

Differences in Collaborative Practice and Professional Communication Between Graduated and Non-Graduated Teacher Professional Education Elementary School: A Causal-Comparative Study

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ABSTRACT

Purpose of the study: This study aimed to determine and quantify the differences in collaborative practice and professional communication between graduate and Non-graduate teacher professional education elementary school teachers, and to identify the indicators that most strongly differentiate the two groups.

Methodology: An ex facto causal-comparative design was applied to 120 elementary school teachers (80 Graduate teacher professional education and 40 Non-teacher professional education) selected through purposive sampling in one regency of East Java, Indonesia. Data were collected with a validated 40-item five-point Likert instrument and analyzed using SPSS Version 26 through descriptive statistics, the Shapiro-Wilk test, Levene's test, independent samples t-tests, and Cohen's d.

Main Findings: Statistically significant differences favored PPG-alumni in collaborative practice ($M = 3.62$ vs 3.08 ; $t(118) = 5.84$, $p < 0.001$, $d = 1.13$) and professional communication ($M = 3.71$ vs 3.18 ; $t(118) = 6.07$, $p < 0.001$, $d = 1.18$). All ten indicators reached significance with large effects, and joint lesson-plan development and school interaction intensity recorded the widest between-group gaps.

Novelty/Originality of this study: This study provides the first effect-size-based comparative evidence of teacher professional education outcomes on the social-relational competencies of Indonesian elementary school teachers, offering a per-indicator diagnostic framework that advances Professional Learning Community theory in an under-represented education system and informs evidence-driven professional development policy. Implications: the findings provide an empirical basis for prioritizing the expansion of in-service teacher professional education and for designing school-level professional development that targets collaborative lesson planning and school interaction intensity.

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1. INTRODUCTION

Indonesia's national education system faces a persistent and well-documented challenge, namely that the quality of elementary school teaching remains uneven across regions, and teacher competence, particularly in its social-relational dimensions, is frequently cited as one of the most significant barriers to equitable learning outcomes [1], [2]. According to the Ministry of Education and Culture, as of 2024 roughly 1.6 million of Indonesia's approximately 3.4 million teachers at the elementary level have yet to complete any form of formal professional certification, including the Teacher Professional Education Program (PPG) [3]. This certification gap has direct consequences for school professional culture, and its scale makes the question of what formal certification actually changes in teachers' professional behaviour an urgent national concern rather than a purely academic one. Under Law Number 14 of 2005 on Teachers and Lecturers, teacher professionalism is defined across four core competencies: pedagogical, professional, personal, and social. The social competency domain, which governs how teachers collaborate and communicate within their professional communities, is the dimension least captured by content-based evaluations yet most consequential for the sustained development of a school's instructional culture.

Teacher collaboration occupies a central place in the global discourse on school improvement. Vangrieken et al. [4], in a systematic review of 82 empirical studies, documented that collaboration ranges from loose aggregates of individuals to genuine team interdependence, and that the depth of collaboration is strongly associated with instructional quality. The theoretical architecture for understanding teacher collaboration is anchored in the Professional Learning Community (PLC) framework, articulated by Hord [5] and elaborated by DuFour and Fullan [6], which treats collective inquiry, collaborative teamwork, and a focus on results as the three pillars of sustained school improvement. Christensen and Jerrim [7], drawing on TALIS 2018 data from 127,339 teachers across 40 countries, found that professional learning communities were consistently associated with stronger teacher outcomes, particularly job satisfaction, collaborative culture, and instructional improvement, although the magnitude of these effects varied across educational contexts. More recently, Ronfeldt et al. [8], using survey and administrative data from over 9,000 teachers in 336 schools, demonstrated that teachers in high-collaboration schools not only achieve greater student learning gains but also improve at higher rates when embedded in quality collaborative environments. Hargreaves and O'Connor [9] introduced the concept of collaborative professionalism, which frames teacher collaboration as a moral commitment to shared accountability rather than a mere organisational strategy, arguing that lasting professional culture requires social structures that model and reinforce mutual responsibility. Taken together, these studies establish that collaboration matters for instructional quality, but they examine collaboration as a property of the school in which teachers already work, and therefore leave open the question of whether collaborative capacity can also be formed through prior professional preparation.

Professional communication functions as the relational infrastructure through which collaboration becomes substantive rather than ceremonial. Khasawneh et al. [10] found that communicative openness and professional dialogue were the mechanisms most predictive of both teacher growth and student achievement within PLCs. Liu et al. [11], in a multilevel moderated mediation study with 3,419 teachers in China, demonstrated that communicative openness was the strongest individual-level predictor of teacher innovation within PLCs, outperforming even the frequency of formal collaborative meetings. In the Indonesian context, Soraya et al. [12] and Wullschleger et al. [13] documented the critical role of professional communication in sustaining teacher learning communities, noting that the absence of structured communicative practices often reduces KKG (Kelompok Kerja Guru) and MGMP meetings to compliance exercises rather than genuine professional dialogues. These studies consistently identify communicative openness as the decisive mechanism, yet they measure it as an outcome of the school environment and do not test whether it can be cultivated through teacher education.

The PPG program is Indonesia's primary institutional response to the teacher quality challenge. Governed by Ministerial Regulation Number 87 of 2013 and continuously updated, including through the 2025 PPG for Prospective Teachers scheme [3], the program combines content-pedagogical deepening, problem- and project-based instructional design, school practicum, and performance assessment into a structured professional formation pathway [14], [15]. Critically, PPG is not merely a credentialing mechanism. From the perspective of Lave and Wenger's [16] situated learning theory, PPG functions as a community of practice in which repeated participatory experiences, including peer teaching, collaborative lesson planning, cross-peer reflective dialogue, and structured professional discussion, generate the internalisation of professional habitus through legitimate peripheral participation. It is this habitus-forming dimension that, theoretically, should produce durable differences in collaborative and communicative behaviour in the post-program workplace.

Despite more than a decade of PPG implementation and a growing literature of evaluative studies [15], [17], a critical gap persists in the research landscape. Existing studies are predominantly descriptive or qualitatively framed, and they rarely employ quantitative comparative designs capable of producing generalisable effect estimates. More specifically, no prior study identified in the literature applies a causal-comparative design with effect size analysis to compare PPG-alumni and Non-PPG elementary school teachers

on the social-relational competency dimensions of collaboration and professional communication. Most comparative work has concentrated on pedagogical and subject-matter competencies, overlooking precisely the dimensions of teacher professionalism that most directly determine the health of school professional culture. The OECD Teaching and Learning International Survey (TALIS 2018) corroborates the urgency of this gap, reporting that collaborative lesson planning and professional exchange remain among the least practised professional activities across participating systems, including those in Southeast Asia [18]. Darling-Hammond et al. [19], in a comprehensive global review of effective teacher professional development, identified sustained collaborative engagement as one of the six defining features of high-impact programs, yet no study has quantified how strongly PPG, as a high-intensity program, shapes these specific capacities relative to teachers who lack such training. The gap is therefore twofold: methodologically, no study has compared PPG-alumni and Non-PPG teachers using a quantitative design capable of estimating effect magnitude; substantively, no study has established whether a national teacher education programme can form the social-relational competencies that the literature treats as products of the school environment. This study addresses precisely that gap. Its novelty lies in providing the first effect-size-based comparative analysis of PPG outcomes on collaborative practice and professional communication among Indonesian elementary school teachers, thereby offering both a theoretical contribution to PLC research in emerging education system contexts and an empirical basis for evidence-driven policy decisions about PPG expansion and school-level professional development design.

Accordingly, this study aimed to determine whether PPG-alumni and Non-PPG elementary school teachers differ significantly in collaborative practice and professional communication, to identify the indicators on which they differ most, and to quantify the magnitude of those differences. The study addressed four research questions. First, is there a statistically significant difference in collaborative practice between PPG-alumni and Non-PPG elementary school teachers? Second, is there a statistically significant difference in professional communication between the two groups? Third, which specific indicators show the largest between-group gaps? Fourth, what is the magnitude of the PPG effect on these two dimensions as measured by Cohen's *d*? The answers carry implications at three levels. Theoretically, the findings extend PLC and situated learning theory with evidence from an under-represented educational context. Empirically, the effect size estimates provide a quantitative basis for cost-benefit analysis of PPG investment. Practically, the per-indicator diagnostic map identifies precise targets for school-based PLC design and in-service training for Non-PPG teachers.

2. RESEARCH METHOD

This study adopted a quantitative ex post facto causal-comparative research design. This design was appropriate because the variable of primary interest, namely whether a teacher had completed the Teacher Professional Education (PPG) program, had already occurred before data collection commenced and was not amenable to experimental manipulation. The researcher therefore compared two naturally formed groups on their scores on the dependent variables, following the procedures described by Fraenkel et al. [20] and Rogers and Revesz [21]. While this design supports the identification of mean differences and effect magnitudes, it does not support strong causal inference equivalent to that achieved by randomised controlled experiments. Table 1 presents the research design schema.

Table 1. Ex Post Facto Causal-Comparative Research Design

Group	Pre-existing Differentiator	Dependent Variable 1	Dependent Variable 2
Group 1 (n = 80)	Teacher Professional Education Alumni	Collaborative Practice (Y1)	Professional Communication (Y2)
Group 2 (n = 40)	Non-Teacher Professional Education	Collaborative Practice (Y1)	Professional Communication (Y2)

The research population comprised all active teachers at public and private elementary schools in one regency of East Java Province, Indonesia, totalling 412 certified teachers. Purposive sampling was applied with four inclusion criteria: first, an active classroom or subject teacher for a minimum of one year; second, full-time permanent status; third, for the PPG group, program completion at least two years before data collection, so that the program's influence could be consolidated in professional practice; and fourth, for the Non-PPG group, no prior participation in any PPG pathway. Document verification of teacher certification records yielded a final sample of 120 teachers, comprising 80 PPG-alumni and 40 Non-PPG teachers. The 80:40 ratio reflects the genuine population distribution of PPG-alumni in this regency, where certified teachers substantially outnumber those who remain uncertified. This sample size is adequate for the analyses conducted. Both groups exceed the minimum of 30 cases per group conventionally required for parametric between-group comparison, and the distributional assumptions of the independent samples t-test were verified empirically rather than assumed: normality and homogeneity of variance were satisfied for both variables in both groups (Section 3.3). The

precision of the resulting estimates is reflected in the narrow 95% confidence intervals reported in Section 3.4 and Section 3.5, which exclude zero for both dependent variables.

Data were collected using a 40-item five-point Likert questionnaire (1 = strongly disagree to 5 = strongly agree), organised into two scales, each covering five indicators with four items per indicator. Prior to deployment, the instrument was piloted with 30 elementary school teachers outside the main study site. Validity was assessed using Pearson product-moment correlation between each item and its scale total, with an acceptance threshold of $r > 0.361$ ($df = 28$, $\alpha = 0.05$). In the pilot test, 38 of the 40 items met this criterion (r range: 0.398 to 0.812). The two items that failed validity testing were replaced with equivalent items developed from the same blueprint before the main data collection, so that the final instrument administered in the study comprised 40 valid items. Reliability was assessed using the Cronbach alpha coefficient, yielding 0.914 for the collaborative practice scale and 0.902 for the professional communication scale, both indicating very high internal consistency [22]. Table 2 presents the instrument grid, and Table 3 summarises the psychometric results.

Table 2. Research Instrument Grid

Variable	Code	Indicator	Items	Scale
Collaborative Practice (Y1)	K1	Collaborative instructional discussion	4	Likert 1–5
	K2	Sharing teaching experience and knowledge	4	Likert 1–5
	K3	Professional teamwork	4	Likert 1–5
	K4	Joint lesson-plan development	4	Likert 1–5
	K5	Collaborative student problem-solving	4	Likert 1–5
Professional Communication (Y2)	KP1	Communicative openness	4	Likert 1–5
	KP2	Professional expression of opinions	4	Likert 1–5
	KP3	Active participation in professional discussions	4	Likert 1–5
	KP4	Constructive feedback giving and receiving	4	Likert 1–5
	KP5	School interaction intensity	4	Likert 1–5
Total			40	

Table 3. Validity and Reliability of Research Instruments

Variable	Valid Items	r Range	Cronbach's Alpha	Reliability Level
Collaborative Practice	20 of 20	0.412 to 0.798	0.914	Very High
Professional Communication	20 of 20	0.398 to 0.812	0.902	Very High
Overall Instrument	40 of 40	0.398 to 0.812	0.932	Very High

Research ethics were observed throughout. The study received institutional approval from the relevant authority, and each participant received an informed consent form detailing the study's purpose, the confidentiality of all individual data, and the right to withdraw at any stage without consequence. Participant identities were anonymised using alphanumeric codes, and no individual data were disclosed to school principals or any third party. The study was conducted without external funding conflicts, contains no fabricated data, and was not submitted concurrently to another publication. Data collection was conducted over six weeks through a combination of paper-based and online (Google Forms) distribution, achieving a return rate of 95.2%. All 120 returned questionnaires passed the completeness check and were retained for analysis.

All statistical analyses were performed using SPSS for Windows Version 26, with Microsoft Excel used for data tabulation. The significance level was set at 0.05 (two-tailed) for all hypothesis tests. The analytical sequence comprised six stages. First, descriptive statistics (mean, standard deviation, minimum, and maximum) were computed for each group, and composite means were interpreted against the five Likert categories reported below. Second, the Shapiro-Wilk normality test was applied to each group on each dependent variable, this test being selected in preference to Kolmogorov-Smirnov because one group contained fewer than 50 cases [23]; normality was retained where the significance value exceeded 0.05. Third, Levene's test was used to examine homogeneity of variances, with homogeneity retained where the significance value exceeded 0.05. Fourth, once both assumptions were satisfied, the independent samples t-test was applied to address RQ1 and RQ2, and for each comparison the t value, degrees of freedom, significance, mean difference, and 95% confidence interval for the mean difference were reported. Fifth, the composite comparisons were decomposed to the indicator level through per-indicator mean comparison in order to address RQ3 and to identify where the largest between-group differences occurred. Sixth, Cohen's d was computed from the pooled standard deviation for all composite and per-indicator comparisons in order to address RQ4. Effect size was interpreted using the benchmarks small (0.20), medium (0.50), large (0.80), and very large (1.20 and above) [24], [25]. The Likert score categories were

1.00 to 1.79 (very low), 1.80 to 2.59 (low), 2.60 to 3.39 (moderate), 3.40 to 4.19 (high), and 4.20 to 5.00 (very high).

3. RESULTS AND DISCUSSION

3.1. Respondent Profile

A total of 120 elementary school teachers participated, comprising 80 Teacher Professional Education-alumni (66.7%) and 40 Non-Teacher Professional Education (33.3%). Table 4 presents the demographic profile. The two groups were broadly comparable in gender distribution, years of service, and educational level, lending confidence that inter-group differences on the dependent variables are not primarily attributable to these demographic covariates.

Table 4. Demographic Profile of Research Respondents

Characteristic	Category	PPG (n=80)	%	Non-PPG (n=40)	%
Gender	Male	29	36.3	16	40.0
	Female	51	63.7	24	60.0
Years of Service	1 to 5	20	25.0	12	30.0
	6 to 10	32	40.0	14	35.0
	11 to 15	20	25.0	10	25.0
	More than 15	8	10.0	4	10.0
Education	Bachelor (S1)	69	86.3	37	92.5
	Master (S2)	11	13.7	3	7.5
Status	Civil Servant / PPPK	61	76.3	23	57.5
	Honorary / Foundation	19	23.7	17	42.5

3.2. Descriptive Statistics

Table 5 shows composite descriptive statistics for both dependent variables. Teacher Professional Education-alumni scored in the high category (3.40 to 4.19) on both variables, while Non-Teacher Professional Education scored in the moderate category (2.60 to 3.39). Raw mean differences of 0.54 (collaboration) and 0.53 (professional communication) points are presented here for orientation, and their statistical significance and practical magnitude are addressed in the inferential analyses in Table 5.

Table 5. Descriptive Statistics: Collaborative Practice and Professional Communication

Variable	Group	n	Min	Max	Mean	SD	Category
Collaborative Practice	PPG	80	2.65	4.55	3.62	0.46	High
	Non-PPG	40	2.10	4.20	3.08	0.51	Moderate
Professional Communication	PPG	80	2.80	4.60	3.71	0.43	High
	Non-PPG	40	2.20	4.30	3.18	0.49	Moderate

3.3. Normality and Homogeneity Tests

Tables 6 and 7 present the results of the assumption tests. All Shapiro-Wilk significance values exceeded 0.05, confirming a normal distribution for both groups on both variables. All Levene significance values also exceeded 0.05, confirming homogeneity of variances. Both parametric assumptions for the independent samples t-test were therefore satisfied.

Table 6. Shapiro-Wilk Normality Test

Variable	Group	Statistic	df	Sig.	Decision
Collaborative Practice	PPG	0.978	80	0.201	Normal
	Non-PPG	0.964	40	0.229	Normal
Professional Communication	PPG	0.981	80	0.287	Normal
	Non-PPG	0.968	40	0.312	Normal

Table 7. Levene's Test for Homogeneity of Variances

Variable	Levene Statistic	df1	df2	Sig.	Decision
Collaborative Practice	0.612	1	118	0.436	Homogeneous
Professional Communication	0.548	1	118	0.461	Homogeneous

3.4. Hypothesis Testing: Collaborative Practice

Table 8 presents the inferential results for RQ1. The value $t(118) = 5.84$ with $p < 0.001$ and a 95% confidence interval of [0.357; 0.723] that excludes zero confirms rejection of the null hypothesis. A statistically

significant difference in collaborative practice exists between PPG-alumni and Non-PPG teachers, with the former group consistently scoring higher.

Table 8. Independent Samples t-Test: Collaborative Practice

	PPG (n=80)	Non-PPG (n=40)	Mean Diff.	t	df	Sig.	95% CI
Mean	3.62	3.08	0.54	5.84	118	< 0.001	[0.357; 0.723]
SD	0.46	0.51					

3.5. Hypothesis Testing: Professional Communication

Table 9 presents the results for RQ2. The value $t(118) = 6.07$ with $p < 0.001$ confirms rejection of the null hypothesis. A statistically significant difference in professional communication exists between the two groups, with Teacher Professional Education(PPG)-alumni again scoring higher (3.71 vs 3.18).

Table 9. Independent Samples t-Test: Professional Communication

	PPG (n=80)	Non-PPG (n=40)	Mean Diff.	t	df	Sig.	95% CI
Mean	3.71	3.18	0.53	6.07	118	< 0.001	[0.357; 0.703]
SD	0.43	0.49					

3.6. Per-Indicator Analysis

Tables 10 and 11 decompose the composite results to the indicator level. For collaborative practice, joint lesson-plan development (K4) showed the largest gap ($\text{delta} = 0.57$, $d = 1.18$), while for professional communication, school interaction intensity (KP5) showed the largest gap ($\text{delta} = 0.55$, $d = 1.17$). All ten indicators reached statistical significance at $p < 0.001$.

Table 10. Per-Indicator Scores: Collaborative Practice

Code	Indicator	PPG	Non-PPG	Delta	Sig.	d
K1	Collaborative instructional discussion	3.71	3.18	0.53	< 0.001	1.10
K2	Sharing teaching experience and knowledge	3.65	3.12	0.53	< 0.001	1.09
K3	Professional teamwork	3.58	3.05	0.53	< 0.001	1.06
K4	Joint lesson-plan development	3.55	2.98	0.57	< 0.001	1.18
K5	Collaborative student problem-solving	3.61	3.07	0.54	< 0.001	1.11
	Composite	3.62	3.08	0.54	< 0.001	1.13

Table 11. Per-Indicator Scores: Professional Communication

Code	Indicator	PPG	Non-PPG	Delta	Sig.	d
KP1	Communicative openness	3.78	3.25	0.53	< 0.001	1.16
KP2	Professional expression of opinions	3.72	3.20	0.52	< 0.001	1.13
KP3	Active participation in professional discussions	3.68	3.15	0.53	< 0.001	1.11
KP4	Constructive feedback giving and receiving	3.65	3.13	0.52	< 0.001	1.08
KP5	School interaction intensity	3.72	3.17	0.55	< 0.001	1.17
	Composite	3.71	3.18	0.53	< 0.001	1.18

3.7. Effect Size Analysis

Table 12 consolidates Cohen's d values for all indicators and composite variables. Every value exceeds 1.0, placing all effects in the large category [24], [25]. The composite d of 1.13 for collaborative practice and 1.18 for professional communication indicates that the observed group differences carry strong practical significance, well beyond the conventional 0.40 threshold often cited as the minimum for meaningful educational impact [26].

Table 12. Cohen's d Effect Sizes: Composite and Per-Indicator Values

Indicator / Variable	Cohen's d	Classification
Collaborative Practice (Composite)	1.13	Large
Professional Communication (Composite)	1.18	Large
K1: Collaborative instructional discussion	1.10	Large
K2: Sharing teaching experience and knowledge	1.09	Large
K3: Professional teamwork	1.06	Large
K4: Joint lesson-plan development	1.18	Large
K5: Collaborative student problem-solving	1.11	Large
KP1: Communicative openness	1.16	Large
KP2: Professional expression of opinions	1.13	Large
KP3: Active participation in professional discussions	1.11	Large
KP4: Constructive feedback giving and receiving	1.08	Large
KP5: School interaction intensity	1.17	Large

Table 13. Summary of Research Question Findings

RQ	Research Question	Key Statistical Finding	Decision
RQ1	Collaborative Practice difference	$t(118) = 5.84, p < 0.001, d = 1.13$	H0 rejected
RQ2	Professional Communication difference	$t(118) = 6.07, p < 0.001, d = 1.18$	H0 rejected
RQ3	Indicators with largest gaps	K4: delta = 0.57; KP5: delta = 0.55	Identified
RQ4	Effect magnitude	Composite d range: 1.13 to 1.18	Large effect

3.8. PPG and the Formation of Collaborative Habitus

The finding that PPG-alumni demonstrate significantly higher collaborative practice ($d = 1.13$) aligns with the program's structural design, which embeds collaborative participation rather than merely instructing participants about collaboration [14], [17]. From Lave and Wenger's [16] perspective, the repeated cycles of peer teaching, group lesson planning, cross-peer reflection, and structured professional discussion that characterise PPG constitute a sustained community of practice in which habitual collaborative behaviour is shaped through legitimate peripheral participation. This process is qualitatively different from one-off workshops, because it is a social learning process in which professional identity is formed rather than merely informed. Hargreaves and O'Connor [9] argued that collaborative professionalism cannot be installed from outside but must be grown through sustained social structures that require and reward mutual accountability. PPG, as a year-long immersive program, provides precisely such a structure.

This interpretation is corroborated by the meta-analytic evidence of Li et al. [27], who documented consistent positive impacts of PLC engagement on instructional practice, and by the large-scale study of Ronfeldt et al. [8], who demonstrated that teachers improve at greater rates when embedded in high-quality collaborative environments. In the Indonesian context, Liang et al. [28] showed that Teacher Learning Centers, which operate on PLC principles, effectively scale professional development gains when supported by facilitative organisational structures. PPG, read through this lens, functions as a national-level preparatory structure that equips teachers to engage meaningfully in the KKG ecosystems and school-based PLCs they will encounter after certification, carrying a social capital portfolio that Non-PPG teachers have not yet had the opportunity to develop. Wullschleger et al. [13] further showed, through theoretical and empirical analysis in elementary schools, that teacher collaboration for school improvement is directly associated with student achievement gains, reinforcing the downstream significance of the collaborative gap documented here.

The slightly wider effect for professional communication ($d = 1.18$) invites a theoretically significant interpretation. Throughout PPG, participants are not only trained to collaborate on technical tasks but are also required to articulate and defend pedagogical judgements, receive critical feedback from peers and field supervisors, and document their reflective responses openly. These experiences develop what Wullschleger et al. [13] identify as psychological resilience, namely the capacity to engage with professional feedback constructively rather than defensively. This emotional regulation dimension is difficult to acquire through self-directed experience at work and is rarely a focus of short-cycle in-service training programs.

The highest absolute score in the PPG group was recorded for communicative openness ($KP1 = 3.78$), the indicator most closely aligned with the concept of psychological safety. Liu et al. [11] identified communicative openness as the strongest individual-level predictor of teacher innovation within PLCs, functioning as a mediator between the PLC structure and the teacher's capacity to generate and implement new instructional ideas. This finding suggests that the most durable legacy of PPG participation may reside not in the quantity of collaborative activities produced, but in the relational quality that enables those activities to be genuinely productive rather than merely compliant.

Joint lesson-plan development (K4, $\delta = 0.57$, $d = 1.18$) recorded both the largest between-group gap and the lowest absolute mean in the Non-PPG group ($M = 2.98$, approaching the low category). This pattern is theoretically significant. Collaborative lesson planning requires a specific form of professional knowledge, namely the ability to coordinate instructional intent, sequence content, and align assessment with learning objectives within a group, and this knowledge is simultaneously tacit and transferable only through guided practice. Ronfeldt et al. [8] found that lesson planning was one of the collaborative activities most predictive of student achievement gains, yet OECD TALIS 2018 data [18] indicate that it is among the least frequently practised across systems. The confluence of high predictive value and low natural occurrence makes this indicator a priority target for structured intervention.

On the communication side, school interaction intensity (KP5, $\delta = 0.55$, $d = 1.17$) captures a broader pattern of professional engagement, including participation in meetings, workshops, collegial events, and school-wide discussions. Affandi et al. [29] noted that Non-PPG teacher participation in KKG meetings tends to be formal and passive rather than substantive. This passivity is not simply a matter of motivation. As Soraya et al. [12] documented in a case study of Indonesian teacher communities, participation in professional collective activities is shaped by prior experience of such environments. Teachers who have not been socialised into active collegial engagement through a program such as PPG often lack the communicative schemas to navigate these environments with confidence.

Cohen's d values above 1.0 across all ten indicators represent a finding of exceptional practical import. In the educational effectiveness literature, Hattie [26] places the hinge-point of meaningful intervention at $d = 0.40$, and effects above 0.80 are rare in naturalistic comparison studies. Values above 1.0 are effectively in the same range as Hattie's top-performing instructional strategies. Darling-Hammond et al. [19], in their global review, identified programs that combine active learning, sustained collaborative practice, coherent content focus, and adequate duration as those producing the highest effect sizes, all of which describe PPG. The effect magnitudes reported here are therefore not anomalies but are consistent with the upper range of what high-intensity, long-duration professional development programs can achieve. For policymakers, this provides a strong quantitative basis for continuing and expanding PPG investment. An effect of $d = 1.13$ to 1.18 on professional practice dimensions means that the difference between a PPG-trained and an untrained teacher in a school's collaborative culture is, in probabilistic terms, large enough to be observable in daily professional interactions.

Three concrete policy implications follow from these findings. First, expanding the PPG In-Service pathway (PPG Dalam Jabatan) to the approximately 1.6 million uncertified active teachers should be treated as a national priority, with special attention to the modules covering collaborative lesson planning and professional communication. The diagnostic value of the per-indicator results lies precisely here, because policymakers need not redesign the entire PPG curriculum but can target these two indicators, which show both the largest gaps and the clearest responsiveness to structured training [30]-[35]. Second, schools must establish explicit PLC structures to sustain the gains that PPG produces. Hidayat et al. [36] demonstrated that instructional leadership operating synergistically with PLC design produces multiplicative improvements in teacher quality. Without school-level structures that require and scaffold collaboration, the habitus formed in PPG risks atrophying in unsupportive workplace environments [37]-[43]. Third, in-service training for Non-PPG teachers should shift away from information-transmission formats toward participatory, practice-based models that mirror the experiential logic of PPG itself, targeting joint lesson planning and structured professional dialogue as the highest-yield intervention points.

Four limitations must be acknowledged. First, the ex post facto design precludes strong causal inference, because unobserved variables such as initial professional motivation, school leadership quality, or external professional networks may account for part of the observed differences [44]-[50]. Second, the self-report questionnaire is susceptible to social desirability bias, particularly in a collectivist cultural context where teachers may present an idealised professional image. Third, the study was conducted in a single regency in East Java, which limits generalisability to frontier, remote, or disadvantaged regions with different professional dynamics. Fourth, the unequal group sizes (80 vs 40), while statistically valid, affect the precision of estimates for the smaller group. Future research should address these limitations through longitudinal pre-post designs, multi-region sampling, and the integration of observational or artefact-based measures of collaborative practice.

4. CONCLUSION

This study produced robust empirical evidence that PPG-alumni and Non-PPG elementary school teachers in East Java, Indonesia differ significantly and substantially on two dimensions of professional competence, namely collaborative practice ($t(118) = 5.84$, $p < 0.001$, $d = 1.13$) and professional communication ($t(118) = 6.07$, $p < 0.001$, $d = 1.18$). These large effect magnitudes, consistent across all ten individual indicators, confirm that the differences are not artefacts of sample configuration but represent genuine contrasts in professional habitus that manifest in daily school interactions. Joint lesson-plan development emerged as the

single most differentiated indicator on the collaboration dimension, and school interaction intensity on the communication dimension, both reflecting skills that require structured, sustained, and guided practice to develop. The theoretical contribution of this study is threefold. It extends PLC and situated learning theory by demonstrating, for the first time with effect size analysis, that a national-level teacher education program functions as a community of practice capable of shaping durable social-relational professional competencies, not only technical-pedagogical ones. It grounds the collaborative professionalism framework of Hargreaves and O'Connor in an emerging education system context, expanding its geographical and institutional scope. It also provides a quantitative bridge between the theoretical construct of professional habitus and an observable, measurable outcome profile that can inform both future theory development and policy analysis.

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AUTHOR CONTRIBUTIONS

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CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

Informed consent was obtained from all participants involved in the study. Participation was voluntary, and respondents were informed about the study purpose, the confidentiality of responses, and their right to withdraw at any time without penalty. No personally identifying information was disclosed in the reporting of results. All images in this article have been authorized and are the property of the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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