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Influence of In-Service Teacher Training on the Implementation of the Integrated Science Curriculum in Public Junior Secondary Schools in Western Region, Kenya

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Abstract- ***The transition from the 8-4-4 system to Competency-Based Education has made teacher preparedness a decisive condition for curriculum reform in Kenya. This paper examines the influence of in-service teacher training on the implementation of the Integrated Science curriculum in public junior secondary schools in the Western Region of Kenya. Anchored on the social constructivist theory of Lev Vygotsky, the study adopted a descriptive survey design within a mixed methods approach. From a universe of 113,237, a sample of 1,087 respondents was drawn using stratified, simple random, systematic and purposive techniques, and 844 (77.6%) responded. Data were collected through questionnaires for students, teachers, heads of department and head teachers, and through interviews with one Regional and four County Quality Assurance and Standards Officers, and were analysed using descriptive statistics and the Chi-square goodness-of-fit test at the 0.05 level of significance. In-service training returned the highest preparedness mean among the four dimensions examined (M = 2.11, SD = 0.77). Five of the six training items departed significantly from an even spread of responses, the strongest being the learners' perception that training had varied teaching methods ($\chi^2 = 245.951$, $p < .001$), while the single exception was the effect of training on lesson planning ($\chi^2 = 2.218$, $p = .330$). The null hypothesis was therefore rejected, and in-service training was found to have a statistically significant influence on implementation. The qualitative evidence attributed the shallow effect on planning to the one-off delivery of training and the dilution of content through the cascade model. The paper concludes that in-service training shaped visible teaching technique more than the planning that should precede it, and recommends a shift from one-off cascade workshops to sustained, school-embedded and planning-centred professional development.***

Keywords: In-Service Teacher Training, Curriculum Implementation, Integrated Science, Teacher Preparedness

I. INTRODUCTION

Kenya's shift from the 8-4-4 system to a Competency-Based Curriculum is among the most far-reaching reforms in the country's education sector. At the junior secondary level it introduced Integrated Science, a subject that fuses biology, chemistry and physics and is intended to be taught through inquiry, practical work and the application of knowledge to real problems [1]. Integrated Science is taught across the three grades of Junior Secondary School, namely Grades 7, 8 and 9, and Grade 9 is the terminal grade of that cycle, at which the learning of the subject across the whole of Junior Secondary School is brought to account and placement into the Science, Technology, Engineering and Mathematics pathways at senior secondary level is determined [1]. Instructional deficits anywhere in the cycle therefore accumulate to that exit point and carry consequences well beyond the junior years. Curriculum change of this scale succeeds at the classroom level less through the merits of its design than through the readiness of the teachers who carry it.

Among the components of preparedness, in-service teacher training occupies a central place, since it is the principal means by which serving teachers are equipped to teach new content through new methods. The value of such training lies not in attendance but in the change it produces in practice, and international evidence holds that development

changes practice only where it is content-focused, collaborative, coached and sustained rather than delivered as a single event [2]. In Kenya, however, the evidence points to a persistent shortfall: many teachers report little or no structured training on the new curriculum [3], the manner of teacher preparation has been shown to shape the fidelity of implementation [4], and only a minority of teachers feel adequately prepared for the reform [5, 6]. This paper reports the first objective of a larger study on teacher preparedness, namely to examine the influence of in-service teacher training on the implementation of the Integrated Science curriculum in public junior secondary schools in the Western Region of Kenya. The corresponding null hypothesis held that in-service teacher training has no statistically significant influence on the implementation of the Integrated Science curriculum.

II. STATEMENT OF THE PROBLEM

The successful realisation of Competency-Based Education rests on teachers' pedagogical alignment, subject-matter mastery and psychological readiness [7], and the government has invested heavily since 2017 in teacher sensitisation, instructional materials and national in-service retooling to prepare the workforce for the transition [8, 9]. Despite this investment, a rift persists between policy intent and classroom reality. A significant majority of Kenyan teachers report inadequate structured training on the new curriculum, which leaves them under-prepared for effective implementation [3], and without continuous training teachers routinely default to passive, rote methods rather than the inquiry the curriculum demands [4]. Within the study area, schools in the Western Region face acute shortfalls in the training and the information and communication technology readiness the curriculum assumes [11], and comparable strains have been documented in neighbouring East African systems undergoing similar competency-based transitions [10].

These conditions carry serious consequences. Where in-service training is thin, the Integrated Science curriculum is reduced to theoretical delivery, the practical and inquiry competencies it is designed to build are not developed, and the validity of the competency-based assessments that depend on them is undermined. Most critically, because Grade 9 is the terminal grade of Junior Secondary School and its results govern placement into the senior secondary STEM pathways, weak preparedness across the Junior Secondary School cycle accumulates to that exit point and risks misplacing learners on the basis of a curriculum that was never fully implemented [1]. The cost of inaction therefore falls on the learner, on the credibility of the national assessment system and on the state's investment in the reform. Yet the level of in-service preparedness specifically among Integrated Science teachers in the Western Region has not been established, since existing studies address other levels, other subjects or earlier stages of the reform. It is this gap that the present study addresses.

III. THEORETICAL FRAMEWORK

The study is anchored on the social constructivist theory developed by Lev Vygotsky, which holds that higher mental functions originate in social processes and that knowledge is co-constructed through shared activity, dialogue and cultural guidance before being internalised by the learner [12]. A central axiom is the zone of proximal development, the distance between what a learner can do alone and what the learner can achieve under the guidance of a more knowledgeable other, within which effective teaching occurs through scaffolding, the graduated support that a teacher supplies and then progressively withdraws as competence grows [13]. Thought is mediated by cultural, physical and symbolic tools, so that instructional resources are not peripheral aids but the very means through which learners manipulate and conceptualise scientific ideas [12].

The framework is well suited to a learner-centred, inquiry-based subject such as Integrated Science in Junior Secondary School, because it casts the teacher as the mediator on whom the enacted curriculum depends. On this view, in-service training is consequential precisely because the pedagogy the curriculum assumes cannot be delivered without a suitably prepared mediator; professional development must itself be collaborative and reflective rather than a one-directional transmission of content [14], and

where it prepares teachers to read and use learners' socio-cultural contexts it deepens their understanding of science [14]. Gaps in training therefore translate directly into gaps in the social scaffolding that learners receive, which makes the influence of training on implementation a question the theory predicts and the present study tests [15].

IV. LITERATURE REVIEW

In-service training and continuing professional development are the principal vehicles through which serving teachers are equipped to implement curriculum change, and the international evidence is consistent that their effect depends on quality and continuity rather than mere occurrence. Reviewing the evidence, Darling-Hammond, Hyler and Gardner [2] found that effective development is content-focused, engages teachers in active learning, supports collaboration, models good practice, provides coaching, and is sustained over time. Studies of reform bear this out: in the Finnish reform teachers needed time and collective sense-making, and training had to be continuing rather than front-loaded [16]; in the Philippines, readiness for a new curriculum depended heavily on the training received [17]; and in Indonesia, readiness for the Kurikulum Merdeka was constrained where training had been brief or rushed [18].

African studies report the same pattern under sharper constraints. In Ghana, teachers' readiness and self-efficacy for the standards-based curriculum were shaped by the training they had received [19], yet systemic weaknesses such as the failure to follow up on in-service programmes left training short of its intended effect [20]. In Nigeria, inadequate and infrequent training left science teachers ill-equipped for the curriculum [21], and in South Africa training and the self-efficacy it builds were central to the quality of science teaching [22]. Across East Africa the concern recurs in the competency-based reforms: teachers in Tanzania were inadequately prepared, with limited training a central weakness [10]; in Uganda insufficient training and limited engagement in workshops constrained implementation [23, 24]; in Rwanda many science teachers had limited knowledge of the curriculum and its methods [25]; and a regional review concluded that teachers across East Africa were asked to implement a demanding reform with inadequate preparation [26].

Within Kenya the evidence points firmly to a shortfall. A large share of teachers reported having received no training on the new curriculum, with a significant relationship between the extent of training and the ability to implement it [3]; only a minority felt adequately prepared [5]; and national figures indicate that only about two in ten teachers held the qualifications the curriculum required [27]. The manner of teacher preparation was shown to shape the fidelity of implementation [4], and a comprehensive programme of pre-service and in-service training was identified as necessary to build learner-centred competence [6]. On the supply side, the Ministry provided digital content and teaching guides from 2020 to support delivery [28]. Within the study area, teachers in Bungoma were found inadequately prepared in the information and communication technology skills the curriculum assumes [11], and public secondary schools in Western Kenya showed similar shortfalls in readiness [29]. What this body of work has not established is the level of in-service preparedness specifically among Integrated Science teachers in the Western Region, which the present study addresses.

V. RESEARCH METHODOLOGY

The study adopted a descriptive survey design within a mixed methods approach, which suits the establishing of the level of a condition such as teacher preparedness across a large, dispersed population [30]. It was conducted in the Western Region of Kenya and targeted the stakeholders in the delivery of the Integrated Science curriculum in public junior secondary schools, namely learners, teachers of Integrated Science, heads of the science department and head teachers, together with the Regional and County Quality Assurance and Standards Officers. The learner respondents were drawn from across the three grades of Junior Secondary School, so that the study captured the delivery of Integrated Science over the whole cycle and not at its terminal grade alone. The universe consisted of 113,237 respondents.

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A sample of 1,087 respondents was drawn using stratified, simple random, systematic and purposive sampling: 271 head teachers, 271 teachers of Integrated Science and heads of department, 540 students, one Regional and four County Quality Assurance and Standards Officers. The student sample was justified using Cochran's formula for an unrestricted population, which returned a baseline of about 385 after finite population correction [31], a threshold consistent with the tables of Krejcie and Morgan [32]; the sample of 540 exceeded this baseline and reduced the effective margin of error to about 4.21%. Data were collected through open- and close-ended questionnaires, interview schedules for the Quality Assurance and Standards Officers, an observation checklist and document analysis. Validity was established through expert review, and reliability was confirmed at the pilot stage through the split-half technique, with the Spearman-Brown coefficient exceeding 0.80. Quantitative data were analysed in the Statistical Package for the Social Sciences using descriptive statistics and the Chi-square goodness-of-fit test at the 0.05 level of significance [33], while qualitative data from the open-ended items and the officer interviews were analysed thematically and synthesised with the quantitative findings. Ethical clearance and a research permit were obtained, participation was voluntary, and the confidentiality of respondents was maintained throughout.

VI. FINDINGS

The study achieved an overall response rate of 844 (77.6%), comprising 220 (81.2%) head teachers, 209 (77.1%) heads of department and teachers, 410 (75.9%) students, and a full return from the Regional and County Quality Assurance and Standards Officers, a rate that exceeded the thresholds commonly recommended for survey generalisation [34]. The learner respondents spanned the three grades of Junior Secondary School, comprising 264 (64.4%) in Grade 9, 91 (22.2%) in Grade 8 and 55 (13.4%) in Grade 7, with the concentration in the terminal grade reflecting the point at which the cumulative delivery of Integrated Science across the cycle is brought to account. On the descriptive measure of preparedness, in which item responses were pooled onto a common three-point scale, in-service teacher training returned the highest mean of the four preparedness dimensions at 2.11 (SD = 0.77), the only dimension to reach the moderate band with confidence, which indicates that the machinery for retooling teachers was reaching most of the workforce.

Six items on the influence of in-service training were then tested using the Chi-square goodness-of-fit test at the 0.05 level of significance, with the null hypothesis rejected where the computed value exceeded the critical value of 9.488 at four degrees of freedom or 5.991 at two degrees of freedom. The results are presented in Table 1.

Table 1 Chi-Square Goodness-of-Fit Results for In-Service Teacher Training

Item	N	Chi-square	df	p-value	Decision
Variation in teaching methods (L)	410	245.951	4	<.001	Significant
Clarification of concepts (L)	410	101.878	4	<.001	Significant
Linkage to real life (L)	410	40.902	4	<.001	Significant
Plan lessons effectively (HT)	220	2.218	2	.330	Not significant
Conduct practical lessons (HT)	220	10.536	2	.005	Significant
Utilise new teaching methods (HT)	220	17.736	2	<.001	Significant

Note. L = learners, HT = head teachers. Critical value 9.488 at df = 4 and 5.991 at df = 2. A result is significant where the computed value exceeds the critical value at $p < 0.05$. Source: Field data (2026).

Table 1 shows that five of the six in-service training items returned chi-square values far above their critical values, with p-values below 0.05, while one did not. Among the learners, the perception that training had varied teaching methods produced the strongest result ($\chi^2 = 245.951$), as 210 (51.2%) agreed that lessons were taught in varied ways while only 91 (22.2%) disagreed. The views that training helped

teachers clarify concepts (χ^2 = 101.878) and link science to real life (χ^2 = 40.902) were also significantly patterned. Among the head teachers, training was judged to have significantly improved the conduct of practical lessons (χ^2 = 10.536) and the use of new teaching methods (χ^2 = 17.736). The single exception was the effect of training on lesson planning, where the chi-square of 2.218 (p = .330) fell below the critical value, because the head teachers were split almost evenly between greatly improved, improved and not improved. Since five of the six items departed significantly from an even spread, the null hypothesis was rejected, and the study found that in-service teacher training has a statistically significant influence on the implementation of the Integrated Science curriculum in Junior Secondary School. The pattern indicates, however, that training left a clear mark on visible classroom technique while its effect on the underlying skill of lesson planning was weak, a reading consistent with the evidence that Kenyan teachers depend on in-service training to build competence [6] but that thin training breeds superficial compliance rather than deep change [35], and with the finding that only sustained, content-focused development reliably reaches practice [2].

The qualitative evidence, drawn from the interviews with the Quality Assurance and Standards Officers and from the open-ended responses, explained this pattern through two themes. First, training was delivered mainly as a single, short event rather than as a continuous process, leaving teachers too little time to absorb and rehearse the new methods; second, it relied on a cascade model in which a few centrally trained teachers were expected to train their colleagues, so that the content thinned at each stage and reached the ordinary classroom teacher in a weakened form. A one-off, technique-focused session can show a teacher how to run a demonstration but cannot build the slower habit of planning an inquiry-based lesson, and the cascade erodes even the technique it sets out to pass on. This is consistent with the view that professional development raises practice only where it is continuous and embedded in daily teaching [36], with the finding that cascade training in Kenyan reform loses fidelity at each tier [37], and with the more hopeful evidence that where training is paired with follow-up support and usable guides teachers sustain the new methods [28]. The influence of training on implementation was therefore real but shallow, and likely to remain so for as long as training is treated as a single event rather than a sustained, planning-centred process.

VII. CONCLUSIONS

The study concludes that in-service teacher training has a statistically significant influence on the implementation of the Integrated Science curriculum, and that it was the strongest of the four dimensions of teacher preparedness examined. The influence was, however, uneven. Training reached most teachers and improved the visible aspects of classroom delivery, such as varied teaching methods, the clarification of concepts and the conduct of practical lessons, but it left the foundational skill of lesson planning largely untouched. The qualitative evidence traced this shortfall to the one-off delivery of the training and to the dilution of content through the cascade model, so that the influence of training on implementation was real but shallow. In-service training is therefore necessary but not sufficient for implementation: it builds technique but not the deeper planning competence that sustained delivery requires, a finding that confirms the view of teacher preparedness as resting on the joint presence of training, resources and support rather than on any single factor [7].

VIII. RECOMMENDATIONS

Arising from the findings, the study makes the following recommendations. First, the Teachers Service Commission and the Ministry of Education should make the in-service training of Integrated Science teachers continuous and practice-based rather than a single, one-off event, and should replace or supplement the cascade model with direct, school-based support so that the content reaches every teacher intact. Second, teacher training and professional development institutions should give explicit attention to lesson planning and assessment for inquiry-based science, and not only to teaching technique, since it is planning that the present training was found to leave weakest. Third, the Ministry of Education, the Kenya Institute of

Curriculum Development and development partners should treat continuous professional support, with structured follow-up, coaching and usable teaching guides, as an integral part of curriculum rollout rather than as a preliminary event, so that the significant but shallow influence of training recorded here can translate into deeper and more durable implementation.

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