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Examining the Impact of Teacher Learning Communities on Self-Efficacy and Professional Learning: An Application of the Theory-Driven Evaluation

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Abstract: Collaborative professional learning is essential for teachers to work collectively in facilitating student learning. A program of Learning Community under Leadership for Learning was launched to support teacher learning in authentic situations in Taiwan. Applying the theory-driven evaluation model, the study aimed to investigate the impact of a program component of teacher learning communities (TLCs) on professional learning beliefs and behaviors. A sample of 226 elementary and junior high school teachers in Taiwan was surveyed and analyzed using structural equation modeling. The findings suggest that the experiences in TLCs had an impact on teachers' professional learning beliefs and behaviors through their self-efficacy. Additionally, teacher self-efficacy was found to have a direct impact on their beliefs and behaviors, and beliefs were found to affect behaviors significantly. This study has expanded the understanding of self-efficacy in relation to professional learning beliefs and behaviors and provided practical insights for effective strategies for teacher development.

Keywords: lesson study; professional learning; teacher beliefs; teacher behaviors; teacher learning community; teacher self-efficacy; theory-driven evaluation; change model



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1. Introduction

In the 21st century, rapid societal changes accelerate the necessity to foster students' competence in learning how to learn and become lifelong learners. To address the new challenge, teachers need to engage in continuous learning. By participating in ongoing professional development in the workplace, teachers can exchange expertise and experience with colleagues, improving their instructional practice. It, in turn, contributes to better quality schooling and enables the achievement of Sustainable Development Goal 4 (SDG4), which focuses on providing inclusive and equitable education. Furthermore, teacher learning plays a crucial role in promoting school sustainability. Over the past two decades, teacher learning communities (TLCs) have become a promising approach for instructional improvement and school change [1–4]. TLCs involve site-based learning where teachers share visions and practices to facilitate student learning. One form of TLCs is lesson study, a traditional activity of professional development in Japan for over a hundred years [5,6]. It is a teacher-driven learning and inquiry process, with features of effective professional development programs such as sharing teaching practice, focusing on student learning, involving active teacher learning, and practice-based in the daily work [7–10].

Expanding the application of learning communities to teachers and students, Sato [11,12] incorporated lesson study into his approach of “learning community” (xue xi gong tong ti) to transform schools. Drawing on Dewey and Vygotsky's theories, he emphasized building teacher collegiality and constructing classrooms as learning communities. In 2012, Sato's

approach was introduced in Taiwan, where Pan and colleagues developed an indigenous model known as Learning Community under Leadership for Learning (further referred to as the Learning Community Program). This model integrated Western theories, Sato's conceptualizations, and local discourses and practices [13–16]. Three components were subsumed in the program: building the school as a learning community, creating teacher learning communities, and developing the classroom as a learning community through implementing a learning-centered pedagogy. This study focused on the second component.

The TLCs of the Learning Community Program focus on teacher collaboration through lesson study, where teachers work together to study and improve classroom lessons [15–17]. However, simply providing opportunities for collaboration does not guarantee desired outcomes. A contrived collegiality [18] or a pseudo-community [19] might occur. This study, therefore, aims to examine whether teachers' participation in TLCs can lead to positive beliefs about collaborative professional learning and its implementation. In the literature, teachers' beliefs have been extensively explored but are much more related to teaching and learning (e.g., [20–23]) than professional learning. Additionally, research has shown a positive relationship between teacher beliefs and behaviors (e.g., [24–26]). This highlights the importance of examining both beliefs and practices in understanding the impact of TLCs on professional learning.

In the former research, Pan and Chen [27] found that teacher engagement in TLCs affected teachers' inclination to change through their professional learning beliefs and behaviors. To further examine the underlying mechanism of the intervention, this study employed a theory-driven evaluation model. This model involves creating a program theory that explains how the program leads to outcomes [28–30]. In other words, the program theory refers to the assumption (why it works) that explains the causal processes expected to happen to acquire program outcomes. Through a review of relevant literature, we identified self-efficacy as a critical factor in teacher outcomes and a potential mediator in the intervention process. Self-efficacy has links to various aspects of teacher performance such as instructional quality [31,32], stress [33], commitment [34], and job satisfaction [35], but its connection to professional learning is under-researched. This study aimed to fill the gap by investigating the impact of TLCs on professional learning beliefs and behaviors, with a focus on self-efficacy as a mediator.

2. Conceptual Background

2.1. Teacher Learning Communities

The concept of teacher learning communities is that individuals with common attitudes and goals can improve their teaching skills and, ultimately, the academic performance of their students if they meet regularly, share expertise, and work collaboratively [36]. These communities use broad-based learning to create an environment where relationships among people are interconnected [13]. Key characteristics of TLCs have been identified: shared values and vision, collective responsibility, reflective professional inquiry, the promotion of group learning, as well as individual learning [1]. Studies have shown that operating TLCs in schools can revitalize teaching and prepare students for the future [37–39].

In addition to the Western discourse and practice, Sato [11,12], a Japanese scholar, proposed the 'learning community' (xue xi gong tong ti) as an approach to transforming schools. Based on Dewey and Vygotsky's theories, Sato uses the traditional form of lesson study to build collegiality among teachers and apply collaborative learning to construct classrooms as learning communities. As a professional development strategy, lesson study includes three steps: planning the lesson together, conducting the lesson with one teacher teaching and others observing, and discussing the lesson afterward, using data collected during the lesson [5,40]. It is an action-inquiry cycle that facilitates teachers to improve instructional practices. In Taiwan, the Ministry of Education has also promoted professional learning communities since 2010 in response to local demands and global education reform. Subsequently, in the policy context of extending basic education from nine to twelve years, the idea of transforming schools into learning communities, as proposed by Sato, was

introduced in Taiwan. The term “learning community” nowadays is widely known by Taiwanese teachers and has been tested in numerous schools.

When embracing a learning community approach, it is essential to consider the cultural context and adapt it accordingly. Pan and colleagues [15,16] have modified Sato’s learning community approach to meet local needs. An indigenous model was developed that utilized “Leadership for Learning” (LfL) as a superordinate concept for learning communities, called the Learning Community under Leadership for Learning program [13–16]. The program posits that leadership is not just a position role [41,42] but also a relational and interactive process [43]. When conceptualizing leadership as organizational behavior, LfL can be regarded as a form of community engagement [44]. By embracing the concept of distributed leadership, learning communities become a platform for leadership practices. Participants foster a collaborative environment through dialogue and peer collaboration. The learning community can be implemented at the school, teacher, or student level, with all participants motivated by the principle of power-sharing and democratic decision-making in learning, leading to improved performance. This study focused on the teacher-level learning community as the intervention.

2.2. Theory-Driven Evaluation

Evaluation is a systematic process of providing credible information to inform practice. Traditionally, an evaluation approach that prioritizes experimental methods mainly focuses on the effectiveness of a program. However, the process of how and why a program produces the desired results still needs to be addressed. Without knowing how the program is implemented or the mechanism by which it triggers the outcomes, evaluators not only limit their ability to gain a deep understanding of the program but also are unable to provide information that is useful for program improvement and betterment [28,30,45].

To address the drawbacks of narrowly focusing on program effects, evaluation approaches driven by theories have been advocated. Although these theory-driven evaluation approaches have been proposed under different names, they mainly specify a program theory and apply it to guide its evaluation planning, design, and implementation, as well as an explanation of evaluation results [28–30,45]. The program theory often includes program inputs, activities, and causal links leading to expected outcomes, which reflect assumptions about how a program produces effects [29,30]. Prior theory and research, views and observation from the field, or its combination constitute potential sources of a program theory [29,46]. Theory-driven evaluation can generate an understanding not only of whether a program achieves its desired goals/outcomes, but also of a causal mechanism under the program for program improvement, accountability, and knowledge generation [29].

Among the theory-driven evaluation approaches, Chen [28] adopts a contextual and integrated perspective of a program configuration that includes action and change models. Chen’s theory-driven evaluation is particularly suitable for understanding a complex program that incorporates multiple components of action and a mechanism underlying the program change [14,28,47]. The action model proposed includes the implementation organization, program implementers, peer organizations/community partners, intervention and service delivery protocols, ecological context, and the target group. The change model includes the causal process of intervention, determinants, and outcomes, which proposes a hypothetical causal link explaining how the outcomes can be acquired. The components of the change model include [14,28,47]:

- Goals and outcomes: goals aim to address unmet needs such as poverty, inadequate education, or poor health. Outcomes are the measurable aspects of these goals.
- Determinants: programs must identify leverage mechanisms, also known as determinants, mediators, or intervening variables, to achieve the set goals.
- Intervention or treatment: any activity within the program that targets changing a determinant is considered an intervention or treatment and is the agent of change in the program.

Conducting an evaluation begins with the development of action and change models. This study applied the change model to examine the effects of the Learning Community program focusing on the component of TLCs. Chen [28] suggested that two approaches based on social science research or the practical experience of stakeholders are usually used to develop causal assumptions of the change model. We applied the former to identify the determinant in the causal mechanism.

2.3. Professional Learning: Beliefs and Behaviors

The teacher professional community focuses on teachers' professional learning, a collaborative and ongoing process that is connected with teachers' classroom practices [8,48–53]. Lesson study, one form of TLCs, intentionally encourages teachers to plan, observe, and discuss the lessons collaboratively [54,55]. Through repeated cycles of reflection and revision, teachers are involved in learning how to address the individual needs of students to maximize their students' learning outcomes [49,56–58].

TLCs and lesson study provide a collaborative structure conducive to teachers' professional learning; nevertheless, they do not ensure the outcomes of teacher learning [59]. Traditionally, teachers work individually and independently in their classrooms. TLCs and lesson study, which promote collaboration and peer observation, cause teachers uncertainty and unease about the new approach. The research conducted in Western and Asian contexts all shows that it is challenging for teachers to de-privatize classroom practices [49,59–62].

For professional learning to be effective, teachers need to be motivated to be involved in TLCs or lesson study continuously [49,58,63]. It is essential to map the way in which teachers who participate in PLCs or lesson study sustain their professional learning behaviors. Additionally, teachers who hold different beliefs about professional learning affect their receptivity to teacher collaboration and their behaviors in collegial practices [59]. Therefore, it is essential to understand the beliefs supporting teachers' continued participation in learning communities or lesson study, not just their behaviors [5,59,63].

Numerous studies have shown the effects of learning communities or lesson study on teachers, students, and schools. The most researched effects of learning communities or lesson study are teachers' outcomes, including knowledge, skills, self-efficacy, and beliefs of instructional practice [5,58,63–67], as well as teacher trust and commitment [34]. Some of the studies also show that learning communities or lesson study facilitate student learning outcomes [9,68,69] and school culture [10]. Compared with the outcomes mentioned above, the effects on teachers' beliefs and behaviors about professional learning have received less attention in the research on learning communities or lesson study. One of the studies that indeed includes beliefs about professional learning has shown that effective lesson study is positively associated with teachers' perceived usefulness of professional learning activities [5], indicating that teachers' involvement facilitates their positive beliefs in professional learning. Furthermore, teachers' experiences in learning communities benefit their professional learning beliefs and behaviors [27].

As teachers' beliefs and behaviors regarding professional learning are crucial outcomes that influence their sustained learning for improving instruction and student achievement [5], exploring this area is of great importance. While a prior study by Pan and Chen [27] established their connections with teacher learning communities, the potential mechanism for the causal relationship has yet to be investigated.

2.4. Teacher Self-Efficacy

The concept of self-efficacy derived from Bandura's [70,71] social cognitive theory is the assessment of one's own capabilities to perform effectively in a specific task. In this vein, teacher self-efficacy can be defined as teachers' beliefs in judging their own capabilities to bring about desired outcomes of student engagement and learning [72–74]. Teachers who believe they can positively impact their students' achievement despite perceived challenges are likely to focus on teaching [72,74,75]. Conversely, teachers with a low sense

of self-efficacy perceive that they can do little to support student learning and are unlikely to devote their efforts to teaching [72].

Teacher self-efficacy is both an important outcome in teachers' change and a predictor of teacher and student outcomes [63,74]. Based on the research findings, teacher self-efficacy is positively related to teachers' engagement, enthusiasm, persistence in teaching, and classroom behaviors [32,72–74,76,77]. Furthermore, teachers with a high level of self-efficacy are open to new ideas and willing to experiment to better meet their students' needs [78]. In addition to teacher outcomes, teacher self-efficacy is related to students' achievement, motivation, adjustment, and self-efficacy [74,77].

According to the social cognitive theory, there are four sources of efficacy information that promote and reinforce self-efficacy [71]. Several studies have shown that the program featuring PLCs or lesson study can provide an avenue for developing teacher self-efficacy through efficacy information (including mastery experiences, vicarious experiences, verbal persuasion, and psychological and emotional experiences) [63,72,79]. For example, Chong and Kong [63] indicated that teachers who participated in lesson study were confident in engaging students since they collaboratively planned lessons and developed knowledge. Besides their own experiences, the teachers felt prepared by observing their colleagues implement the lesson they planned together. After receiving constructive and non-threatening feedback, teachers also strengthened their self-efficacy in negotiating the challenges that they had faced.

After reviewing the relevant literature, we found that teacher self-efficacy is not only an important outcome of learning communities or lesson study but also plays a crucial role in the other aspects of teacher outcomes. Therefore, we inferred that it could be a mediator in the causal mechanism when assessing the program effect. Using the change model proposed by Chen [28] to conduct program evaluation, this study analyzed TLCs as the intervention, self-efficacy as the determinant, and teachers' professional learning beliefs and behaviors as the outcomes. Figure 1 displays the change model proposed in this study.

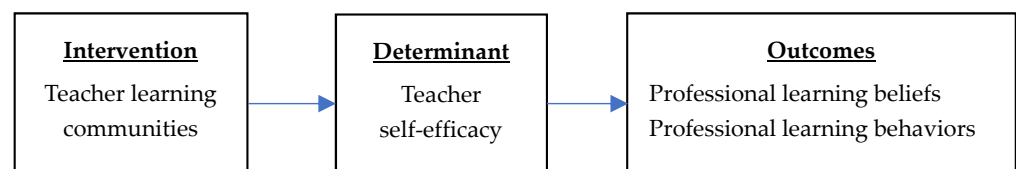


Figure 1. The change model.

According to the change model, the study aimed to examine whether teacher participation in learning communities affects professional learning beliefs and behaviors through teacher self-efficacy. Specifically, the research questions addressed are:

1. How are experiences in teacher learning communities associated with teacher self-efficacy and professional learning beliefs?
2. To what extent are experiences in teacher learning communities related to teacher self-efficacy and professional learning behaviors?

3. Methodology

3.1. Participants and Procedures

This study used a survey design to evaluate the impact of teachers' experiences in learning communities. Participants were recruited from 33 pilot schools involved in the Learning Community under Leadership for Learning program supported by the Ministry of Education in Taiwan. Data were collected from an online survey of 737 teachers (including office directors and section chiefs), with 226 valid responses obtained from elementary and junior high school teachers. The participants comprised 67% females and 33% males, with 62% being non-administrators (teachers only) and 38% holding administrative positions (such as office directors and section chiefs). The breakdown by school level showed that 58% of participants were elementary school teachers, and 42% were junior high school teachers.

3.2. Measures

The study evaluated the effects of participation in TLCs using a questionnaire comprising four scales. The program intervention analyzed as the independent variable referred to teachers' participation in learning communities by implementing lesson study. The determinant was teacher self-efficacy, while program outcomes were teachers' beliefs and behaviors regarding professional learning. The research team developed the questionnaire, which was reviewed by 15 experts, including university faculty members and school practitioners. A pilot test with 218 schoolteachers was conducted. The study performed item analysis and reliability tests to ensure the instrument's quality. In addition, principal axis factor analysis with Promax oblique rotation and confirmatory factor analyses were used, following Matsunaga's [80] suggestion. The confirmatory factor analysis reported the values of composite reliability (CR) and average variance extracted (AVE). CR measures the degree of internal consistency of latent variables with a cut-off value of 0.60 [81]. AVE indicates the average explanatory power of each observed variable about the latent variable it belongs to, with a preferred value higher than 0.50 [82].

- **Teacher learning communities.** The scale used to evaluate teacher participation in learning communities consisted of three items that assess teachers' experiences: "participating in class observations in learning communities", "participating in discussion after class observation in learning communities", and "participating in joint lesson planning in learning communities". Teachers collaborate across schools in the Learning Community program, forming networked learning communities. Their participation in these activities extends beyond their schools. Respondents rated their frequency of involvement from "never", "one to two", "three to four", "five to six", to "seven and more" times, which were coded as a five-point scale. The Cronbach's α of the scale was 0.92; the scale had a CR value of 0.93 and an AVE value of 0.81.
- **Teacher self-efficacy.** A scale was used to measure teachers' self-efficacy, which used previous research by Guskey and Passaro [83], Soodak and Podell [84], Hoy and Woolfolk [85], and Tschannen-Moran and Hoy [74] as references. Three items were subsumed: "I can motivate students not invested in their studies to become more dedicated to learning", "My teaching can develop the potential of each student", and "I feel empowered as a teacher when operating classrooms as learning communities". Participants were asked to rate their perceptions on a six-point scale. The Cronbach's α of the scale was 0.80, the CR value was 0.82, and the AVE value was 0.61.
- **Professional learning beliefs.** A scale was developed to measure teachers' beliefs about professional learning, using three items based on social constructivism [86] and the concept of teacher learning communities proposed by Sato [12] and Pan et al. [15,16]. Participants were asked to rate their agreement with each statement on a six-point Likert scale. The items of the scale are "Although joint lesson planning takes more time, it is more effective and rewarding than doing it alone", "Although the open class is a bit disturbing, it is still worth it", and "As a teacher, you must be able to discuss your teaching ideas and methods with others in order to teach better". The Cronbach's α of the scale was 0.73; the scale had a CR value of 0.76 and an AVE extracted value of 0.52.
- **Professional learning behaviors.** Teachers' professional learning behaviors were evaluated using a six-point scale. It included three items that reflect the behaviors encouraged in teacher learning communities [15,16]. They are "I discuss with my peers how to design learning activities, such as big ideas, key questions, and what students are able to know and do", "I discuss with my peers whether and where student learning is happening", and "I discuss the multifaceted nature and particularity of student learning with peers through class observation". The Cronbach's α of the scale was 0.88, the CR value was 0.88, and the AVE value was 0.71.

The questionnaire results indicate that the four scales used to measure the effects of teacher learning communities have good internal consistency and explanatory power. The

CR values for the four scales range from 0.76 to 0.93, which meet or exceed the standard of 0.60. Additionally, the discriminant validity of the model is ensured by comparing the square root of the AVE of each variable with the correlation coefficients of the variable with other variables. When the square root value exceeds the correlation coefficient, the variable is distinct from other variables [82]. In Table 1, the square root of the AVE of each variable in the diagonal is greater than its contrasting correlation coefficients, indicating that the model has acceptable discriminant validity.

Table 1. Discriminant validity of the main constructs.

	AVE	1	2	3	4
1. Experiences in TLCs	0.81	0.90			
2. Teacher self-efficacy	0.61	0.34	0.78		
3. Professional learning beliefs	0.52	0.18	0.60	0.72	
4. Professional learning behaviors	0.71	0.29	0.66	0.71	0.84

3.3. Analysis Strategies

This study used SPSS 24 to conduct descriptive statistics, including means, standard deviations, and correlations, to analyze teachers' participation in learning communities, self-efficacy, and beliefs and behaviors regarding professional learning. Next, using AMOS 24.0, we conducted structural equation modeling to examine the relationships among these variables. The commonly accepted indices were employed, such as the root mean square error of approximation (RMSEA), the comparative fit index (CFI), the Tracker-Lewis index (TLI), and the standardized root mean squared residual (SRMR), to evaluate the model's fit. We considered the model to be a good fit when the CFI was greater than or equal to 0.90, the TLI was greater than or equal to 0.90, the RMSEA was less than or equal to 0.08, and the SRMR was less than or equal to 0.08 [87]. Lastly, to confirm the significance of the indirect effect, we used bootstrapping to resample the data 5000 times and yielded a parameter estimate for the indirect and total effects. The mediating effect is considered statistically significant when the 95% bias-corrected confidence interval for the parameter estimate does not contain zero [88,89].

4. Findings

4.1. Teachers' Perceptions of Experiences in TLCs, Self-Efficacy, and Professional Learning

Table 2 shows the descriptive statistics for all measured variables. On a five-point scale, the average score of teachers' participation in learning communities was 2.74. It reveals that the average frequency of teachers experiencing the steps of lesson study was between four and five times. The mean scores for professional learning beliefs and behaviors were 4.71 and 4.74, respectively, on a six-point scale, indicating a high-intermediate level. The average score for teachers' self-efficacy was 4.39. All four variables had a positive correlation.

Table 2. The means and correlation matrix.

	M	SD	Experiences in TLCs	Professional Learning Beliefs	Professional Learning Behaviors
Experiences in TLCs	2.74	0.96			
Professional learning	4.72	0.66			
Professional learning beliefs	4.71	0.72	0.18 ***		
Professional learning behaviors	4.74	0.76	0.31 ***	0.59 ***	
Teacher self-efficacy	4.39	0.70	0.34 ***	0.55 ***	0.59 ***

*** $p < 0.001$.

4.2. The Effects of Teacher Participation in Learning Communities on Teacher Self-Efficacy and Professional Learning

According to the change model developed in this study, we hypothesized that the relationship between teachers’ participation in learning communities and professional learning beliefs and behaviors is mediated by self-efficacy. Figure 2 shows the standardized structural model. The fit of the data is considered satisfactory (RMSEA = 0.07, CFI = 0.97, TLI = 0.96, SRMR = 0.06).

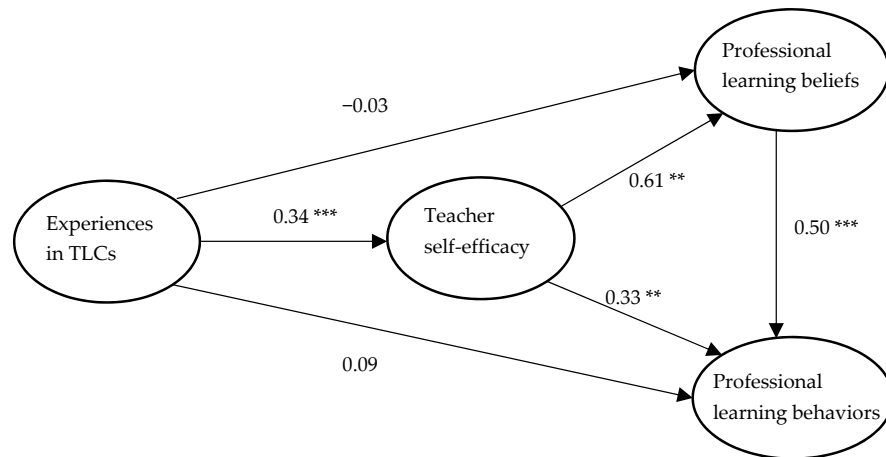


Figure 2. The mediation model of teacher learning communities affecting teacher self-efficacy and professional learning. Note: ** refers to $p < 0.01$, *** refers to $p < 0.001$.

The results in Figure 2 indicate that there is no significant impact of participating in TLCs on teachers’ beliefs ($\beta = -0.03, p > 0.05$) and behaviors ($\beta = 0.09, p > 0.05$) about professional learning. The effect was shown through the teachers’ self-efficacy. In the simple model examining the one-to-one connections, positive relationships were found between TLCs and professional learning beliefs and behaviors ($\beta = 0.17, p < 0.01$; $\beta = 0.28, p < 0.01$) (not Tabled). However, the effect of TLCs decreased in the mediation model.

Additionally, experiences of TLCs positively affected teachers’ self-efficacy ($\beta = 0.34, p < 0.001$), and self-efficacy had a significant impact on both beliefs ($\beta = 0.61, p < 0.01$) and behaviors ($\beta = 0.33, p < 0.01$) about professional learning. Beliefs were also positively associated with behaviors ($\beta = 0.50, p < 0.001$).

Significance tests using bootstrapping procedures with a 95% percentile interval were conducted to verify the mediation effects (Table 3). The results suggest that participating in TLCs can enhance teachers’ beliefs and behaviors about professional learning through self-efficacy. Self-efficacy is a significant mediator. The study obtained a full mediation model for the paths from TLCs’ experiences to professional learning beliefs and behaviors.

Table 3. Bootstrapping results of standardized indirect effects.

	Point Estimates	Product of Coefficients		Bootstrapping		p
		SE	Z	Percentile 95% CI		
				Lower	Upper	
Experiences in TLCs→TSE→PL beliefs	0.12	0.04	3.15	0.06	0.22	0.000
Participation in TLCs→PL beliefs	−0.02	0.05	−0.38	−0.12	0.07	0.672
Experiences in TLCs→TSE→PL behaviors	0.09	0.03	2.84	0.04	0.17	0.001
Experiences in TLCs→PL behaviors	0.07	0.05	1.47	−0.02	0.17	0.121
Experiences in TLCs→TSE→PL beliefs→PL behaviors	0.08	0.03	3.32	0.05	0.15	0.000

Note: TLCs: Teacher learning communities, TSE: Teacher self-efficacy, PL beliefs: Professional learning beliefs, PL behaviors: Professional learning behaviors.

5. Discussion and Conclusions

Continuous professional learning in the workplace is crucial for teacher development and instructional improvement, which ultimately benefits student performance. To support teacher learning in authentic situations, the Learning Community Program, funded by the Ministry of Education in Taiwan, was launched by Pan and colleagues [13–16]. This study aimed to assess if the TLCs component of the program affects teachers' professional learning beliefs and behaviors by using a change model proposed by Chen [28]. A structural equation modeling was conducted to investigate the causal mechanism of the intervention process, with teachers' experiences in TLCs as the program activities, teacher self-efficacy as a determinant, and professional learning beliefs and behaviors as the outcomes. The sample consisted of elementary and junior high school teachers in Taiwan. Several findings were yielded with implications for policy and practice.

Firstly, teachers' participation in TLCs was found to affect their self-efficacy significantly. In TLCs, teachers immersed themselves in lesson study. They accumulated experience in the study of subject content and student thinking, observation of classroom teaching, and discussing how student learning may occur [15,16]. These experiences allow teachers to become familiar with how to operate classrooms as learning communities and how to materialize the concepts of learner-centered pedagogy. The repeated cycles of experimentation and reflection contributed to the increase in teacher confidence in facilitating student learning. In Akiba et al.'s [64] study, teacher participation in the effective inquiry process has led to positive changes in teacher self-efficacy. Liu and Liao [90] also asserted that professional development programs that were job-embedded, inquiry-oriented, and involved collaborative learning advanced teacher self-efficacy. In the same vein, well-designed professional development programs catalyzing their beliefs about their efficacy in teaching were found in other studies [5,72,79,91].

The second noteworthy finding was that teacher self-efficacy was positively associated with professional learning beliefs and practices. In the past, substantial research has analyzed teacher self-efficacy as the predictor of teachers' instructional practice and quality [31,32], teacher commitment [34], job satisfaction [35,92,93], and student achievement [94]. Empirical inquiry into the linkage of self-efficacy and professional learning is relatively limited. In the studies of Lee et al. [34] and Moolenaar et al. [94], a positive and high correlation between PLC implementation and teacher collective efficacy was depicted. More recently, Karacabey et al. [95] and Liu and Hallinger [96] investigated the relationship in reverse and argued that collective teacher efficacy was beneficial to teachers' professional learning. Karacabey et al. [95] asserted that school collective capacity provides greater opportunities for teachers to engage in professional learning. Additionally, collective or self-efficacy is a significant "pathway" through which leadership supports teachers' professional learning [95,96]. The findings are consistent with ours, but we further included the investigation of teacher beliefs about professional learning.

Teacher beliefs influencing practice has been an extensively studied topic (e.g., [24–26]), while some studies hold a different point of view that teachers change their beliefs through practice [97]. This study adopted the two perspectives to examine how teachers practicing in lesson study affected their beliefs about professional learning and further reinforced their behaviors of job-embedded collaborative learning. Despite initial expectations, the study found that participating in lesson study did not have a significant impact on teachers' beliefs or behaviors related to professional learning. However, a positive correlation between teachers' beliefs and behaviors was observed. Teachers who valued the importance of professional learning and thought highly of sharing with colleagues, jointly planning lessons, and allowing for peer observation, were more likely to engage in behaviors such as discussing big ideas, key questions, and student learning outcomes in the lesson design. They also tended to share with colleagues how and where student learning occurs.

Finally, the results showed that experiences in TLCs did not directly affect beliefs and behaviors about professional learning. Instead, the impact was revealed through self-efficacy. It suggests that only teachers who have developed a sense of self-efficacy

may see changes in their beliefs and behaviors as a result of participating in lesson study. Previous research by Pan and Chen [27] found that teachers' involvement in learning communities catalyzed teacher learning, which is similar to the findings of this study. When examining one-to-one linkage in the simple model, TLCs had some impact on either beliefs or behaviors. However, these effects diminished in the mediation model, indicating that self-efficacy played a crucial role in mediating the effects of TLCs on teachers' professional learning beliefs and behaviors.

The study proposes that the path of "TLCs-self-efficacy-professional learning beliefs and behaviors" explains the causal mechanism of the intervention process. Using the theory-driven evaluation model contributes to identifying a key determinant for the success of program implementation.

The findings of this study have important implications for policy, practice, and future research. Firstly, TLCs can be effectively implemented through the use of lesson study, which can strengthen professional competence and improve instructional practice. The teacher-led inquiry approach promotes teacher ownership of the intervention, and its integration into daily work reduces the burden of additional professional development activities. Secondly, for TLCs to be successful, it is essential to provide sufficient meeting time for teacher groups to engage in a continuous process of studying student thinking and experimenting with instructional approaches. This increases teacher content, pedagogy, and learner knowledge, which can enhance teacher self-efficacy and improve teaching effectiveness. Therefore, school leaders should create an enabling environment for teachers to engage in the ongoing inquiry into curriculum, instruction, and student thinking and learning. Thirdly, this study found a positive relationship between self-efficacy and professional learning. Future research should investigate this relationship further and examine the potential reciprocal relationships between the two constructs. Besides, the concept of collective efficacy in addition to individual self-efficacy is also worth exploring.

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