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ORGANIZING PROFESSIONAL DEVELOPMENT TO ENHANCE PRIMARY SCHOOL ADMINISTRATORS' COMPETENCE IN MANAGING MATHEMATICS TEACHING: A CIPO- BASED APPROACH

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ABSTRACT

This study examines how professional development can be organized to strengthen primary school administrators' competence in managing mathematics teaching through the Context-Input-Process-Output (CIPO) model. The study responds to the need for more subject-specific instructional leadership in the context of Vietnam's competency-based curriculum reform. A sequential mixed-methods design was used, combining document analysis, questionnaire survey, expert consultation, and a pilot intervention. The empirical component involved 295 primary school administrators in Nghe An Province, Vietnam. Based on the literature on instructional leadership, professional development, and school effectiveness, the study developed a CIPO-based framework and six interrelated measures for organizing professional development: (1) needs assessment and context diagnosis; (2) competency-based modular program design; (3) diversified delivery formats; (4) school-based application and guided self-development; (5) post-training monitoring, mentoring, and support; and (6) resource mobilization for a sustainable professional learning environment. Descriptive evidence from the pilot intervention indicates a clear upward shift in competence. The mean score increased from 5.72 before the intervention to 7.10 after the intervention, while the variance, standard deviation, and coefficient of variation all declined. The proportion of administrators scoring 7.0 or above rose from 24.41% to 59.66%, whereas the proportion scoring 5.5 or below fell from 52.88% to 14.24%. These results suggest that a CIPO-based approach can provide a coherent and practical structure for subject-specific professional development in school leadership. The study contributes to the literature by linking mathematics instructional management with a system-based model of professional learning and by offering an operational framework that can guide leadership development under current primary education reform conditions.

Keywords: Primary School Administrators; Mathematics Teaching Management; Professional, Development; Instructional Leadership; CIPO Model

1. INTRODUCTION

Current reform in Vietnam's general education system has shifted primary education from a knowledge-transmission orientation toward competency-based learning. Within this reform, mathematics is expected to develop not only computational skills but also reasoning, problem solving, communication, and the effective use of mathematical tools in everyday life (Ministry of Education and Training [MOET], 2018). This policy direction reflects a broader international concern with foundational learning. UNESCO reported that only 44% of learners worldwide achieve minimum proficiency in mathematics at the end of primary education, underscoring the continuing challenge of improving mathematics teaching in the early years of schooling (UNESCO, 2024).

In this context, the quality of mathematics teaching is not only a classroom issue but also a leadership issue. Research has consistently shown that school leaders influence student outcomes most strongly when their work is directly connected to curriculum, teaching, and teacher learning. Hallinger (2005) emphasized that instructional leadership remains important because it places teaching and learning at the center of school improvement. Likewise, Robinson et al. (2008) found that leadership practices most closely tied to teaching and teacher development exert the strongest effects on student outcomes.

For primary schools, this expectation has special significance because mathematics occupies a foundational position in the formation of core competencies. Managing mathematics teaching therefore involves much more than monitoring curriculum compliance. It requires school leaders to plan instruction strategically, support teacher collaboration, use student learning evidence to guide improvement, and build the organizational conditions needed for effective classroom practice. Studies in mathematics education leadership suggest that such work requires subject-specific support rather than generic managerial training alone (Braseth, 2021; Johnson & Williams, 2023).

However, professional development for school leaders is still often organized around broad administrative requirements, with relatively limited attention to subject-specific instructional management. This creates a practical and theoretical gap. Although the literature explains why instructional leadership matters and what characteristics make professional learning effective, less is known about how to organize professional development systematically so that primary school administrators can lead mathematics teaching more effectively.

The present study addresses this gap through the CIPO model - Context, Input, Process, and Output. Rather than treating professional development as a one-off training event, the model allows it to be designed as a coherent system that begins with contextual diagnosis, is supported by appropriate inputs, is implemented through active processes, and is evaluated through concrete outputs. Accordingly, the study pursues two research questions: (1) What CIPO-based framework and measures can be used to organize professional development for primary school administrators in managing mathematics teaching? and (2) What changes in administrators' competence are associated with pilot implementation of the proposed measures?

2. LITERATURE REVIEW

2.1. Instructional leadership and principal professional development

The instructional leadership literature provides a strong rationale for focusing on school leaders' role in teaching quality. Hallinger (2005) argued that instructional leadership remains a durable perspective in educational administration because it orients leadership work toward curriculum, instruction, and learning. Robinson et al. (2008) reached a similar conclusion in their meta-analysis, showing that leadership practices directly related to teaching and teacher learning have stronger effects on student outcomes than broader leadership approaches.

The professional development literature also suggests that leadership competence does not improve substantially through short and fragmented training alone. Effective professional learning is typically sustained, practice-based, collaborative, and closely connected to authentic professional tasks. Borko (2004) and Desimone (2009) both emphasized that meaningful professional development should be examined in relation to the context of implementation, content focus, active learning, coherence, duration, and collective participation. More recent syntheses on principal learning indicate that high-quality opportunities for school leaders are associated with stronger professional practice, improved school climate, and better teacher and student outcomes (Darling-Hammond et al., 2022).

2.2. Mathematics-specific leadership and the CIPO model

Within mathematics education, leadership demands are particularly specific. School leaders are expected to support teachers in implementing curriculum reform, organizing professional dialogue around instruction, and using evidence from student performance to improve teaching. Braseth (2021) showed that principals' support for

mathematics teachers' professional development depends on shared goals, teacher ownership, and sustained support for practice-based learning. Johnson and Williams (2023) further demonstrated that mathematics-specific, district-led professional development can strengthen elementary administrators' self-efficacy in mathematics instructional leadership.

These studies imply that competence in managing mathematics teaching should be understood as a composite of pedagogical and organizational capabilities. In the present study, this competence includes planning the management of mathematics teaching, organizing curriculum implementation and teacher collaboration, directing instructional improvement, using evidence for decision making, and ensuring enabling conditions and resources for effective mathematics teaching.

To organize the development of this competence, the study adopts the CIPO model. In this framework, Context refers to curriculum reform demands, policy requirements, school conditions, and local characteristics. Input refers to participants' needs, training content, facilitators, materials, funding, and technological support. Process refers to the implementation of professional development through diagnosis, active learning, coaching, collaboration, school-based application, and reflection. Output refers to the immediate and near-term results of professional development, particularly improvement in administrators' competence and management practice (Scheerens, 1990; Chang & Lin, 2018).

2.3. Analytical framework of the study

Based on the reviewed literature, the study assumes that effective professional development for mathematics teaching management depends on the interaction of four linked elements: contextual relevance, quality inputs, practice-oriented implementation, and evidence-based outputs. In analytical terms, the proposed logic can be summarized as follows: Context + Input + Process -> Output -> improved competence in managing mathematics teaching.

This framework positions professional development as a cyclical system rather than a discrete activity. It also provides the conceptual basis for the design of the empirical study, the formulation of proposed measures, and the interpretation of the pilot results presented below.

3. METHOD

3.1. Research design

The study employed a sequential mixed-methods design (Creswell & Plano Clark, 2018). In the first phase, policy documents and relevant literature were analyzed to identify the core dimensions of competence in managing mathematics teaching and to establish the CIPO-based analytical framework. In the second phase, a questionnaire survey was administered to primary school administrators to examine the current organization of professional development and the level of competence related to mathematics teaching management. In the third phase, proposed measures were refined through expert consultation and then piloted, followed by a before-and-after descriptive assessment of participant competence.

3.2. Participants and setting

The empirical component involved 295 primary school administrators from Nghe An Province, Vietnam. A purposive sampling strategy was used because the study focused on administrators who were directly involved in school governance, instructional leadership, and the management of subject teaching. Nghe An was selected as the research setting because it includes diverse primary school conditions and provides a relevant context for examining leadership development under current curriculum reform.

3.3. Instruments and procedures

Three sources of evidence were used: document analysis, questionnaire survey, and expert consultation. The questionnaire examined competence in managing mathematics teaching as well as perceptions of the organization of professional development under the CIPO model. The instrument was reviewed by specialists in educational management and piloted for clarity before formal administration.

After the baseline analysis, the study formulated a CIPO-based framework and six operational measures for organizing professional development. These measures were discussed with experienced administrators and educational experts and then implemented in a pilot intervention. Competence scores were recorded before and after the intervention using the same rating framework so that changes in score distribution could be described.

3.4. Data analysis

Quantitative data were analyzed through descriptive statistics, including frequencies, percentages, mean scores, variance, standard

deviation, and coefficient of variation. Because the available data were organized at the distribution level, the study treats the pilot findings as descriptive evidence rather than as a basis for strong causal inference. Qualitative feedback from experts and practitioners was analyzed thematically to identify recurring patterns related to contextual needs, implementation conditions, and program improvement (Braun & Clarke, 2006). Instrument review and pilot checking were undertaken to strengthen internal consistency and content validity in line with common recommendations for educational research instruments (Taber, 2018).

3.5. Ethical considerations

Participants were informed of the purpose of the study and the voluntary nature of their participation. No personally identifying information is reported, and the data were used only for academic purposes. The study sought to minimize any professional risk to participants by ensuring that survey responses and feedback were treated confidentially.

4. RESULTS

4.1. A CIPO-based process for organizing professional development

The analysis of the implementation content identified a five-step process for organizing professional development to enhance primary school principals' competence in managing mathematics teaching activities. The process reflects a systematic application of the CIPO model, in which professional development is structured as a continuous cycle rather than a one-off training event. The first step is a needs assessment and baseline competence diagnosis. The findings show that this phase plays a foundational role because it provides empirical evidence for designing relevant professional development content. In practice, the diagnosis should address all four CIPO dimensions. At the context level, it examines principals' capacity to interpret policy requirements, curriculum reform demands, and local socio-economic conditions. At the input level, it focuses on their management of teachers, students, facilities, instructional materials, and other supporting resources for mathematics teaching. At the process level, attention is given to their ability to plan, direct, monitor, and support mathematics teaching activities in schools. At the output level, the diagnosis examines how principals evaluate teaching quality, analyze student learning results, and use feedback to improve instructional management. The findings further indicate that a combination of questionnaires, interviews, classroom observations, and professional record reviews is necessary to ensure a comprehensive and valid assessment

The second step involves planning the professional development program and preparing the necessary implementation conditions. The results indicate that effective planning should specify objectives, participants, timeline, content, and delivery modes, while ensuring alignment with principals' actual working conditions. Importantly, the content should be organized into competency-based modules corresponding to the CIPO framework, including contextual analysis, management of instructional inputs, leadership of the teaching process, and evaluation of outcomes for continuous improvement. The file also highlights that implementation readiness depends on the availability of qualified trainers, practical learning materials, digital platforms, facilities, and institutional coordination among educational authorities and schools. This suggests that professional development quality depends not only on content relevance but also on the adequacy of supporting conditions.

The third step concerns implementation. The findings show that professional development should be organized through flexible and diversified forms, including centralized workshops, guided self-study, cluster-based professional exchange, online learning, and school-based support. More importantly, the training process should move beyond transmissive instruction and engage principals in active learning activities such as group discussion, case analysis, experience sharing, lesson-based reflection, and the development of school-level management plans. These strategies allow principals to apply the CIPO model to authentic school situations and gradually develop a more integrated and practice-oriented management mindset. The results therefore suggest that implementation quality is strengthened when theory is consistently linked to real leadership tasks in mathematics teaching.

The fourth and fifth steps are monitoring, support, evaluation, and adjustment. The findings indicate that continuous supervision during implementation is essential for ensuring participation, tracking progress, and identifying difficulties that arise in practice. Educational authorities and trainers are expected to provide direct professional support through observation, consultation, review of school management records, and guidance in solving practical leadership problems. After implementation, the results should be evaluated by comparing principals' competence before and after participation, examining changes in school-level

management practices, and considering evidence from mathematics teaching outcomes. This evaluative information then serves as feedback for revising content, methods, and organizational arrangements in subsequent cycles. Overall, the results demonstrate that organizing professional development through a CIPO-based process creates a coherent mechanism linking diagnosis, preparation, implementation, support, and improvement, thereby strengthening principals' competence in managing mathematics teaching activities in primary schools.

4.2. A CIPO-based framework and six measures for organizing professional development

Analysis of the documents, survey information and expert feedback suggests that professional development for mathematics teaching management should be organized as a cycle with five linked activities: baseline diagnosis, preparation of enabling inputs, flexible implementation, continuous support, and evaluation for program adjustment. This structure reflects the logic of the CIPO model, in which professional learning begins with contextual understanding, is supported by suitable inputs, is enacted through practice-oriented processes and is refined through evidence of outputs.

From this process, six interrelated measures were derived. These measures do not function as isolated recommendations; rather, they reinforce one another within a coherent development cycle. Table 1 summarizes the measures and their operational focus.

Table 1. CIPO-based measures for organizing professional development in mathematics teaching management

CIPO dimension	Measure	Operational focus
Context	1. Needs assessment and context diagnosis	Analyze curriculum reform demands, school realities, and administrators' baseline competence before training.
Input	2. Competency-based modular program design	Develop modules aligned with the target competence: planning, organizing, directing, evaluation, and resource support for mathematics teaching.
Process	3. Diversified delivery formats	Combine workshops, online exchange, peer learning, guided self-study, and cluster-based activities.
Process	4. School-based application and guided self-development	Require participants to apply learning to authentic school problems and reflect on practice.
Process/Output	5. Post-training monitoring, mentoring, and support	Provide follow-up coaching, supervision, and feedback during implementation.
Input/Context	6. Resource mobilization and a sustainable learning environment	Ensure trainers, materials, digital infrastructure, funding, and institutional coordination for continuous learning.

The first measure emphasizes that professional development must begin with contextual and diagnostic work rather than with predetermined generic content. The second measure translates the diagnostic findings into a modular program aligned with the competence to be developed. The third and fourth measures address the quality of implementation by combining multiple learning formats with direct application to school-level tasks. The fifth measure extends professional development beyond the training event itself through mentoring and monitoring. The sixth measure highlights the institutional conditions required for sustainability, including personnel, materials, digital tools, and coordination among educational authorities and schools.

4.3. Descriptive results of the pilot intervention

4.3.1. Distribution of competence scores before and after the intervention

Table 2 presents the score distribution before and after the pilot intervention. The distribution

shifted clearly toward higher score bands. Before the intervention, scores were concentrated mainly in the lower and middle ranges. After the intervention, the distribution moved upward, with more participants clustered between 6.5 and 8.5. Low score bands from 3.0 to 4.0 disappeared completely in the post-intervention distribution.

Table 2. Distribution of competence scores before and after the intervention (n = 295)

Score (Xi)	Before intervention	After intervention
3.0	7	0
3.5	13	0
4.0	31	0
4.5	30	4
5.0	38	11
5.5	37	27
6.0	38	37
6.5	29	40
7.0	25	48
7.5	20	39
8.0	13	37
8.5	7	18
9.0	5	19
9.5	2	13
10.0	0	2
Mean score	5.72	7.10

The mean score increased from 5.72 to 7.10, a gain of 1.38 points. At the same time, the upward shift in frequency across the higher score categories suggests that the intervention was associated with broader improvement across the sample rather than with isolated gains among a small number of participants.

4.3.2. Comparative descriptive statistics

Table 3 shows the comparative descriptive statistics for the two assessments. Improvement was observed not only in the average score but also in the internal consistency of the distribution.

Table 3. Comparative descriptive statistics before and after the intervention

Measurement	Mean	Variance	Standard deviation	Coefficient of variation (%)
Before intervention	5.72	2.05	1.43	25.09
After intervention	7.10	1.48	1.22	17.15

The decline in variance, standard deviation, and coefficient of variation indicates that competence levels became more homogeneous after the intervention. In practical terms, this means that the pilot was associated not only with higher performance on average but also with a narrower gap between lower- and higher-performing administrators.

4.3.3. Key cumulative indicators

To clarify the distributional shift, Table 4 summarizes several threshold indicators. These figures show a substantial reduction in lower scores and a strong expansion of moderate-to-high and high scores after the intervention.

Table 4. Key cumulative indicators before and after the intervention

Indicator	Before (%)	After (%)	Change (percentage points)
Score ≤ 5.5	52.88	14.24	-38.64
Score ≥ 7.0	24.41	59.66	+35.25
Score ≥ 8.0	9.15	30.17	+21.02

The proportion of administrators scoring 5.5 or below fell from 52.88% before the intervention to 14.24% after it. In contrast, the proportion scoring 7.0 or above increased from 24.41% to 59.66%,

while the share scoring 8.0 or above rose from 9.15% to 30.17%. Taken together, these results indicate a meaningful upward movement in the competence profile of the sample.

5. DISCUSSION

The findings support the central premise of the study: professional development is likely to be more useful for school leaders when it is organized as a coherent, subject-specific system rather than as fragmented administrative training. The CIPO-based framework helped connect contextual diagnosis, program design, implementation, support, and evaluation into one developmental cycle. The upward shift in competence is therefore consistent with the broader literature showing that instructional leadership improves when professional learning is closely tied to authentic practice and supported over time (Borko, 2004; Desimone, 2009; Darling-Hammond et al., 2022).

The study also reinforces the argument that mathematics leadership should not be treated as a generic extension of school administration. Mathematics teaching involves distinctive demands related to curriculum enactment, teacher collaboration, evidence use, and pedagogical improvement. The present findings align with Braseth (2021) and Johnson and Williams (2023), both of whom highlighted the value of mathematics-specific leadership development. In the current study, the proposed measures were designed around these specific demands, which likely explains why the intervention was associated with improvements across the full score distribution rather than only at the top end.

Another important result is the reduction in score dispersion after the intervention. This pattern suggests that the pilot may have been especially helpful for administrators with weaker initial competence, thereby narrowing the internal competence gap within the sample. From a practical perspective, this is significant because more balanced leadership capacity across schools can support more stable and equitable implementation of mathematics teaching reform.

At the same time, the results should be interpreted cautiously. The intervention evidence is descriptive and based on a before-and-after comparison without a control group. Because the available data were reported at the distribution level, the study does not claim confirmed causal impact. Future research should therefore test the framework with individual-level paired data, inferential analysis, and longer-term follow-up to determine whether the observed gains are statistically robust and sustainable over time.

Even with these limitations, the study has important implications. For theory, it demonstrates the usefulness of integrating instructional leadership, mathematics-specific leadership, and system-based professional development into one analytical model. For practice, it suggests that educational authorities should design professional development for mathematics teaching management as a continuous cycle of diagnosis, modular learning, school-based application, mentoring, and evidence-based review rather than as an isolated training workshop.

6. CONCLUSION

This study examined how professional development can be organized to strengthen primary school administrators' competence in managing mathematics teaching through the CIPO model. By combining document analysis, survey data, expert consultation, and a pilot intervention with 295 administrators in Nghe An Province, the study developed a coherent framework and six operational measures for organizing professional development in this subject-specific domain.

Descriptive results from the pilot intervention indicate a clear positive shift in competence. The mean score increased from 5.72 to 7.10, while variance, standard deviation, and coefficient of variation all decreased. The score distribution also shifted upward, with a sharp reduction in low scores and a substantial increase in the proportion of participants reaching moderate-to-high and high competence levels.

The study therefore contributes a practical and theoretically grounded model for leadership development in mathematics teaching management. Although further inferential and longitudinal research is needed, the findings suggest that a CIPO-based approach offers a promising way to organize professional development for primary school leadership under current curriculum reform.

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