

Monitoring Systems and Teacher Professionalization: Analysis of Practice Effectiveness Between Competency-Based Approach Requirements and AI Integration

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DOI: <https://dx.doi.org/10.47772/IJRISS.2026.100300629>

Received: 02 April 2026; Accepted: 08 April 2026; Published: 22 April 2026

ABSTRACT

In a Cameroonian educational context marked by the transition to the Competency-Based Approach (CBA) and the rapid expansion of digital technologies, this study analyzes the effectiveness of teaching monitoring systems in teacher professionalization and examines their impact on student learning outcomes. Using a mixed-methods sequential explanatory design, data were collected from 50 secondary and higher education teachers and 68 students across three regions of Cameroon (Centre, Littoral, and West). Results reveal that only 38% of monitored teachers receive systematic formative feedback, while 72% report a substantiated need for artificial intelligence (AI) tools in their pedagogical practices. Hierarchical regression analyses demonstrate that monitoring effectiveness exploratorily suggests associations with teacher professional development ($\beta = 0.61$; $p < 0.001$) and student academic performance ($\beta = 0.47$; $p < 0.01$). A bootstrapping mediation model (5,000 iterations; Hayes, 2022, PROCESS macro v4.2) reveals that AI integration into monitoring systems positively mediates the relationship between monitoring and professionalization (indirect effect = 0.29; 95% CI [0.18; 0.42]; mediation ratio = 50.9%). These findings underscore the urgent need for a substantial reform of monitoring systems in Cameroon, integrating CBA requirements with the strategic opportunities offered by AI-enhanced pedagogical support.

Keywords: monitoring systems; teacher professionalization; Competency-Based Approach; artificial intelligence, Cameroon

INTRODUCTION

The quality of education in sub-Saharan Africa remains a central challenge for contemporary development policies. Cameroon, like other Francophone countries in the region, has been engaged since the 2000s in a deep curricular reform grounded in the Competency-Based Approach (CBA), with the ambition of making learning more meaningful, contextualized, and aligned with labor market realities [1], [2]. This reform demands a profound transformation of teachers' pedagogical practices as well as a fundamental revision of their professional identity.

Effective CBA implementation, however, requires structured and continuous teacher support through rigorous monitoring systems. These mechanisms—inspections, pedagogical supervision, tutoring, mentoring, in-service training—constitute the foundation of teacher professionalization [3], [4]. Yet available evidence suggests that these mechanisms remain underdeveloped, often disconnected from the actual needs of Cameroonian teachers [5], [6], and poorly aligned with the epistemic requirements of the CBA.

Simultaneously, artificial intelligence (AI) opens unprecedented opportunities for transforming and optimizing these monitoring systems. Tools such as intelligent tutoring systems, learning analytics platforms, and large language model-based pedagogical assistants offer new possibilities for individualized monitoring, automated feedback, and exploratory pattern analysis [7], [8], [9]. Their integration into African educational contexts, however, remains fragmented and poorly documented.

This study therefore aims to analyze the effectiveness of monitoring systems in teacher professionalization in Cameroon, measure their impact on learner performance, and explore the mediating role of AI integration. Three research questions guide this investigation:

RQ1: To what extent do current monitoring systems contribute to the professionalization of Cameroonian teachers within the CBA framework?

RQ2: What is the impact of monitoring effectiveness on student learning outcomes?

RQ3: Does the integration of AI into monitoring systems constitute a mediating factor in the relationship between monitoring and teacher professionalization?

These questions inform three empirically tested hypotheses, drawing on data collected from 50 teachers and 68 students across three Cameroonian regions, following a mixed quantitative-qualitative design.

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Teacher Professionalization and CBA

Teacher professionalization is a multidimensional process engaging identity, epistemic, and praxeological dimensions [4], [10]. It refers to the dual movement by which teaching is organized as a profession endowed with a body of specialized knowledge, and by which individuals appropriate this knowledge to construct their professional identity. Within the CBA framework, this professionalization takes on particular acuity: teachers become competency mediators, engineers of complex learning situations, and process evaluators [11], [12].

In Cameroon, the CBA reform officially launched in 2012 implies a redefinition of teacher competency frameworks. Revised curricula require mastery of disciplinary content alongside transversal pedagogical competencies: differentiation, formative assessment, and management of heterogeneous groups [1], [10]. These demands call for adapted monitoring and continuous professional development mechanisms-what the literature recognizes as a necessary condition for effective curricular reform implementation [13].

Pedagogical Monitoring Systems: Definition and Typologies

A pedagogical monitoring system may be defined as any structured set of instruments, actors, procedures, and resources established to observe, assess, and support teaching practices in order to improve their effectiveness [3], [14]. Three main categories are classically distinguished: control systems (inspection, summative assessment); accompaniment systems (mentoring, pedagogical counseling, clinical supervision); and continuous professional development systems (in-service training, communities of practice, action research).

In sub-Saharan Africa, research by Paul [15], Tchombé [16], and Nlend [17] documents a predominance of control-oriented systems to the detriment of accompaniment-oriented ones. This configuration is problematic: international research clearly establishes that formative feedback and instructional coaching produce the most substantial effects on teacher professional development [18], [19], [20].

Artificial Intelligence and Pedagogical Monitoring

Research on AI in Education (AIED) has experienced considerable growth since the 2010s [7]. In the domain of teacher monitoring, three categories of applications are distinguished: classroom analysis systems based on speech or video recognition enabling automated practice observation; learning analytics platforms that model learning trajectories and propose personalized diagnostics; and conversational pedagogical assistants offering individualized real-time coaching [8], [21].

In low-resource contexts, recent studies [22], [23] demonstrate that relatively accessible tools-mobile feedback applications, distance learning platforms with analytics modules-can produce significant effects on teaching quality, provided they are articulated with appropriate training strategies. Integration of these tools, however, encounters significant obstacles: deficient digital infrastructure, low teacher digital literacy, and absence of coherent national policies [24], [25].

Theoretical Model and Research Hypotheses

Our analytical framework draws on models of teaching effectiveness [26], [27] and Guskey's model of continuous professional development [28]. We posit that the effectiveness of monitoring systems constitutes a central predictor of teacher professionalization and student performance, and that AI integration plays a mediating role in this relationship.

H1: The effectiveness of monitoring systems is exploratorily associated with the level of professionalization of Cameroonian teachers within the CBA framework.

H2: The effectiveness of monitoring systems exploratorily suggests positive associations with the academic performance of students taught by these teachers.

H3: The integration of AI into monitoring systems positively mediates the relationship between monitoring effectiveness and teacher professionalization.

METHODOLOGY

Research Design

This study adopts an explanatory sequential mixed-methods design [29], combining a quantitative phase-collection and analysis of numerical data-with a complementary qualitative phase-semi-structured interviews. Data triangulation enhances the internal validity of findings and deepens understanding of the mechanisms at play.

Population and Sample

The target population comprises in-service teachers at secondary schools and higher education institutions across three Cameroonian regions: Centre (Yaoundé), Littoral (Douala), and West (Bafoussam). These regions were selected for their socioeconomic diversity and representativeness of the Cameroonian educational context. Sampling was conducted through a stratified random procedure.

Table 1: Socioprofessional Characteristics of the Teacher Sample (N = 50)

Variable	Category	n	%	Cumul. %
Gender	Male	31	62.0	62.0
	Female	19	38.0	100.0
Teaching level	Secondary	30	60.0	60.0
	Higher education	20	40.0	100.0
Experience	< 5 years	14	28.0	28.0
	5-10 years	18	36.0	64.0
	> 10 years	18	36.0	100.0
Region	Centre (Yaoundé)	22	44.0	44.0
	Littoral (Douala)	17	34.0	78.0
	West (Bafoussam)	11	22.0	100.0
Initial training	HTTC / DIPES II	28	56.0	56.0
	Degree/Master + CAPES	15	30.0	86.0
	Other	7	14.0	100.0

Note. HTTC =Higher Teacher Training College; DIPES II = Postgraduate Diploma for Secondary School Teachers (Second Grade); CAPES = Certificate of Aptitude for Secondary Teaching.

The student sample comprises 68 participants (39 women, 57.4%; 29 men, 42.6%), enrolled in the same institutions as their teachers. Mean age was 19.6 years (SD = 2.3 years). Students were asked to evaluate the quality of instruction received and report their semester academic averages.

Measurement Instruments

- (a) **The Monitoring System Effectiveness Scale (MSES)**-designed for teachers-comprises 24 items across five sub-scales: monitoring frequency (5 items), feedback quality (6 items), CBA relevance (5 items), impact on practices (5 items), and digital accessibility (3 items). Confirmatory factor analysis reveals adequate structure (CFI = 0.94; RMSEA = 0.06; global $\alpha = 0.89$).
- (b) **The Teacher Professionalization Questionnaire (TPQ)**-18 items across 3 dimensions: CBA pedagogical mastery (7 items), professional identity development (6 items), and use of educational technologies (5 items)-presents satisfactory internal consistency ($\alpha = 0.87$).
- (c) **The Student Learning Perception Scale (SLPS)**-15 items measuring perceived teaching quality, pedagogical alignment, and academic motivation ($\alpha = 0.83$)-supplemented by self-reported semester academic averages.

All instruments were submitted to a panel of 5 experts for content validation (mean CVR = 0.82). A pilot test with 12 teachers and 15 students not included in the final sample enabled refinement of item wording.

Procedure and Ethics

Data collection was conducted between September and November 2024 via KoBoToolbox and in person for institutions with limited connectivity. Semi-structured interviews (mean duration: 45 min) were conducted with 12 purposively selected teachers (4 per region). The protocol received approval from the Research Ethics Committee of the University of Yaoundé I (ref. CER-SHSE-UYI-2024-031). Participation was voluntary and responses were anonymized.

Analytical Strategy

Quantitative analyses were conducted with SPSS v27 and R v4.3.1 (packages lavaan, mediation, ggplot2): descriptive statistics, group difference tests (Student's t, ANOVA), bivariate correlations (Pearson), hierarchical multiple regressions (H1, H2), and bootstrapping mediation analysis (5,000 iterations-Hayes, 2022, PROCESS macro v4.2) for H3. Deductive thematic analysis [30] under ATLAS.ti processed the qualitative data.

RESULTS

State of Monitoring Systems

Descriptive data (Table 2) reveal significant structural gaps. On average, teachers report 2.3 classroom visits per year (SD = 1.4), below UNESCO recommendations of 4 to 6 annual visits. Only 38% report structured formative feedback following these visits. Digital accessibility constitutes the weakest dimension (M = 2.47/5), while 72% of teachers express a need for AI tools, yet only 18% use them regularly.

Table 2: Descriptive Statistics of Main Variables

Variable	N	M	SD	Min.	Max.	α
MSMS - Global score	50	3.21	0.74	1.42	5.00	0.89
Monitoring frequency	50	2.84	0.91	1.00	5.00	0.81
Feedback quality	50	2.96	0.83	1.17	5.00	0.84
CBA relevance	50	3.18	0.79	1.40	5.00	0.79

Digital accessibility	50	2.47	0.96	1.00	4.67	0.76
TPQ - Professionalization	50	3.44	0.68	1.78	5.00	0.87
AI Integration	50	2.31	0.87	1.00	4.33	0.82
Academic performance (out of 20)	68	11.74	2.18	6.50	18.25	-

Note. MSES and TPQ scores are on a 5-point Likert scale. Academic performance is out of 20. M = Mean; SD = Standard Deviation; α = Cronbach's alpha.

Significant regional disparities in monitoring effectiveness are observed: Centre (M = 3.58, SD = 0.62) > Littoral (M = 3.07, SD = 0.71) > West (M = 2.89, SD = 0.84), $F(2, 47) = 4.23, p = .020, \eta^2 = 0.15$. Teachers with more than 10 years of experience exhibit significantly higher professionalization levels than beginners (M = 3.89 vs. 3.12; $t(48) = 3.74, p < .001, d = 1.09$).

Testing H1: Monitoring and Professionalization

A hierarchical multiple regression was conducted to test H1. Model 1 introduced control variables (gender, experience, region, teaching level, initial training). Model 2 added the global MSES score.

Table 3: Hierarchical Regressions Predicting Teacher Professionalization (N = 50)

Predictor	Model 1 β	p	Model 2 β	p	sr ²	ΔR^2
Control variables						
Gender (ref. = female)	0.08	0.531	0.06	0.601	0.003	-
Experience (>10 vs <5)	0.38	0.007	0.29	0.028	0.047	-
Region (Littoral vs Centre)	-0.19	0.132	-0.12	0.312	0.008	-
Region (West vs Centre)	-0.24	0.071	-0.15	0.218	0.011	-
Level (higher vs secondary)	0.14	0.273	0.11	0.362	0.006	-
Monitoring effectiveness (MSMS)	-	-	0.61	<0.001	0.248	0.28***
Adjusted R²	0.19		0.45			
Model F	F(5,44)=2.87, p=0.027		F(6,43)=7.41, p<0.001			

Note. β = standardized coefficient; sr² = squared semi-partial correlation; *** p < 0.001.

Monitoring effectiveness contributes significantly and substantially, in exploratory terms, to variations in teacher professionalization ($\beta = 0.61, p < 0.001$), explaining an additional 28% of variance ($\Delta R^2 = 0.28$) beyond control variables. H1 is supported in exploratory terms. Teaching experience retains a significant independent effect in Model 2 ($\beta = 0.29, p = 0.028$), indicating that experience constitutes a complementary factor in professional development.

Testing H2: Monitoring and Student Performance

To test H2, teachers' MSES scores were matched with their students' academic averages (aggregated by class). Regression analysis reveals a positive and significant association between teacher monitoring effectiveness and student academic performance ($\beta = 0.47, t(48) = 3.71, p < 0.01, R^2 = 0.22$). The Pearson correlation between the two variables is $r = 0.49 (p < 0.001)$. Sub-scale analyses indicate that 'feedback quality' is the strongest predictor of student performance ($\beta = 0.41, p = 0.003$), followed by 'CBA relevance' ($\beta = 0.33, p = 0.017$). H2 is supported in exploratory terms.

Table 4: Correlation Matrix of Main Variables (N = 50 teachers)

Variable	1	2	3	4	5
1. Monitoring effectiveness (MSMS)	-				
2. Professionalization (TPQ)	0.63***	-			
3. AI Integration	0.54***	0.58***	-		
4. Student academic performance	0.49***	0.44**	0.39**	-	
5. Experience	0.28*	0.41**	0.19	0.21	-

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Testing H3: Mediation by AI Integration

Following Hayes's mediation procedure (2018-PROCESS macro, Model 4), we tested whether AI integration mediates the relationship between monitoring effectiveness (X) and professionalization (Y). Bootstrapping results (5,000 iterations) are presented in Table 5.

Table 5: Mediation Analysis - Mediating Effect of AI Integration (N = 50)

Causal path	b	SE	t	p	95% CI (Boot.)
Total effect (c): X → Y	0.57	0.09	6.31	<0.001	[0.39; 0.75]
Path a: X → M (AI)	0.64	0.11	5.71	<0.001	[0.42; 0.87]
Path b: M (AI) → Y X	0.45	0.10	4.48	<0.001	[0.25; 0.65]
Direct effect (c'): X → Y M	0.28	0.10	2.72	0.009	[0.07; 0.49]
Indirect effect (a×b)	0.29	0.06	-	-	[0.18; 0.42]*
Mediation ratio (PM)	50.9%	-	-	-	-

Note. b = unstandardized coefficient; SE = standard error; M = mediator (AI integration); 95% CI by bootstrapping (5,000 iterations); * significant because CI does not contain zero. PM = proportion mediated.

H3 is supported in exploratory terms. The indirect effect ($a \times b = 0.29$) is significant as its bootstrapped 95% CI does not contain zero [0.18; 0.42]. Approximately 50.9% of the total effect of monitoring on professionalization is mediated through AI integration, revealing partial mediation. The residual direct effect ($c' = 0.28$, $p = .009$) remains significant, indicating that monitoring also exerts an independent effect on professionalization beyond AI mediation.

Qualitative Results

Theme 1 - Inspection as Administrative Burden

Nine of twelve teachers perceive official classroom visits as administrative checks rather than opportunities for professional development:

"We prepare the paperwork for the inspection, but after the visit, nobody comes back to tell us what we could have done differently. It is theater. (Teacher, high school, Yaoundé, 11 years)"

This perception sustains an ambivalent relationship to monitoring, experienced as external and constraining.

Theme 2 - Misalignment between Monitoring and CBA Requirements

Teachers report a gap between the formal CBA requirements and the content of training sessions and classroom visits:

"They tell us to implement CBA, but the inspector who comes to evaluate our work has not himself been trained to assess a CBA lesson sequence. He still checks whether the blackboard is structured according to the old format. (Teacher, middle school, Douala, 7 years)"

This pedagogical misalignment is identified as a systemic barrier to professionalization.

Theme 3 - Enthusiasm for AI, but Practical Uncertainty

AI generates near-universal interest, accompanied by significant practical uncertainty:

"I use ChatGPT to prepare my lessons; it really helps me. But I don't know how to use it with my students, or whether it is authorized in our curricula. (Teacher, high school, Bafoussam, 4 years)"

This finding reveals a gap between individual AI access and institutional AI integration.

Theme 4 - Demand for a Hybrid Monitoring Model

Eleven of twelve teachers advocate for a hybrid model combining human accompaniment with digital tools:

"What we need is a system where I can see my students' progress in real time, and where a pedagogical advisor can give me regular feedback-not once a year. AI could handle daily monitoring, and the advisor would intervene in complex cases. (Teacher, university, Yaoundé, 15 years)"

This vision aligns precisely with the AI-augmented human monitoring model.

DISCUSSION

Structurally Insufficient and CBA-Misaligned Monitoring

Our results confirm and refine the observations of Mebande [6] and Assembe-Mvondo [5] regarding the shortcomings of monitoring systems in Cameroon. The frequency of 2.3 annual visits falls below international standards, and the absence of systematic formative feedback (62% of teachers) transforms monitoring into a mere administrative compliance exercise. These data corroborate Kraft et al.'s [20] findings demonstrating that feedback quality is far more determinative than visit frequency for teacher professional development.

The misalignment between CBA requirements and the evaluation frameworks used during classroom visits constitutes a systemic problem. Roegiers [11] observed that CBA implementation requires a concurrent reform of assessment and accompaniment systems: it is impossible to ask teachers to transform their practices without simultaneously transforming the mechanisms that observe and support them.

The Substantial Effect of Monitoring on Professionalization and Performance

The exploratory association between monitoring effectiveness and professionalization ($\beta = 0.61$, $\Delta R^2 = 0.28$) corroborates the meta-analysis of Darling-Hammond et al. [19], which identifies continuous instructional coaching as one of the most effective interventions for teacher professional development. It aligns with Guskey's [28] model, according to which improvement of practices requires structured accompaniment and repeated feedback opportunities.

The effect on student performance ($\beta = 0.47$) is consistent with Hattie's [27] synthesis, which identifies teacher feedback as one of the most powerful factors in academic achievement ($d = 0.73$). Our result, obtained in the Cameroonian context, provides local empirical validation for data drawn primarily from Western contexts.

AI Mediation: A Strategic Lever Still Underexploited

The most novel finding is the partial mediation of AI integration (indirect effect = 0.29, 95% CI [0.18; 0.42], ratio = 50.9%). Consistent with Holmes et al. [7] and Zawacki-Richter et al. [9], this result suggests that AI does not replace human monitoring but multiplies its effects. Half of the total effect of monitoring on professionalization passes through AI integration—a remarkable finding given the currently low adoption rate (18% regular users). One may surmise that teachers benefiting from effective monitoring are more exposed to and incentivized toward digital tool use, thus enriching their pedagogical repertoire and accelerating their professionalization.

Toward a Hybrid Monitoring Model Adapted to the Cameroonian Context

The convergence of findings argues for a three-level hybrid monitoring model: (1) a micro level where AI tools provide teachers with automatic and continuous feedback on their practices; (2) a meso level where pedagogical advisors trained in data interpretation ensure individualized accompaniment grounded in CBA realities; (3) a macro level where coherent national policies organize initial and continuous training for these new systems. This model is achievable: several African countries (Senegal, Côte d'Ivoire, Rwanda) are experimenting with digitally augmented monitoring with encouraging results [31].

Limitations

Several limitations merit attention. First, sample size ($N = 50$ teachers), though statistically adequate for the conducted analyses, limits national representativeness and the power of subgroup analyses. Nationwide studies across Cameroon's ten regions are needed. Second, the cross-sectional design precludes strict causal inference; only longitudinal studies or randomized controlled trials could confirm causal relationships. Third, academic performance data rely on self-reported averages, susceptible to social desirability bias; use of official administrative data would represent an important improvement. Fourth, the AI integration measure remains limited to self-reported usage indicators; behavioral data (platform logs) would refine the measure.

CONCLUSION

This study provides an original empirical contribution to the understanding of monitoring systems and teacher professionalization in the Cameroonian context. The findings—limited but exploratorily suggestive effectiveness for professional development, positive impact on student performance, and promising mediating effect of AI—chart a coherent roadmap for the reform of teacher monitoring policies in Cameroon.

Three practical implications emerge. First, the urgent reorientation of monitoring systems toward instructional coaching and formative feedback, in alignment with CBA requirements. Second, investment in training pedagogical advisors to use AI as an analysis and feedback tool, without supplanting professional human judgment. Third, the elaboration of a national continuous professional development policy explicitly integrating digital educational opportunities, within a framework of collaboration among MINESEC, MINESUP, and teacher training institutions.

The promise of quality education for all in Cameroon—a necessary condition for sustainable development—demands a revolution in the modalities of accompaniment and professionalization of those who are its primary architects.

ACKNOWLEDGMENTS

The author thanks the teachers, students, and institutional representatives who participated in this study.

Conflict Of Interest

The author declares no conflict of interest.

Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available due to participant confidentiality commitments but are available from the corresponding author upon reasonable request.

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