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Professional Learning and Career Stage in Ghanaian Teachers' Instructional Curiosity, Delivery, and Perceived Success: A Cross-Sectional Study

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Abstract

Professional development is central to Ghana's teacher-professionalism agenda, yet demographic characteristics are still often treated as shorthand for differences in teaching. This study examined how demographic and professional characteristics were associated with three previously validated teacher-report scales: instructional curiosity-in-practice, instructional delivery, and perceived instructional success (ISST-10). The study used data from 399 Ghanaian teachers. Because score distributions were negatively skewed and group sizes were unequal, primary comparisons used Welch tests, Hedges' g, Games–Howell post hoc tests, and Benjamini–Hochberg false-discovery-rate control. Adjusted models entered gender, age, qualification, teaching experience, school location, subject, and in-service training simultaneously and used HC3 heteroskedasticity-robust standard errors; Huber M-estimation provided sensitivity analyses. Teachers reporting in-service training scored higher on instructional curiosity (g = 0.62), instructional delivery (g = 0.66), and perceived instructional success (g = 0.85). After simultaneous adjustment and multiplicity control, in-service training and teaching experience remained independently associated with all three outcomes, while age was independently associated only with instructional delivery. Gender, school location, subject, and qualification did not show consistent adjusted associations. Model R^2 values ranged from .184 to .212, and Huber sensitivity analyses reproduced the core training and experience pattern. Professional learning and career stage were therefore more consistently related to teachers' self-reported instructional functioning than fixed demographic characteristics.

Introduction

Teacher quality is enacted rather than possessed as a single stable attribute (Strom and Martin 2022; Witter and Hattie 2024). In classrooms, teachers must notice uncertainty, invite and evaluate learner ideas, adapt explanations, maintain instructional flow, judge whether students understand, and reflect on what should change next (Ha et al. 2024; Watkins and Manz 2022). These processes draw on knowledge and skill, but also on professional dispositions such as curiosity, responsiveness, and confidence in the consequences of instruction. Contemporary research therefore increasingly treats teaching as a dynamic professional practice rather than inferring quality directly from age, academic credentials, or years in service (Gore et al. 2024; Jerrim et al. 2025; Leijen et al. 2024).

This distinction matters in Ghana, where teacher professionalism is now explicitly organised around standards, licensing, and continuing professional development (Abakah 2023a; Abakah et al. 2022; Annan 2020). The National Teachers' Standards position professional values, knowledge, practice, reflection, and career-long learning as common expectations for teachers across levels (National Teaching Council [NTC] 2021a). Ghana's professional-development framework similarly defines professional development as a systematic and sustained process for maintaining and extending teachers' knowledge, values, and skills, with professional learning embedded in a recurring career cycle rather than treated as an optional event (NTC 2021b). The policy question is therefore no longer simply

whether teachers have accumulated years of service, but whether professional learning and career conditions are associated with instructional practices that support improvement.

Recent evidence makes professional development a plausible, but not automatically causal, correlate of instructional functioning. A meta-analysis of 128 high-quality teacher-professional-development studies found a positive average effect on student achievement, but also substantial between-study heterogeneity, indicating that participation alone does not guarantee improvement (Visscher et al. 2025). Other studies found positive average associations between the professional development teachers typically receive and both instruction and achievement, while warning that only a minority of included studies used designs capable of strong causal inference (Lindvall et al. 2025; Silva Didier et al. 2025; Visscher-Voerman et al. 2026). This distinction is important for cross-sectional teacher surveys: training participation may mark access to learning opportunities, motivation, institutional support, or selection into development activities, but it should not be interpreted as an intervention effect without an appropriate design.

Specifically, Ghanaian-oriented studies reinforce both the importance and the implementation challenges of professional learning. Salifu et al. (2024) documented constraints affecting teacher professional development in Ghana and highlighted the need for stronger follow-up, resourcing, and decentralised support. Coffie et al. (2025) showed, in the context of curriculum reform, that structured professional learning can support changes in teachers' classroom practices. Siemoh et al. (2025) likewise emphasised the relevance of in-service teachers' pedagogical content knowledge for instructional effectiveness. More broadly, a recent systematic review led by Ghanaian researchers identified collaborative learning, practical training, mentorship, and sustained institutional support as recurring features of professional development associated with changes in instructional practice (Amemasor et al. 2025). Together, these studies suggest that professional learning should be treated as a substantive feature of teachers' working lives, not merely a demographic checkbox.

Teaching experience is more complicated. Experience can provide opportunities to accumulate routines, pedagogical judgement, and context knowledge, yet years of service are not equivalent to expertise (Abakah 2023b; Gore et al. 2024). Research across teachers with a wide range of experience found no simple monotonic relationship between years taught and the quality of observed pedagogy, arguing instead for high-impact professional learning across the career span (Gore et al. 2024). Sun and Yin (2025), however, found that teaching experience predicted membership in teacher self-efficacy profiles, whereas gender and school location did not. These findings support a career-stage perspective: experience may matter, but its relationship with instructional functioning can be nonlinear and dependent on professional context.

Three teacher-report constructs are particularly useful for examining this issue. Instructional curiosity-in-practice captures an enacted orientation toward uncertainty and alternatives. For example, inviting student ideas, adapting plans, asking open questions, and seeking better ways to teach. Curiosity in teaching has been conceptualised as relational and generative rather than simply a trait of the teacher

(Cavicchi 2024), and educator curiosity has been linked to professional-learning concerns (Birenbaum and Nasser-Abu Alhija 2020). Instructional delivery concerns the enactment of teaching through monitoring understanding, adapting explanation, maintaining attention and flow, making learning relevant, and reflecting after lessons. Perceived instructional success captures teachers' judgements that their teaching produces understanding, progress, mastery, meaningful learning, and successful lesson outcomes.

These constructs should not be treated as interchangeable with objective teaching quality. Teacher self-reports are valuable for studying professional beliefs and perceived practice, but their associations can be inflated by common-source self-evaluation. Jerrim et al. (2025), using the TALIS Video Study, showed that relationships involving teacher self-efficacy and instructional quality varied markedly according to whether instructional quality was rated by teachers or expert observers. The present three scales also overlap conceptually: curiosity can motivate adaptation, effective delivery can contribute to success, and successful lessons can reinforce teachers' willingness to explore. It is therefore important to examine each validated score while being explicit that they represent related self-reported facets of instructional functioning.

Despite Ghana's formal commitment to continuous professional development, little evidence has compared a broad set of demographic and professional characteristics against multiple validated measures of teachers' instructional self-perceptions within the same sample. Such analysis can clarify whether fixed characteristics such as gender, age, location, subject area, and qualification show consistent differences once career experience and professional learning are considered simultaneously. It can also identify which factors are most useful for professional-development policy.

The Present Study

This study examined demographic and professional correlates of three previously validated 10-item teacher-report scales among Ghanaian teachers. The focus was not to revalidate the instruments, but to use their final scoring forms to examine group differences and adjusted associations. Three research questions guided the analysis:

1. 1. How do instructional curiosity-in-practice, instructional delivery, and perceived instructional success vary across gender, age, academic qualification, teaching experience, school location, subject area, and reported in-service training?
2. 2. Which demographic and professional characteristics retain independent associations with each validated scale score when all characteristics are entered simultaneously?
3. 3. Are the principal associations stable when analyses use heteroskedasticity-robust inference and a robust regression estimator that reduces sensitivity to outlying responses?

Methods

Research Design

The study used a cross-sectional survey on professional pre-tertiary teachers. These teachers were randomly selected through table of random numbers from the Ga East Municipal, Agona West District, and Akim Oda Municipality in Ghana.

Participants

The sample comprised 399 teachers. Men represented 50.9% of the sample and women 49.1%. The modal age category was 35–44 years (29.3%), followed by 45–54 years (28.1%) and 25–34 years (25.1%). Almost half held a bachelor's degree (46.6%), while 27.8% held a master's degree. Teaching experience was distributed across the career span: 20.1% had fewer than five years, 31.6% had 5–10 years, 24.1% had 11–15 years, 15.5% had 16–20 years, and 8.8% had more than 20 years. Most teachers worked in rural schools (53.4%). A large majority (84.2%) reported having received in-service training. Table 1 presents the demographic information.

Table 1
Participant demographic and professional characteristics

Variable	Category	N	%
Gender	Male	203	50.9
Gender	Female	196	49.1
Age	Below 25	51	12.8
Age	25–34	100	25.1
Age	35–44	117	29.3
Age	45–54	112	28.1
Age	55 and above	19	4.8
Highest qualification	Certificate/Diploma	66	16.5
Highest qualification	Bachelor's degree	186	46.6
Highest qualification	Master's degree	111	27.8
Highest qualification	Doctorate	18	4.5
Highest qualification	Other	18	4.5
Teaching experience	Less than 5 years	80	20.1
Teaching experience	5–10 years	126	31.6
Teaching experience	11–15 years	96	24.1
Teaching experience	16–20 years	62	15.5
Teaching experience	More than 20 years	35	8.8
School location	Rural	213	53.4
School location	Peri-Urban	102	25.6
School location	Urban	84	21.1
Subject	English	40	10.0
Subject	Mathematics	54	13.5
Subject	Science	42	10.5
Subject	Social Studies	42	10.5
Subject	Other	221	55.4
In-service training	Yes	336	84.2
In-service training	No	63	15.8

Measures

Instructional Curiosity-in-Practice Scale for Teachers (ICTS-10)

The Instructional Curiosity-in-Practice Scale for Teachers (ICTS-10) is the validated 10-item brief form of a 30-item literature-derived candidate pool. The construct captures enacted instructional inquiry, including inviting learner ideas, adapting plans, posing open-ended questions, permitting alternative solution routes, welcoming new ideas, accommodating differing abilities, allowing flexible expression, responding creatively to unexpected situations, making learning enjoyable, and continuing to search for improved teaching approaches. The original scale-development analysis used a random split of the 399 teachers into development (n = 200) and holdout (n = 199) samples. Principal-axis exploratory factor analysis (EFA) showed excellent factorability (KMO = .945; Bartlett's $\chi^2(435) = 2944.80$, $p < .001$), and 1,000-replication parallel analysis supported one dominant factor. A one-factor maximum-likelihood CFA in the untouched holdout sample showed excellent fit, $\chi^2(35) = 33.79$, $p = .526$, CFI = 1.000, TLI = 1.000, RMSEA = .000, 90% CI [.000, .049], SRMR = .036; standardised loadings ranged from .507 to .707. Full-sample reliability was strong ($\alpha = .878$; $\omega = .879$); holdout composite reliability (CR) was .855 and average variance extracted (AVE) was .374. The 10-item mean correlated r = .949 with the original 30-item mean, indicating strong rank-order score retention. The available validation record supports literature-based content representation through explicit construct definition and item-to-domain correspondence. Items were rated from 1 (Strongly disagree) to 5 (Strongly agree).

Instructional Delivery Scale for Teachers (IDST-10)

The Instructional Delivery Scale for Teachers (IDST-10) is the validated 10-item form of an initial 30-item, literature-derived pool assessing constructive classroom enactment. Its retained content covers checking understanding, adapting teaching when students do not understand, maintaining attention, summarising key points, correcting mistakes clearly, sustaining lesson flow, handling unexpected classroom situations, establishing relevance, maintaining task focus, and reflecting after lessons. Before large-sample psychometric testing, the candidate pool underwent expert content validation for relevance, representativeness, clarity, and alignment with instructional delivery, followed by face validation with teachers comparable to the target population to establish comprehensibility and contextual appropriateness. In the random-split validation, principal-axis EFA in the development sample (n = 200) showed strong factorability (KMO = .941; Bartlett's $\chi^2(435) = 2887.91$, $p < .001$), and 1,000-replication parallel analysis retained one factor. The final one-factor CFA in the independent holdout sample (n = 198) showed good fit, $\chi^2(35) = 61.28$, $p = .004$, CFI = .950, TLI = .936, RMSEA = .062, 90% CI [.035, .087], SRMR = .046; standardised loadings ranged from .508 to .698. Full-sample reliability was strong ($\alpha = .871$; $\omega = .872$), with CR = .848 and AVE = .360. The brief score correlated r = .951 with the 30-item mean. Items used a 1–5 agreement response format.

Perceived Instructional Success Scale for Teachers (ISST-10)

The Instructional Success Scale for Teachers (ISST-10) is a validated 10-item measure of perceived instructional consequences. The 30-item candidate pool was generated deductively from literature on teacher efficacy, instructional quality, adaptive instruction, student engagement, learning outcomes, and Ghana's professional expectations for teachers. Expert content validation evaluated relevance, representativeness, clarity, and construct alignment; teachers from the intended population then completed face-validity review for comprehensibility, naturalness of wording, classroom relevance, response burden, and cultural appropriateness, followed by pilot refinement. Principal-axis EFA in the development sample (n = 200) showed excellent factorability (KMO = .934; Bartlett's $\chi^2(435) = 2748.55$, $p < .001$), and 1,000-replication parallel analysis supported one dominant factor. A one-factor maximum-likelihood CFA in the untouched holdout sample (n = 199) showed good fit, $\chi^2(35) = 52.38$, $p = .030$, CFI = .967, TLI = .958, RMSEA = .050, 90% CI [.016, .077], SRMR = .045; standardised loadings ranged approximately from .46 to .71. Reliability was strong ($\alpha = .860$; $\omega = .861$), with CR = .848 and AVE = .362. The 10-item mean correlated $r = .941$ with the original 30-item mean. The final scale represents teachers' appraisals of student understanding and improvement, lesson-goal attainment, positive and meaningful learning, mastery of difficult concepts, sustained interest, responsiveness to learner diversity, facilitation of learning, and overall instructional success. Items used the same 1–5 agreement response format. Table 2 presents the results.

Table 2

Prior validation evidence for the three focal 10-item scales

Scale	Development/structural evidence	Holdout CFA	Reliability and convergent evidence	Additional validation evidence
INSTRUCTIONAL CURIOSITY	30-item literature-derived pool; EFA n = 200; KMO=.945; Bartlett $\chi^2(435) = 2944.80$, p<.001; parallel analysis: 1 factor	n = 199; $\chi^2(35) = 33.79$, p=.526; CFI = 1.000; TLI = 1.000; RMSEA=.000 [.000,.049]; SRMR=.036; λ = .507-.707	α = .878; ω = .879; CR=.855; AVE=.374	10-item vs 30-item r=.949; known-groups training g=.62; high HTMT with companion scales
IDST-10	Literature-derived 30-item pool; expert content and teacher face validation; EFA n = 200; KMO=.941; Bartlett $\chi^2(435) = 2887.91$, p<.001; parallel analysis: 1 factor	n = 198; $\chi^2(35) = 61.28$, p=.004; CFI=.950; TLI=.936; RMSEA=.062 [.035,.087]; SRMR=.046; λ = .508-.698	α = .871; ω = .872; CR=.848; AVE=.360	10-item vs 30-item r=.951; known-groups training g=.66; HTMT=.975 with ICST and .970 with ISST
ISST-10	Literature-derived 30-item pool; expert content validation, teacher face validation and pilot refinement; EFA n = 200; KMO=.934; Bartlett $\chi^2(435) = 2748.55$, p<.001; parallel analysis: 1 factor	n = 199; $\chi^2(35) = 52.38$, p=.030; CFI=.967; TLI=.958; RMSEA=.050 [.016,.077]; SRMR=.045; λ ≈ .46-.71	α = .860; ω = .861; CR=.848; AVE=.362	10-item vs 30-item r=.941; known-groups training g=.85; HTMT=.950 with ICST and .973 with IDST

Statistical Analysis

Statistical analyses were conducted in Python 3.13 using pandas 2.2.3 and NumPy 2.3.5 for data management, SciPy 1.17.0 for inferential tests and bootstrap procedures, statsmodels 0.14.6 for Welch ANOVA, heteroskedasticity-robust regression, joint Wald tests, and Huber M-estimation, and scikit-learn 1.8.0 for the one-factor loading solution used in the omega calculation. Analytic choices were prespecified to address unequal group sizes, skewed scale scores, multiplicity, and the observational design.

For binary characteristics, unadjusted group differences were tested with Welch's independent-samples t test and expressed as Hedges' g. For characteristics with three or more groups, Welch's heteroskedastic

one-way ANOVA was used; eta squared is reported as a descriptive omnibus effect size. When an omnibus multi-group test survived false-discovery-rate correction, Games–Howell comparisons were used to locate pairwise differences. The 21 primary omnibus comparisons (seven characteristics across three outcomes) were controlled using the Benjamini–Hochberg false-discovery-rate procedure.

Adjusted analyses used separate ordinary least-squares models for instructional curiosity, instructional delivery, and perceived instructional success. Gender, age, qualification, teaching experience, school location, subject, and in-service training were entered simultaneously as categorical predictors. HC3 heteroskedasticity-consistent standard errors and confidence intervals were used. Each multi-category factor was evaluated with a joint robust Wald test, and the 21 factor-by-outcome tests were again subjected to Benjamini–Hochberg control. Reference categories were male, age 25–34 years, bachelor's degree, 5–10 years of experience, rural school, 'other' subject, and no in-service training. The unique descriptive contribution of each factor was summarised by the drop-one change in R^2 (ΔR^2). Variance inflation factors were inspected; the maximum VIF was 2.08.

Two sensitivity analyses were used. First, Huber M-estimation fitted the same adjusted models after standardising each outcome, reducing the influence of extreme residuals. Second, the unadjusted training-group Hedges' g estimates were accompanied by 5,000-resample percentile bootstrap confidence intervals. Statistical tests were two-sided with $\alpha = .05$; multiplicity-adjusted q values, confidence intervals, and effect sizes were prioritised over isolated nominal p values.

Taken together, seven demographic characteristics were analysed exactly as gender; age group; highest qualification; years of teaching experience; school location; subject area; and reported in-service training. The training item was binary (yes/no).

Results

Scale Descriptives and Reliability

All three validated scores were high on the 1–5 metric. Instructional curiosity had M = 4.18 (SD = 0.62), instructional delivery M = 4.19 (SD = 0.59), and perceived instructional success M = 4.20 (SD = 0.58). Internal consistency was strong: alpha/omega were .878/.879 for instructional curiosity, .871/.872 for IDST-10, and .860/.861 for ISST-10. The scales were also strongly intercorrelated. Pearson correlations ranged from .826 to .854, while Spearman correlations ranged from .689 to .701. Thus, the outcomes are empirically related and should be interpreted as neighbouring self-reported instructional facets and not independent indicators of objective teacher quality. Table 3 presents the results.

Table 3
Descriptive statistics, reliability, and inter-scale correlations

Scale	M	SD	α	ω	Skew	1	2	3
1. INSTRUCTIONAL CURIOSITY	4.177	0.616	0.878	0.879	-1.887	—		
2. IDST-10	4.194	0.592	0.871	0.872	-1.978	0.854	—	
3. ISST-10	4.201	0.576	0.860	0.861	-1.947	0.826	0.840	—

Note: Correlations are Pearson r. All p<.001. Spearman ρ values were .701 (ICST-IDST), .697 (ICST-ISST), and .689 (IDST-ISST).

Unadjusted Demographic and Professional Differences

The strongest and most consistent unadjusted difference involved in-service training. Teachers reporting training scored higher than those reporting no training on instructional curiosity(trained M = 4.24, SD = 0.57; untrained M = 3.86, SD = 0.73; g = 0.62, q=.002), instructional delivery (4.25, 0.53 vs. 3.87, 0.79; g = 0.66, q=.002), and perceived instructional success (4.28, 0.49 vs. 3.80, 0.79; g = 0.85, q<.001). Bootstrap 95% confidence intervals for g were [0.33, 0.96], [0.34, 1.04], and [0.52, 1.22], respectively.

Teaching experience was also associated with all three outcomes after false-discovery-rate correction. The profile was not linear. Scores tended to be highest in the 5–10- and 11–15-year groups and lower among teachers with 16–20 or more than 20 years of experience. For instructional curiosity, the 11–15-year group scored above the 16–20-year and > 20-year groups in Games–Howell comparisons, while the 5–10-year group also scored above the > 20-year group. For instructional delivery, both the 5–10- and 11–15-year groups scored above later-career groups in several pairwise contrasts. For perceived instructional success, the 5–10- and 11–15-year groups scored above the 16–20-year group. These are cross-sectional career-stage differences, not within-person decline.

Age, qualification, gender, location, and subject yielded a less consistent pattern. Age differences survived unadjusted false-discovery-rate control for instructional delivery and perceived instructional success, but not instructional curiosity. Qualification differences survived for all three unadjusted outcomes, although the pattern attenuated in adjusted models. Gender, school location, and subject area did not survive false-discovery-rate correction for any outcome. Table 4 and Fig. 1 present the results.

Table 4

Robust unadjusted omnibus comparisons across demographic and professional characteristics

Outcome	Factor	Welch statistic	P	q (BH)	Effect
Instructional Curiosity	Gender	t=-1.02	0.309	0.361	g=-0.10
Instructional Curiosity	Age	F = 2.50	0.046	0.081	η^2=0.020
Instructional Curiosity	Qualification	F = 3.17	0.020	0.041	η^2=0.041
Instructional Curiosity	Experience	F = 5.73	< .001	0.002	η^2=0.074
Instructional Curiosity	Location	F = 0.85	0.429	0.450	η^2=0.005
Instructional Curiosity	Subject	F = 2.01	0.098	0.146	η^2=0.022
Instructional Curiosity	Training	t = 3.86	< .001	0.002	g = 0.62
Instructional Delivery	Gender	t=-1.85	0.065	0.105	g=-0.18
Instructional Delivery	Age	F = 3.89	0.005	0.013	η^2=0.041
Instructional Delivery	Qualification	F = 4.06	0.005	0.013	η^2=0.054
Instructional Delivery	Experience	F = 4.76	0.001	0.004	η^2=0.077
Instructional Delivery	Location	F = 0.94	0.391	0.432	η^2=0.006
Instructional Delivery	Subject	F = 0.69	0.597	0.597	η^2=0.007
Instructional Delivery	Training	t = 3.70	< .001	0.002	g = 0.66
Perceived Instructional Success	Gender	t=-1.59	0.114	0.159	g=-0.16
Perceived Instructional Success	Age	F = 2.99	0.022	0.042	η^2=0.024
Perceived Instructional Success	Qualification	F = 4.94	0.002	0.005	η^2=0.059
Perceived Instructional Success	Experience	F = 5.33	< .001	0.002	η^2=0.065
Perceived Instructional Success	Location	F = 1.28	0.282	0.348	η^2=0.008
Perceived Instructional Success	Subject	F = 1.30	0.275	0.348	η^2=0.014
Perceived Instructional Success	Training	t = 4.56	< .001	< .001	g = 0.85

Note. For binary factors, effect=Hedges' g; for multi-category factors, effect=descriptive η^2. Benjamini–Hochberg correction was applied across the 21 omnibus tests.

Adjusted Associations

When all seven characteristics were entered simultaneously, the models explained 18.4% of instructional curiosity variance (adjusted R^2=.140), 21.2% of instructional delivery variance (adjusted R^2=.170), and 20.6% of instructional success variance (adjusted R^2=.164). Robust model-wide tests were significant for all three outcomes. After Benjamini–Hochberg correction of the factor-level Wald tests, only two predictors were consistently associated with all three scores: teaching experience and in-service training. Age remained independently associated with instructional delivery only.

Training showed the clearest actionable association. Relative to teachers reporting no training, those reporting in-service training scored 0.296 points higher on instructional curiosity (95% CI [0.098, 0.494], p=.003), 0.332 points higher on instructional delivery (95% CI [0.132, 0.532], p=.001), and 0.403 points higher on perceived instructional success (95% CI [0.197, 0.610], p<.001), holding the other demographic and professional variables constant. Training uniquely accounted for approximately 2.6%, 3.6%, and 5.6% of variance in instructional curiosity, instructional delivery, and perceived instructional success, respectively.

Teaching experience made the largest unique contribution to instructional curiosity(ΔR^2=.066) and instructional delivery (δr^2=.063) and a substantial contribution to perceived instructional success (ΔR^2=.047). Compared with the 5–10-year reference group, teachers with more than 20 years of experience scored lower on instructional curiosity (B=-0.528, 95% CI [-0.894, -0.161], p=.005), instructional delivery (B=-0.524, 95% CI [-0.856, -0.191], p=.002), and perceived instructional success (B=-0.389, 95% CI [-0.721, -0.056], p=.022). The 16–20-year group also scored lower on perceived instructional success (B=-0.214, 95% CI [-0.416, -0.013], p=.037), although the corresponding instructional curiosity and instructional delivery contrasts were not statistically conclusive.

Age was independently related to instructional delivery at the joint-factor level (q=.022). The ≥ 55-year group had a higher adjusted instructional delivery score than the 25–34-year reference group (B = 0.516, 95% CI [0.206, 0.827], p=.001). This positive residual age contrast coexisted with lower scores in the longest-experience category, illustrating why age and experience should not be treated as interchangeable. The age coefficient describes differences among teachers with comparable experience and other covariates; it does not indicate a developmental age effect.

Qualification showed unadjusted differences, but its joint adjusted associations did not survive false-discovery-rate correction. Gender, school location, and subject area were not independently associated with any outcome after adjustment. These findings argue against interpreting fixed demographic categories as reliable proxies for teachers' self-reported instructional functioning in this sample. Table 5 and Fig. 2 present the results.

Table 5

HC3-robust adjusted joint factor tests and unique variance contributions

Outcome	Factor	Wald χ^2(df)	P	q (BH)	ΔR^2
Instructional Curiosity	Gender	0.25 (1)	0.620	0.620	0.001
Instructional Curiosity	Age	8.46 (4)	0.076	0.145	0.019
Instructional Curiosity	Qualification	7.57 (4)	0.109	0.176	0.026
Instructional Curiosity	Teaching experience	17.92 (4)	0.001	0.009	0.066
Instructional Curiosity	School location	4.59 (2)	0.101	0.176	0.010
Instructional Curiosity	Subject	8.60 (4)	0.072	0.145	0.021
Instructional Curiosity	In-service training	8.60 (1)	0.003	0.018	0.026
Instructional Delivery	Gender	1.72 (1)	0.190	0.266	0.004
Instructional Delivery	Age	14.80 (4)	0.005	0.022	0.035
Instructional Delivery	Qualification	10.79 (4)	0.029	0.068	0.040
Instructional Delivery	Teaching experience	14.20 (4)	0.007	0.023	0.063
Instructional Delivery	School location	3.02 (2)	0.221	0.290	0.008
Instructional Delivery	Subject	4.53 (4)	0.339	0.375	0.010
Instructional Delivery	In-service training	10.63 (1)	0.001	0.009	0.036
Perceived Instructional Success	Gender	0.92 (1)	0.337	0.375	0.002
Perceived Instructional Success	Age	3.69 (4)	0.449	0.472	0.012
Perceived Instructional Success	Qualification	11.30 (4)	0.023	0.061	0.034
Perceived Instructional Success	Teaching experience	13.81 (4)	0.008	0.024	0.047
Perceived Instructional Success	School location	3.83 (2)	0.147	0.221	0.010
Perceived Instructional Success	Subject	4.93 (4)	0.295	0.364	0.010
Perceived Instructional Success	In-service training	14.62 (1)	< .001	0.003	0.056

Note: All models included all seven factors simultaneously and used HC3 heteroskedasticity-robust covariance estimates. ΔR^2 is the reduction in model R^2 when the factor is removed from the full model.

Robustness Checks

Huber M-estimation reproduced the central pattern after standardising each outcome. Reported in-service training remained positively associated with instructional curiosity (B = 0.393, p<.001), instructional delivery (0.450, p<.001), and perceived instructional success (0.514, p<.001). The > 20-year experience contrast relative to 5–10 years remained negative for instructional curiosity (-0.405, p=.006) and instructional delivery (-0.373, p=.007) and remained negative, though less precise, for perceived instructional success (-0.257, p=.070). The 16–20-year contrast remained negative for perceived instructional success (-0.284, p=.017). The agreement between HC3 and Huber estimates reduces concern that the main findings are driven by a small number of extreme teacher self-ratings.

Discussion

The analysis provides a clear answer to the practical question underlying the study. Across three validated teacher-report scales, the most consistent correlates were not gender, location, subject, or academic qualification. They were reported participation in in-service training and teaching experience. This pattern held after simultaneous adjustment, false-discovery-rate control, and robust-regression sensitivity analysis. The result does not establish that professional development caused higher instructional functioning, but it identifies professional learning and career stage as more informative correlates than most fixed demographic categories in this Ghanaian sample.

The training finding is both substantively coherent and policy-relevant. Ghana's professional-development framework treats continuing learning as a recurring professional responsibility rather than a remedial activity reserved for struggling teachers (NTC 2021b). In the present data, teachers reporting in-service training were higher not only in perceived instructional delivery but also in curiosity-in-practice and perceived instructional success. The association was largest for ISST-10, where the unadjusted standardised difference was g = 0.85 and training accounted for the largest drop-one share of adjusted variance. One plausible interpretation is that exposure to professional learning is accompanied by a stronger sense of instructional agency and success, as well as a greater readiness to adapt and explore. This is compatible with recent synthesis evidence showing that well-designed professional development can support instructional practice and student outcomes, especially when it incorporates multiple principles of effective professional learning (Amemasor et al. 2025; Visscher et al. 2025).

However, the training variable in this dataset is deliberately interpreted conservatively. It records only whether teachers reported in-service training; it contains no information about content, duration, quality, recency, provider, coaching, follow-up, or whether participation was self-selected. Lindvall et al. (2025) caution that positive associations between typical professional development and instruction are frequently estimated in studies that do not support causal inference. Ghanaian evidence also shows that the implementation of professional development can be constrained by weak follow-up and uneven access (Salifu et al. 2024). Accordingly, the present result is best understood as a robust observational

signal that justifies stronger longitudinal or quasi-experimental evaluation of specified professional-learning experiences.

The experience pattern is equally important because it was nonlinear. Teachers in the 5–10- and 11–15-year ranges generally reported the strongest scores, whereas later-career groups, particularly those with more than 20 years of experience reported lower scores after adjustment. It would be inappropriate to describe this as evidence that long-serving teachers become less effective. The measures are self-reports, the design is cross-sectional, and experience groups may differ in cohort, role demands, exposure to curriculum reforms, leadership responsibilities, subject allocations, technological change, or opportunities for recent professional learning. The safer interpretation is that career stage matters and that professional support should not stop after induction.

That interpretation is consistent with a broader literature questioning simple equations between experience and quality. Gore et al. (2024), using observed lessons, found no general difference in teaching quality across a wide range of experience and argued for high-impact professional development throughout teachers' careers. Sun and Yin (2025) nevertheless found that teaching experience predicted teacher self-efficacy profile membership, showing that career stage can remain psychologically meaningful even where fixed demographics such as gender and school location are less predictive. The present Ghanaian data add a complementary perspective: experience was strongly associated with how teachers appraised their own instructional curiosity, delivery, and success, but not in a simple linear progression.

The adjusted age result underscores this point. Age was independently associated only with instructional delivery, and the oldest age group had a positive adjusted contrast after experience was held constant. This is not contradictory to the negative > 20-years experience contrast; it reflects the fact that age and experience capture overlapping but non-identical aspects of career history. Some teachers enter teaching later, change roles, or accumulate years differently. Because the data are categorical and cross-sectional, the safest conclusion is that age has limited independent explanatory value once experience and professional learning are taken into account.

Qualification also illustrates why unadjusted demographic differences require caution. Qualification was associated with all three outcomes in robust unadjusted tests, but its joint adjusted effects did not survive multiplicity correction. Small cells for doctorate and 'other' qualifications further limit precision. Academic credentials are important for preparation and professional status, but these results do not support ranking teachers' current self-reported instructional functioning by qualification category. Instructional work depends on what teachers know and do in context, and recent research suggests that the relationship among pedagogical knowledge, self-efficacy, and instructional quality is more complex than any single credential can represent (Leijen et al. 2024).

The absence of consistent adjusted differences by gender, school location, and subject is also informative. In this sample, these characteristics explained little unique variance after other factors were held constant. Sun and Yin (2025) similarly found no significant gender or school-location prediction of

teacher self-efficacy profile membership in their study. The present result should not be generalised to all Ghanaian teachers, especially because the subject category ‘other’ was heterogeneous and the dataset did not permit jurisdiction-level modelling. Even so, the findings caution against deficit assumptions about rural teachers, particular subject groups, or teachers of either gender based solely on demographic membership.

A further interpretive issue is the very high overlap among the three validated scales. Pearson correlations exceeded .82, while rank correlations were around .69–.70. Some of this overlap is theoretically meaningful: teachers who are more open to learner ideas may adapt instruction more effectively, and teachers who perceive stronger delivery may also judge their teaching as successful. Yet common positive wording, one-time administration, and a single teacher source can also create a general positive self-evaluation factor. Jerrim et al. (2025) demonstrate why this matters: teacher-reported instructional quality can show much stronger associations with teacher beliefs than expert-observer ratings do. The current outcomes should therefore be read as three related self-perceived facets of instructional functioning, not as independent observations of classroom quality.

This measurement caution does not make the findings uninformative. Self-reports are particularly relevant when the research question concerns professional orientation, reflection, perceived adaptation, and perceived success. Curiosity in teaching, for example, includes the teacher’s readiness to engage uncertainty and alternatives—features that are partly internal and may not be captured by a single observation (Cavicchi 2024).

Conclusion

Among the studied Ghanaian teachers, reported in-service training and teaching experience were the most consistent demographic and professional correlates of instructional curiosity-in-practice, instructional delivery, and perceived instructional success. Training associations were positive across all three outcomes and remained robust after simultaneous adjustment, multiplicity control, and Huber sensitivity analysis. Experience showed a nonlinear career-stage pattern, with lower self-reported scores in some later-career groups relative to teachers with 5–10 years of experience. Gender, school location, subject, and qualification did not show consistent adjusted associations, while age independently related only to instructional delivery. These findings support sustained, needs-responsive professional learning across the teaching career and caution against using fixed demographic characteristics as proxies for teaching quality. Because the outcomes are overlapping self-reports and the design is cross-sectional, the results should guide further multimethod and longitudinal research rather than high-stakes appraisal.

Implications for Teacher Development and Policy

The findings favour a career-long rather than front-loaded model of teacher development. Because experience differences were evident beyond the early-career period, professional learning should be deliberately available to mid- and late-career teachers, with attention to adaptation, learner

responsiveness, lesson reflection, and changing curricular demands. Ghana's existing CPD architecture provides a policy mechanism for such support.

Second, professional-development monitoring should move beyond attendance. The present binary training variable could not distinguish a brief workshop from sustained coaching or collaborative inquiry. Programme evaluation should document content, duration, follow-up, facilitation, school support, and opportunities for practice and feedback. This would allow Ghanaian research to test which professional-learning designs are associated with meaningful changes rather than merely whether teachers attended something.

Finally, teacher support should be based more on demonstrated professional needs. Needs assessment can combine teachers' instructional curiosity, delivery and perceived with observation and student evidence to identify specific areas for coaching or collaborative professional learning.

Limitations

First, the design is cross-sectional and observational. The in-service-training association cannot be interpreted causally, and the experience pattern cannot be read as within-person career change. Second, all three outcomes are positively keyed teacher self-reports collected in the same survey, creating common-method and self-enhancement risk. Third, although the scales were separately validated, their strong correlations mean discriminant validity remains incomplete. Finally, the demographic models explained approximately one fifth of score variance, leaving most variation attributable to factors not measured in the current study.

Suggestion for Future Research

The later-career pattern deserves constructive investigation rather than deficit labelling. Importantly, long-serving teachers possess substantial contextual and professional knowledge but this was not the case in the current study. Therefore, future research should examine whether lower self-ratings in some later-career groups reflect workload, leadership responsibilities, curriculum transitions, technology demands, reduced access to development, occupational fatigue, cohort differences, or greater self-critical standards. Such evidence would support differentiated professional learning across career stages.

Abbreviations

AVE
average variance extracted
CFA
confirmatory factor analysis
CPD
continuing professional development

CR
composite reliability
EFA
exploratory factor analysis
HC3
heteroskedasticity-consistent covariance estimator type 3
ICTS-10
Instructional Curiosity-in-Practice Scale for Teachers
IDST-10
Instructional Delivery Scale for Teachers
ISST-10
Perceived Instructional Success Scale for Teachers
KMO
Kaiser-Meyer-Olkin measure
NTC
National Teaching Council
VIF
variance inflation factor.

Declarations

Ethics approval and consent to participate

Ethics review body: Department of Counselling Psychology, University of Education, Winneba. Approval number: UEW-CPSY/EDU/2026. Approval date: [2nd February, 2026]. All respondents provided informed consent before taking part in the study. Likewise, the study followed the Declaration of Helsinki is a set of ethical principles for medical research involving human participants (World Medical Association, 2020).

Consent for publication

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Competing interests

The authors declare no competing interest

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Author Contribution

I.M., R.I., S.O.B., P.A., M.A., & B.Y.D. contributed equally from conceptualisation of ideas to the completion of this article.

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Data Availability

The data used for this study is available and can be given upon a reasonable request from the corresponding author.

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Figures

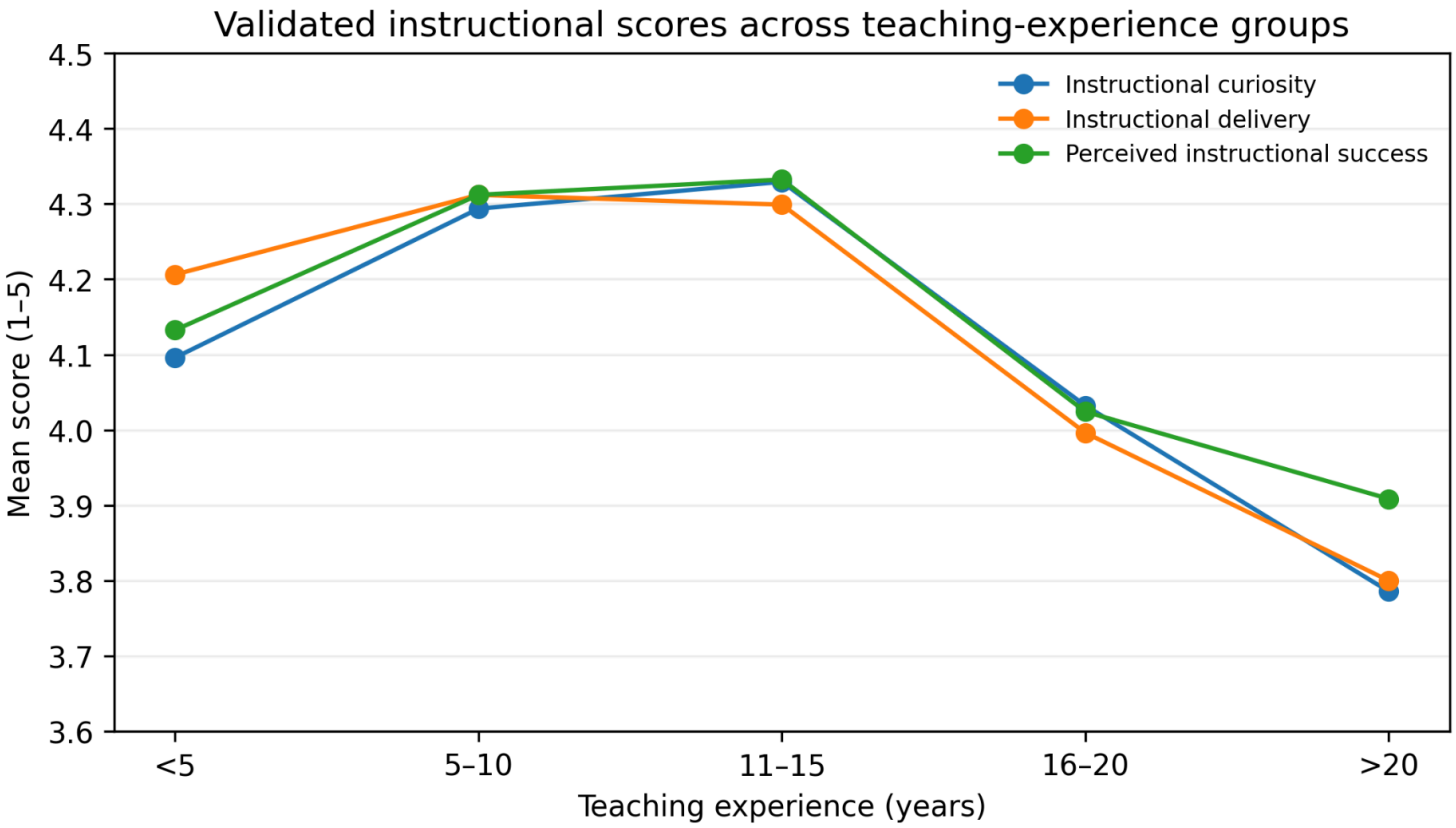

Figure 1

Mean validated scale scores across teaching-experience groups.

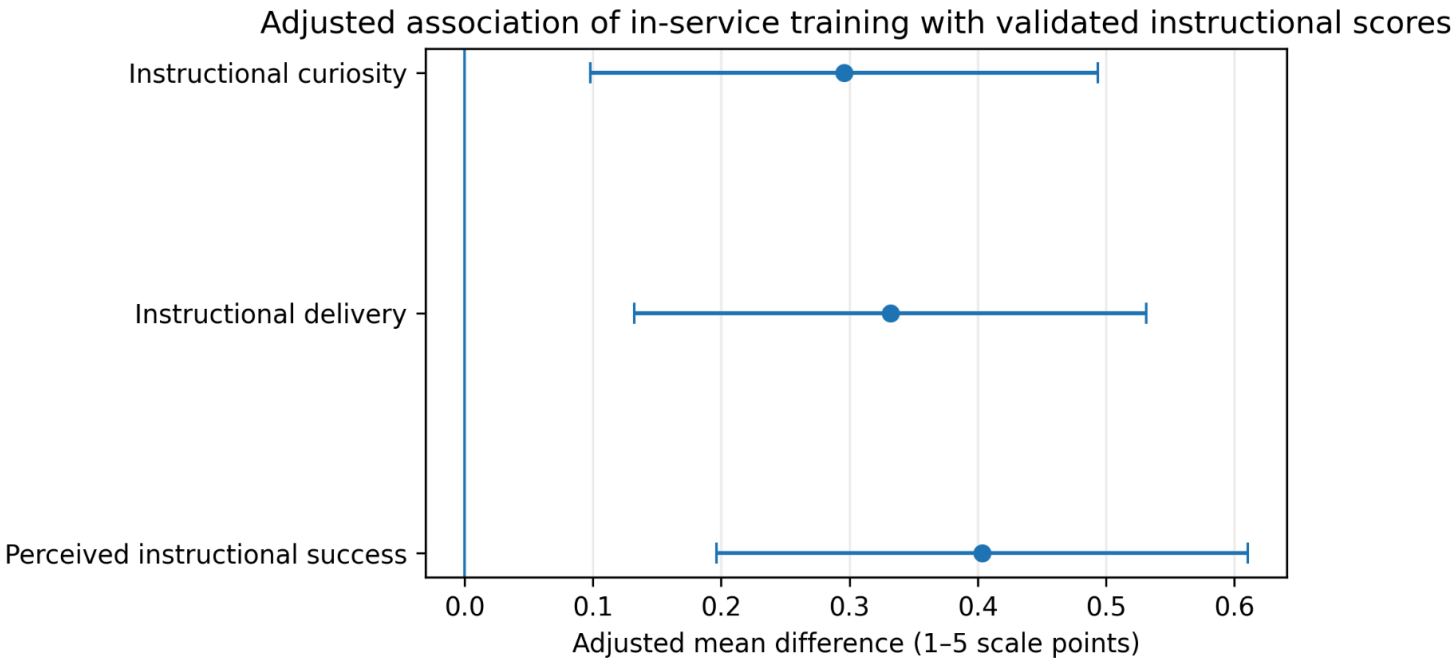

Figure 2

Adjusted mean-score differences associated with reported in-service training. Error bars show HC3 95% confidence intervals.

Supplementary Files

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