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Gender and Professional Qualification as Correlates of Teacher Competence in Mathematical Modelling: Evidence from Edo South Senatorial District, Nigeria

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Abstract

Gender and professional qualification are frequently proposed as correlates of teacher competence in mathematics education, yet their combined effect on competence to teach an unfamiliar, applied curriculum component such as Mathematical Modelling remains under-examined in the Nigerian context. This study investigated whether gender and professional qualification were significantly associated with Further Mathematics teachers' competence in teaching the Mathematical Modelling component of Nigeria's Further Mathematics Curriculum (FMC). A descriptive survey design was adopted, with a multi-stage stratified sample of 40 Further Mathematics teachers (29 males, 11 females) drawn from 26 public and private senior secondary schools in Edo South Senatorial District, Nigeria. Composite teacher competence was measured using the 32-item Mathematical Modeling Evaluation Questionnaire I (MMEQ I; Cronbach's alpha = .717), content-validated by subject and measurement experts. Independent-samples t-tests showed that male teachers scored significantly higher than female teachers, $t(38) = 2.77$, $p = .009$, while professionally qualified teachers scored higher than non-professionally qualified teachers, though not significantly, $t(32) = 1.88$, $p = .069$. Findings are interpreted through Bandura's (1997) self-efficacy theory, suggesting a gendered confidence gap in applied mathematical reasoning rather than a qualification-based gap. The study recommends gender-responsive continuing professional development and cautions against relying on formal qualification alone to predict competence in newly introduced curriculum content.

Keywords: gender, professional qualification, teacher competence, self-efficacy theory, mathematical modelling, further mathematics curriculum, Nigeria

1 Introduction

Mathematics curriculum reform is frequently evaluated by what is written into the syllabus, yet its classroom fate depends heavily on who is available to teach the new content and how well-equipped they are to do so. Nigeria's introduction of a Mathematical Modelling component into the Further Mathematics Curriculum (FMC) in 2011, as part of the New Senior Secondary Education reform, placed an unfamiliar, application-oriented strand of Operations Research into the hands of a Further Mathematics teaching workforce that had received little, if any, dedicated pre-service or in-service preparation for teaching it. Unlike long-established Further Mathematics content such as calculus or algebra, Mathematical Modelling requires teachers to guide students through open-ended, real-world problem construction rather than procedural recall, a pedagogical demand that most Nigerian teacher-training programmes of the period did not explicitly address. This mismatch between curriculum ambition and teacher preparation raises a specific empirical question that this study investigates directly. Two teacher characteristics are routinely cited in the literature as shaping how well new mathematics content is absorbed into practice: gender, given the long-documented and contested relationship between gender and mathematics performance and confidence (Fennema & Sherman, 1977), and professional teaching qualification, given evidence that formal pedagogical training shapes instructional quality more reliably than subject-matter credentials alone (Garet, Porter, Desimone, Birman, & Yoon, 2001). However, prior work in this evaluation programme has established that Further Mathematics teachers as a group reported comparatively low confidence in the Mathematical Modelling component, without yet establishing whether that low confidence was distributed evenly across teachers or concentrated in identifiable subgroups. This gap matters for policy: if the gap is broadly distributed, general professional development would suffice; if it concentrates by gender or qualification pathway, targeted intervention is required instead.

This paper examines both factors empirically, asking whether male and female Further Mathematics teachers, and professionally and non-professionally qualified teachers, differed in their competence to teach the Mathematical Modelling component in the years immediately following its introduction. Specifically, the study addressed two research questions: (1) Is there a significant difference in Mathematical Modelling competence between male and female Further Mathematics teachers? (2) Is there a significant difference in Mathematical Modelling competence between professionally and non-professionally qualified Further Mathematics teachers? The question carries direct relevance for Nigeria's current mathematics curriculum reform agenda under the 2025 NERDC framework (NERDC, 2025): if new content areas systematically disadvantage particular groups of teachers, whether by gender or by qualification pathway, then reform rollout plans that ignore these differences risk reproducing old inequities inside new curricula.

The analysis reported here forms part of a wider evaluation of the Mathematical Modelling component's implementation in Edo South Senatorial District. Where a companion analysis has examined resource-level implementation gaps (materials, textbooks, and examination alignment), this paper turns to the teacher-level question of who was, and was not, prepared to deliver the new content. This teacher-level focus is not incidental to the broader Nigerian mathematics curriculum reform trajectory. Odili (2006) traced how successive Nigerian mathematics curriculum reforms, from the mid-twentieth-century Traditional Mathematics syllabus through to the New Senior Secondary Education Curriculum, have repeatedly introduced ambitious new content areas without a corresponding, systematic evaluation of whether the existing teaching workforce was demographically and professionally equipped to deliver them. The Mathematical Modelling component offers an unusually clean test case for this pattern, because it was introduced simultaneously, as a single new syllabus strand, to an entire cohort of Further Mathematics teachers in 2011, rather than being phased in gradually or targeted at newly trained teachers. Any competence differences that subsequently emerged among this teacher cohort can therefore be attributed with reasonable confidence to characteristics of the teachers themselves, such as gender or qualification pathway, rather than to differential exposure to the reform, making this an informative setting in which to isolate the correlates of competence that curriculum planners most need to understand before Nigeria's next major reform, the 2025 NERDC framework, reaches classrooms.

2 Literature Review/Theoretical Framework

2.1 Theoretical Framework: Bandura's Self-Efficacy Theory

This study is anchored in Bandura's (1997) self-efficacy theory, which holds that an individual's belief in their capability to organise and execute the actions required to perform a task, their self-efficacy, is a stronger predictor of task performance and persistence than objective skill alone. Self-efficacy beliefs are shaped primarily through four sources: mastery experiences (successfully performing the task before), vicarious experiences (observing similar others succeed), verbal persuasion (encouragement from credible others), and physiological or affective states (the anxiety or confidence a task provokes). Applied to teaching, self-efficacy theory predicts that a teacher's confidence in delivering specific content, rather than their general teaching ability, will vary with how much relevant mastery experience, modelling, and encouragement they have received for that specific content. Bandura's framework provides the explicit theoretical grounding for the gender-gap argument advanced in this study. Because Mathematical Modelling was a genuinely new curriculum addition in 2011, no cohort of Nigerian Further Mathematics teachers, male or female, had prior mastery experience teaching it through formal training. Self-efficacy theory predicts that, under these conditions of shared unfamiliarity, any confidence gap that nonetheless emerges between groups is more likely attributable to pre-existing differences in mathematics-specific self-efficacy, of the kind long documented along gender lines in the broader mathematics education literature, than to differential access to modelling-specific training, since neither group had meaningfully greater access to such training than the other. This theoretical positioning also generates a testable prediction that structures the remainder of this study: if the gender gap in competence is genuinely a self-efficacy phenomenon rather than a training-access phenomenon, it should be detectable even in a sample where, as here, formal access to Mathematical Modelling training was effectively uniform across gender at the point of curriculum introduction.

2.2 Gender and Mathematics Teaching

The relationship between gender and mathematics achievement and instruction has been studied since Fennema and Sherman's (1977) foundational work identified attitudinal, rather than purely cognitive differences as the primary driver of sex-related gaps in mathematics performance. Subsequent research applying self-efficacy theory specifically to STEM teachers has continued to find gendered patterns: Sellami, Santhosh, Michaleczek, Alazaizeh, and Madad (2024), using Bandura's self-efficacy theory as their explicit framework, found significant differences in instructional self-efficacy for science, mathematics, and technology among 322 Qatari middle and high school teachers, varying by gender, school type, and academic qualification, closely mirroring the pattern investigated in the present study. Similarly, Njiku, Mutarutinya, and Maniraho (2022), studying 125 mathematics teachers in Tanzania, found that gender was a significant influence on teachers' self-efficacy for integrating new, less familiar instructional demands into their teaching, a pattern directly analogous to the introduction of an unfamiliar content strand such as Mathematical Modelling. Hendricks, Olawale, and Saddiq (2024), examining preservice high school teachers' self-efficacy for teaching mathematics through a Bandura-grounded lens, likewise found that self-efficacy beliefs, not raw content knowledge, were the more direct predictor of teachers' anticipated performance.

Closer to the present study's context, Ilori (2021) found significant gender imbalance in the mathematics teaching profession in Esan West Local Government Area of Edo State; however, that study's evidence base was drawn from primary school teachers and learning outcomes, a substantially different instructional and developmental context from the senior-secondary Further Mathematics teachers examined here, and its findings are therefore cited as broadly corroborating evidence of gendered patterns in Nigerian mathematics teaching rather than as direct evidence at the senior-secondary level. Zinyahs (2024) documented gender bias in how mathematics teachers in North Central Nigeria interact with students in the classroom, with consequences for pupils' confidence and performance. These findings suggest that gender dynamics in Nigerian mathematics education operate at both the student-achievement level and the teacher-practice level, making teacher-level gender analysis, as undertaken here, a necessary complement to the more commonly studied student-level gender gap. Where the modelling literature is concerned, gender has received comparatively little direct attention, despite modelling's dependence on the same confidence and self-efficacy factors that Fennema and Sherman (1977) identified as central to earlier gender gaps in mathematics performance. If female teachers report lower confidence in applied, open-ended mathematical tasks, a plausible extension of the broader gender-and-mathematics literature, this could translate into lower self-rated competence in exactly the kind of content that Mathematical Modelling represents.

2.3 Professional Qualification and Teaching Competence

A separate strand of literature distinguishes the effect of subject-matter credentials from that of formal pedagogical training. Garet et al. (2001) found that sustained, content-focused professional development, the kind typically embedded in formal teacher-education programmes, was a stronger predictor of effective teaching practice than credentials alone. Tschannen-Moran and Woolfolk Hoy (2001), in their influential review of the teacher-efficacy construct, similarly argued that efficacy beliefs are shaped less by the credential a teacher holds than by the specific mastery experiences their training provided; a teacher with a general education credential but no modelling-specific mastery experience would, on this account, be expected to show efficacy gains no greater than a subject-matter graduate with equally limited exposure. In the Nigerian context, the Teachers Registration Council of Nigeria (TRCN) has for some years pursued a professionalisation agenda requiring recognised pedagogical qualifications (such as the Postgraduate Diploma in Education or Bachelor of Education) for teacher licensure, reflecting a policy assumption that professional training, independent of subject-matter degrees, meaningfully improves classroom competence. Where a curriculum reform introduces genuinely new content, such as Mathematical Modelling, the value of prior pedagogical training in helping teachers adapt is an empirical question this study is positioned to test. Taken together, this literature review identifies a clear gap that the present study addresses: while self-efficacy theory has been applied to gender differences among STEM and mathematics teachers in Qatar, Tanzania, and elsewhere (Sellami et al., 2024; Njiku et al., 2022; Hendricks et al., 2024), and while gendered patterns have been documented among Nigerian mathematics teachers at the primary level (Ilori, 2021) and in classroom interaction patterns (Zinyahs, 2024), no prior study has applied self-efficacy theory to test gender and professional-qualification differences in Nigerian senior-secondary teachers' competence to teach a newly introduced, applied mathematics curriculum component. This study fills that gap.

2.4 Mathematical Modelling Pedagogy and Teacher Competence

A further body of literature relevant to this study concerns the specific pedagogical demands of mathematical modelling as a content and instructional approach, independent of the gender and qualification questions addressed above. Blum and Niss (1991) characterised mathematical modelling as the process of translating real-world phenomena into mathematical structures for analysis, prediction, and decision-making, a process that requires teachers to guide open-ended, multi-step reasoning rather than to demonstrate a single, pre-specified procedure. Lesh and Doerr (2003) extended this characterisation into an explicit modelling cycle, describing teaching for modelling competence as requiring teachers to support students through iterative description, formulation, manipulation, and verification of their own models, a cycle with no single correct path and, consequently, no single teaching script a teacher can simply transmit. This pedagogical characterisation has direct implications for the self-efficacy argument developed in this study. Because mastery experience, the strongest source of self-efficacy in Bandura's (1997) framework, accrues through successfully performing a task oneself, and because Lesh and Doerr's (2003) modelling cycle is inherently more open-ended and less scriptable than procedural mathematics teaching, Further Mathematics teachers of either gender would be expected to accumulate mastery experience for Mathematical Modelling more slowly than for procedural content, even under otherwise similar teaching conditions. Where a pre-existing gender gap in mathematics-specific confidence already exists, as the broader literature reviewed above suggests, this slower, more effortful path to mastery experience in modelling specifically may amplify rather than neutralise that pre-existing gap, offering a plausible mechanism for why the gender difference observed in this study emerged in a component defined by open-ended, applied reasoning rather than in more procedural areas of the Further Mathematics syllabus.

2.5 Statement of the Problem

If gender or professional qualification systematically predicts how competently Further Mathematics teachers can teach the Mathematical Modelling component, then curriculum reform rollout that does not account for these differences risks leaving specific groups of teachers, and by extension their students, underserved. No prior study had empirically tested whether such differences existed among Further Mathematics teachers delivering the Mathematical Modelling component introduced in 2011. This study addressed that gap by testing, in Edo South Senatorial District, whether teacher competence in Mathematical Modelling differed significantly by gender and by professional teaching qualification.

3 Materials and Methods

3.1 Research Design

The study adopted a descriptive survey design, using a structured, validated questionnaire to compare teacher competence scores across two demographic groupings: gender and professional teaching qualification. Survey design was appropriate because the research questions concerned existing differences within a defined teacher population, rather than the effect of an experimental intervention.

3.2 Population, Sample, and Sampling Technique

The population comprised all Further Mathematics teachers in public and private senior secondary schools across the seven Local Government Areas (LGAs) of Edo South Senatorial District: Egor, Ikpoba-Okha, Oredo, Orhionmwon, Ovia North-East, Ovia South-West, and Uhunmwode. Of 409 public and private schools in the district, only 29 offered Further Mathematics; three were used for the pilot study, leaving 26 schools (21 private, 5 public) in the main sample. Using multi-stage stratified sampling, first by school type and then by whether a school offered Further Mathematics, the study drew a total of 40 Further Mathematics teachers from the 26 sampled schools. Of these, 29 were males and 11 were females. For the qualification comparison, 34 teachers for whom qualification data were fully recorded were classified as either professionally qualified (holding a B.Sc.(Ed) or M.Ed, n = 11) or non-professionally qualified (holding a B.Sc. or M.Sc. without a formal education credential, n = 23).

Table **1**

Sample Distribution of Teachers by Gender and Professional Qualification

Grouping	Category	N	% of Sample
Gender (N = 40)	Males	29	72.5%
	Females	11	27.5%
Qualification (N = 34)	Professional (B.Sc.(Ed)/M.Ed)	11	32.4%
	Non-professional (B.Sc./M.Sc.)	23	67.6%

Note. Qualification data were fully recorded for 34 of the 40 sampled teachers.

3.3 Research Instrument

The Mathematical Modeling Evaluation Questionnaire I (MMEQ I), a 32-item Likert-type instrument, elicited teachers' self-rated professional competence across four content strands of the Mathematical Modelling component: History, Nature and Models of Operations Research (11 items); Inventory and Replacement Models (11 items); Games Theory (7 items); and Constructing Models for Real-Life Problems (3 items). Each item used a four-point response format (Strongly Agree = 4 to Strongly Disagree = 1), yielding a possible composite competence score range of 32 to 128 per teacher. This composite score served as the dependent variable for both the gender and qualification comparisons reported below. Demographic items on the same instrument recorded each respondent's sex and educational qualification.

3.4 Validity and Reliability

MMEQ I was content-validated initially by the researcher's supervisors and a measurement and evaluation specialist, who removed items judged unsuitable and refined item wording, with a second, independent subject-matter reviewer subsequently confirming the appropriateness of item content and difficulty level for Further Mathematics teachers. Reliability was established through pilot testing with Further Mathematics teachers in three non-sampled schools, using Cronbach's alpha. The instrument yielded an overall reliability coefficient of 0.717, with subscale coefficients ranging from 0.703 (Games Theory) to 0.903 (History, Nature and Models), indicating acceptable internal consistency (Omorogiuwa, 2006).

3.5 Data Collection Procedure

The questionnaire was administered in person by the researcher and trained research assistants to sampled teachers in their respective schools, following prior written permission from school authorities. Participation was voluntary, and teachers were informed of the study's academic purpose, the confidentiality of their individual responses, and their right to withdraw at any point without consequence before providing verbal informed consent. No identifying information beyond school type, gender, and qualification category was collected, and completed questionnaires were coded numerically to protect respondent anonymity during analysis.

3.6 Method of Data Analysis

The independent-samples t-test was used to test for differences in mean composite competence score between male and female teachers, and separately between professionally and non-professionally qualified teachers, at the 0.05 level of significance.

4 Results

4.1 Gender and Teacher Competence

Table 2 reports the independent-samples t-test comparing male and female Further Mathematics teachers' composite competence scores on the Mathematical Modelling component.

Table **2**

Independent-Samples t-Test of Teacher Competence in Mathematical Modelling, by Gender

Gender	n	Mean	SD	df	t	Sig. (2-tailed)
Male	29	94.55	24.36	38	2.773	.009
Female	11	73.81	5.65			

The mean composite competence score of male teachers ($M = 94.55$, $SD = 24.36$) was significantly higher than that of female teachers ($M = 73.81$, $SD = 5.65$), $t(38) = 2.773$, $p = .009$. Testing at the .05 level of significance, the null hypothesis of no significant difference in competence by gender was rejected: male Further Mathematics teachers in the sample rated themselves, and were positioned by this composite measure, as significantly more competent in teaching the Mathematical Modelling component than their female colleagues. The markedly smaller standard deviation among female teachers (5.65

versus 24.36 for males) also indicates that female teachers' self-ratings were more tightly clustered at the lower end of the scale, suggesting a more uniformly held perception of limited competence rather than a few low outlying scores.

4.2 Professional Qualification and Teacher Competence

Table 3 reports the independent-samples t-test comparing professionally and non-professionally qualified teachers' composite competence scores.

Table **3**

Independent-Samples t-Test of Teacher Competence in Mathematical Modelling, by Professional Qualification

Qualification	n	Mean	SD	df	t	p-value
Professional (B.Sc.(Ed)/M.Ed)	11	98.72	26.29	32	1.882	.069
Non-professional (B.Sc./M.Sc.)	23	83.21	20.51			

Professionally qualified teachers recorded a higher mean composite competence score (M = 98.72, SD = 26.29) than non-professionally qualified teachers (M = 83.21, SD = 20.51). However, this difference did not reach statistical significance at the .05 level, $t(32) = 1.882$, $p = .069$, and the null hypothesis of no significant difference in competence by qualification was retained. The direction of the difference is consistent with the view that formal pedagogical training confers an advantage in teaching unfamiliar content, but on this sample the advantage was not large enough, or the sample not large enough, to rule out chance as an explanation.

5 Discussion

The significant gender difference in self-rated competence, favouring male teachers, extends a well-documented pattern in the gender-and-mathematics literature from student achievement into teacher competence. Interpreted through Bandura's (1997) self-efficacy theory, because Mathematical Modelling was equally unfamiliar to male and female teachers alike at the point of its 2011 introduction, with neither group possessing prior mastery experience specific to this content, the gender gap observed here is unlikely to reflect differential training access and more plausibly reflects a pre-existing gendered difference in mathematics-specific self-efficacy that the introduction of unfamiliar content exposed rather than created. This interpretation is consistent with Fennema and Sherman's (1977) foundational finding that attitudinal and confidence factors, rather than cognitive ability, drove much of the historical sex-related gap in mathematics achievement, and it extends more directly to teachers through the STEM-teacher self-efficacy findings of Sellami et al. (2024) in Qatar and Njiku et al. (2022) in Tanzania, both of which found gendered self-efficacy differences using Bandura's framework in contexts structurally similar to the present study: teachers facing content or technology demands for which prior training had not adequately prepared either gender group.

This interpretation is consistent with Ilori's (2021) finding of gender imbalance in the mathematics teaching profession in Edo State, although, as noted in the literature review, that study's primary-school evidence base means it corroborates rather than directly confirms the senior-secondary pattern documented here, and with Zinyahs's (2024) documentation of gender-differentiated classroom practice among Nigerian mathematics teachers. The finding carries a specific implication for curriculum reform. Because Mathematical Modelling was a genuinely new addition to the Further Mathematics Curriculum, no cohort of Nigerian teachers, male or female, entered the profession having been trained to teach it. The gender gap observed here therefore cannot easily be attributed to differential access to modelling-specific training; it more plausibly reflects a general confidence and self-efficacy gap in applied mathematical reasoning that pre-dates the reform, which the reform then exposed rather than created. If curriculum reforms continue to introduce open-ended, applied content without deliberately designed support for teachers who report lower confidence in such content, reform rollout risks widening, rather than narrowing, this gap.

The non-significant qualification difference is a more encouraging finding for teacher-training policy. While professionally qualified teachers scored higher on average, the gap was not statistically reliable, offering no strong evidence that non-professionally qualified Further Mathematics teachers, most of whom hold a B.Sc. or M.Sc. without a formal education credential, are systematically less able to teach Mathematical Modelling once in the classroom. This nuances Garet et al.'s (2001) broader finding that formal pedagogical training predicts teaching quality, and is consistent with Tschannen-Moran and Woolfolk Hoy's (2001) argument that efficacy is shaped by task-specific mastery experience rather than credential type alone: it may hold more strongly for sustained, content-specific professional development than for a general professional qualification credential in isolation. For Mathematical Modelling specifically, targeted in-service training may matter more than the type of initial teaching qualification a teacher holds.

These findings carry both theoretical and practical significance. Theoretically, the results extend Bandura's (1997) self-efficacy theory into a curriculum-reform setting rarely examined in the existing self-efficacy literature: a context in which an entirely new content area is introduced simultaneously to an entire teaching workforce, eliminating pre-existing differences in training access as an explanation for any observed gap and thereby isolating pre-existing self-efficacy differences as the more probable driver. This design feature, largely a by-product of how the 2011 reform was implemented rather than a deliberate methodological choice, gives the finding an unusual degree of interpretive clarity relative to studies conducted in settings where training access itself varies by gender. Practically, the finding that competence tracked gender but not qualification suggests that Nigerian teacher-training and continuing-education policy should not assume that formal credentialing alone will close competence gaps in newly introduced content; targeted, mastery-experience-building professional development, of the kind Lesh and Doerr's (2003) modelling cycle suggests is necessary for this specific content, is likely to be a more direct lever than credential requirements.

6 Limitations

Several limitations should be considered when interpreting these findings. First, the female sub-sample was small ($n = 11$), which limits statistical power for the gender comparison and warrants caution in generalising the magnitude, though not necessarily the direction, of the observed gap; a larger, more balanced sample would allow more precise estimation. Second, the study was confined to a single senatorial district (Edo South), and while the sampling technique was rigorous within that district, the findings may not generalise to Further Mathematics teachers in other parts of Nigeria with different teacher-training infrastructures or gender compositions. Third, teacher competence was measured through self-report rather than through direct classroom observation or performance assessment; self-rated competence is a reasonable proxy for self-efficacy under Bandura's (1997) framework, but it remains a distinct construct from demonstrated instructional skill, and future research would benefit from triangulating self-rated competence with classroom-based measures. Fourth, while the instrument's content validation involved subject and measurement experts, it relied on a comparatively small validation panel rather than a larger, more diverse expert review process, which may limit the extent to which item wording was tested against a broader range of professional judgement. These limitations do not undermine the core finding of a statistically significant gender difference, but they do suggest that the finding should be treated as an initial, geographically bounded diagnostic rather than a definitive, generalisable estimate of the gender gap in Mathematical Modelling competence nationally.

7 Conclusion

This study found a statistically significant gender gap favouring male teachers in self-rated competence to teach the Mathematical Modelling component of the Further Mathematics Curriculum, but no statistically significant gap by professional teaching qualification. Read together, these findings suggest that the confidence and competence gaps most likely to undermine mathematics curriculum reform in Nigeria may run along gender lines more reliably than along formal qualification lines. As Nigeria implements its 2025 NERDC curriculum reform, deliberate attention to gender-responsive teacher support, grounded in self-efficacy-building strategies such as structured mastery experiences and mentoring, rather than reliance on qualification credentials alone, is likely to matter more for closing this specific gap than credentialing policy by itself.

Building on these findings, three concrete directions are recommended for curriculum planners, teacher-training institutions, and professional bodies such as the Mathematical Association of Nigeria (MAN). First, continuing professional development for newly introduced, applied mathematics content should be explicitly designed around Bandura's (1997) mastery-experience principle, providing female teachers in particular with structured, low-stakes opportunities to practise modelling instruction with feedback, rather than relying on one-off orientation sessions. Second, because qualification type was not a reliable predictor of competence, teacher-deployment decisions for newly introduced content should not assume that professionally qualified teachers are automatically better prepared; content-specific training needs should be assessed directly rather than inferred from credentials. Third, future curriculum reforms, including the 2025 NERDC rollout, should build gender-disaggregated competence monitoring into their implementation design from the outset, so that gaps of the kind identified in this study can be detected and addressed within the first reform cycle rather than discovered retrospectively, as occurred here more than a decade after the Mathematical Modelling component's introduction.

8 Declarations

Ethical statements: This study involved anonymous survey participation by adult Further Mathematics teachers. All participating teachers provided verbal informed consent after being briefed on the study's academic purpose, the voluntary nature of participation, and the confidentiality of their responses; no identifying personal information was collected. Institutional research clearance was obtained prior to data collection in accordance with the researcher's affiliated institution's standard procedures for educational survey research.

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