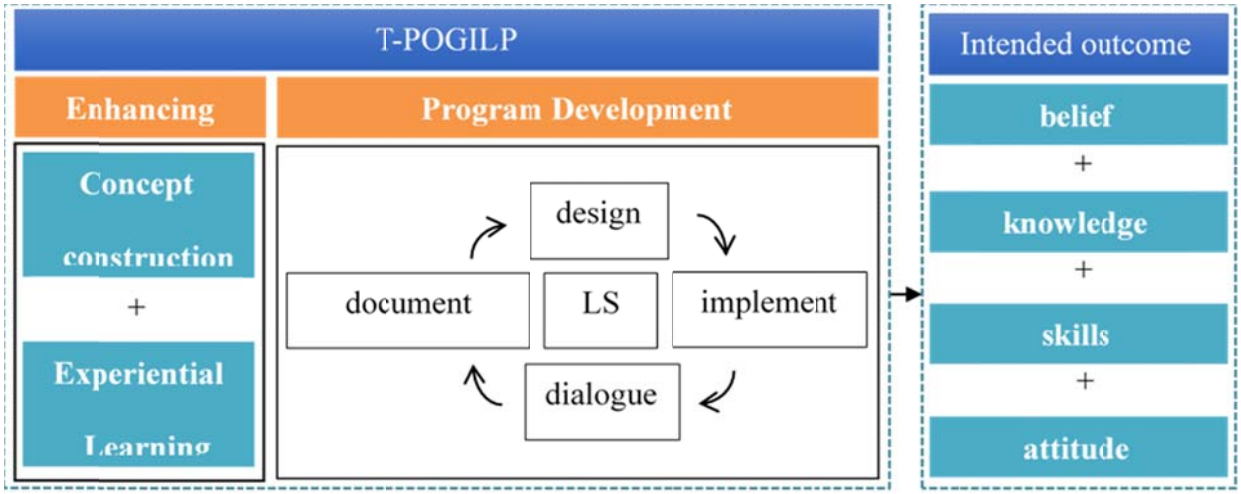

Fig. 1. Framework of phases for POGIL professional development

2.2 Program Participants

The study involved two principals and five natural science teachers from two junior high schools in central Taiwan. Participants' teaching experience ranged from seven to 32 years.

2.3 Data Collection and Analysis

Data were collected through multiple sources: POGIL Knowledge Test, Belief Scale, E-Portfolio, Interviews. The qualitative data were analyzed through organization, coding, thematic analysis, and interpretation. The quantitative data were processed using SPSS for Windows. Descriptive statistics were used to compare pre-test and post-test scores, assessing changes in participants' knowledge and beliefs.

3. Results

3.1 Teachers' Teaching Beliefs Change

The Teacher Belief Scale measured changes in teachers' teaching beliefs. The scale consisted of three dimensions and 34 items: (1) curriculum and lesson plans (9 items), (2) instruction and assessment (16 items), and (3) student learning (9 items). Each dimension was divided into two orientations, "teacher-centered"(TC) and "student-centered"(LC). Participants responded to the items on a five-point Likert scale ranging from 1, "not at all compliant," to 5, "completely compliant." As shown in Table 1, post-test scores for the teacher-centered orientation were lower than pre-test scores, while student-centered scores increased across all dimensions. These results indicate a significant shift in teachers' beliefs toward a student-centered and development-oriented perspective, aligning more closely with the educational philosophy of POGIL.

Table 1. Mean and SD of the pre-and post-test tests of the Teacher Teaching Belief Scale

Dimension	orientation	*Pre-est*		*Post-test*	
		M	*SD*	*M*	*SD*
Curriculum design	TC	3.95	1.14	4.57	1.28
	LC	4.88	0.72	5.70	0.46
Learning assessment	TC	4.53	0.84	4.65	1.28
	LC	4.63	0.83	5.63	0.53
Student learning	TC	4.42	0.72	4.53	1.44
	LC	4.67	0.49	5.67	0.48

3.2 Teachers' Knowledge and Perspectives of POGIL

To assess teachers' knowledge of POGIL, this study administered the POGIL Knowledge Test, which comprised 20 items across four dimensions: (1) theory (5 items), curriculum design (5 items), teaching activity (5 items), and learning assessment (5 items). Each correct response was awarded five points, with a maximum score of 100 points. As shown in Table 2, post-test scores significantly increased across all dimensions, demonstrating that the Lesson Study approach effectively enhanced teachers' understanding of POGIL principles, curriculum design, and instructional strategies.

Table 2. The mean of the pre- and post-tests of the teacher's POGIL knowledge test

code	theory		curriculum design		teaching activity		learning assessment	
	Pre-t	Post-t	Pre-t	Post-t	Pre-t	Post-t	Pre-t	Post-t
TA1	30	80	25	90	30	90	30	90
TA2	30	85	30	85	30	90	30	90
TA3	20	80	35	85	25	85	40	100
TA4	30	85	30	90	30	90	35	85
TB1	35	95	25	95	35	90	25	95
TB2	35	95	20	90	30	90	30	95
TB3	25	90	25	95	40	100	30	80
overall	29	87	27	90	31	91	31	91

Teachers shared insights on the benefits of POGIL pedagogy through their e-portfolios:

"POGIL fosters student cooperation and active engagement in learning." (TA1)

"POGIL's structured learning cycle—exploration, concept development, and application—promotes deeper learning." (TA2)

"POGIL enhances communication, collaboration, and critical thinking by encouraging students to discuss and share ideas in small groups." (TA3)

"POGIL helps students develop metacognitive skills, allowing them to reflect on their learning processes and self-regulate their progress." (TB2)

"POGIL encourages critical thinking, problem-solving, and logical reasoning, making learning more engaging and meaningful." (TB3)

Despite recognizing POGIL's advantages, participants also highlighted potential challenges in implementing this approach:

"The POGIL process requires significant instructional time, which adds pressure to complete the curriculum." (TA1)

"POGIL is effective, but it depends on students' motivation—if they lack initiative, the approach may be less effective." (TA2)

"Not all units are suitable for POGIL, so careful planning and discussion are necessary before implementation." (TA3)

"While teachers act as facilitators in POGIL, they must master the methodology to implement it effectively." (TB2)

3.3 Teachers' Perceptions of the Lesson Study Approach

To evaluate the impact of Lesson Study (LS) on teacher professional development, participants completed the Lesson Study Scale, consisting of 25 items across five dimensions: 1. Identifying Goals and Research Focus (5 items); 2. Collaborative Lesson Planning (5 items); 3. Lesson Implementation and Observation (5 items); 4. Post-Lesson Debrief and Reflection (5 items); 5. Documentation and Sharing (5 items). Responses were recorded on a five-point Likert scale (1 = "Not at all compliant" to 5 = "Completely compliant"). Table 3 indicates that post-test scores were higher across all dimensions, suggesting that LS contributed significantly to teacher professional development.

Table 3. Mean and standard deviation of the pre- and post-test tests of the Lesson Study scale

Dimension	*Pre-est*		*Post-test*	
	M	*SD*	*M*	*SD*
identifying goals and research focus	3.95	1.14	4.57	1.28
collaborative lesson planning	4.88	0.72	5.70	0.46
lesson implementation and observation	4.53	0.84	4.65	1.28
post-lesson debrief and reflection	4.63	0.83	5.63	0.53
documentation and sharing	4.42	0.72	4.53	1.44
overall	4.67	0.49	5.67	0.48

Teachers provided qualitative feedback on the benefits of Lesson Study:

"Lesson Study deepened my understanding of POGIL strategies and helped me design more structured lesson plans." (TA1)

"Through Lesson Study, I was able to implement differentiated instruction to meet students' diverse learning needs." (TA2)

"Lesson Study allowed me to gather student feedback, gaining valuable insights into their learning experiences." (TA3)

"Engaging in structured discussions during Lesson Study helped me refine my instructional strategies." (TB1)

"Lesson Study enabled me to anticipate challenges and develop contingency plans, improving my teaching practice." (TB2)flection Daily 20230426)

Based on these results, this study concludes that teachers' instructional beliefs evolved from a teacher-centered approach to a more student-centered one, aligning closely with POGIL principles. Their understanding of POGIL significantly improved, particularly in theoretical foundations, curriculum design, instructional strategies, and assessment methods. Furthermore, Lesson Study proved to be a valuable tool for professional development, fostering collaboration, lesson refinement, and instructional enhancement. While teachers recognized the benefits of POGIL, they also highlighted challenges such as time constraints, student motivation, and the need for greater teacher expertise. This study highlights the effectiveness of Lesson Study as a professional development model and the impact of POGIL on instructional transformation.

4. Discussion

This study implemented the Lesson Study (LS) approach to enhance teachers' professional development in Process Oriented Guided Inquiry Learning (POGIL). The findings indicate that LS significantly improved participants' understanding of POGIL, including its theoretical underpinnings, instructional design, and assessment strategies. Through hands-on engagement and structured reflection, teachers deepened their knowledge and developed more effective classroom applications. These results are consistent with previous studies (Lewis et al., 2009; Lewis & Perry, 2017; Özdemir, 2019), which emphasize LS as a collaborative model that enhances pedagogical content knowledge through systematic inquiry and collegial support.

4.1 Impact on Teachers' Teaching Beliefs

A central finding of this study is the shift in teachers' instructional beliefs from teacher-centered to student-centered orientations. This transformation aligns with prior research (Jansen et al., 2021), which suggests that LS promotes learner-centered practices by encouraging reflection on actual classroom interactions. The collaborative nature of LS—particularly through lesson observation and post-lesson discussion—exposes teachers to student engagement, peer collaboration, and autonomous learning, reinforcing the value of inquiry-driven pedagogies like POGIL.

This shift is especially relevant in the context of 21st-century competencies, where fostering students' critical thinking, creativity, communication, collaboration, and complex problem-solving (the 5Cs) is paramount. By analyzing student responses and learning outcomes, teachers become more attuned to the benefits of active learning and increasingly committed to its application.

4.2 Enhancement of Teachers' Professional Development

The study further underscores LS as an effective vehicle for sustained professional development. Participants engaged in iterative cycles of planning, teaching, observation, and reflection, which led to long-term instructional improvement. This aligns with the literature (Cheung & Wong, 2014; Godfrey et al., 2018; Lewis et al., 2009; Murphy et al., 2017; Seleznyov, 2019), highlighting LS as a transformative process that not only enhances lesson quality but also reshapes teachers' beliefs, strategies, and capacities for student-centered instruction.

Notably, LS also provided a safe and supportive environment for teachers to experiment with innovative pedagogies like POGIL. The collaborative structure reduced isolation, fostered shared responsibility, and created a professional learning community focused on inquiry and improvement. This environment is crucial for the meaningful integration of educational innovations and the continuous evolution of teaching practices.

4.3 Bridging the Gap Between Theory and Practice

An important insight from this study is the role of LS in bridging the persistent gap between educational theory and classroom practice. The cyclic and reflective nature of LS allows teachers to test pedagogical theories, evaluate their impact, and refine implementation in real time. Through collaborative planning and analysis, theoretical concepts such as inquiry-based learning are translated into actionable classroom strategies.

The integration of POGIL within the LS framework proved particularly beneficial. Teachers gained practical experience with POGIL through lesson enactment, peer feedback, and structured dialogue, enabling them to overcome initial implementation challenges. As a result, they not only understood the principles of POGIL but also developed the confidence and competence to apply them effectively in diverse instructional contexts.

4.4 Challenges of POGIL Approach

Despite the benefits, this study also identified key challenges in implementing POGIL. Time constraints were a primary concern, as the structured POGIL cycle often demands more classroom time than traditional instruction. Fitting POGIL activities into a rigid semester schedule can be difficult, especially when balancing other curricular demands.

Another challenge is student motivation. POGIL requires active participation and self-directed learning, which may be hindered if students are disengaged or unfamiliar with this approach. The success of POGIL, therefore, depends on strategies that cultivate intrinsic motivation and foster learner autonomy.

To mitigate these challenges, future research should investigate adaptive implementation models and explore cross-disciplinary applications of POGIL. By addressing practical barriers and contextual considerations, educators can optimize the use of POGIL and enhance its potential for promoting active, student-centered learning across various educational settings.

Acknowledgement

The author gratefully acknowledges the financial support provided by the Ministry of Science and Technology, Taiwan, under Grant No. NSTC 112-2410-H-018-005-MY2. Special thanks are extended to the participating school principals and science teachers for their invaluable collaboration throughout the study.

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