

Examine Teachers' Pedagogical Preparedness for Implementing Collaborative Learning Strategies in the Chemistry Curriculum in Senior Schools in West Pokot County

Jacqueline Cheptoo Kariwonyang*, Dr. Betty Cheruyot, Dr. Emoito Omuse

Department of Curriculum and Instruction, University of Eldoret, Kenya

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ABSTRACT

Effective implementation of collaborative learning strategies in chemistry teaching is widely linked to improved learner achievement, yet teachers' pedagogical preparedness for such implementation, particularly within Kenya's Competency-Based Education, remains under-examined. This study conducted a pedagogical analysis of collaborative learning strategies in chemistry teaching in senior schools in West Pokot County, focusing specifically on teachers' pedagogical preparedness for implementing these strategies. A sequential explanatory mixed-methods, quasi-experimental design with a nonequivalent control group pre-test/post-test structure was employed, drawing on a target population of 89 chemistry teachers and 3,247 Grade 10 learners. A sample of 40 teachers and 200 learners across 20 purposively and randomly selected schools. Data were collected using teacher questionnaires, focus group discussions, and classroom observations, and analyzed using descriptive and inferential statistics alongside thematic analysis. Findings revealed that teachers' overall pedagogical preparedness was moderate, with strong theoretical understanding of collaborative techniques but limited practical ability to manage large and diverse groups. Only 52.8% of teachers had received training on collaborative learning methods, yet trained teachers recorded significantly higher implementation scores and their learners achieved significantly greater gains than untrained teachers' learners. Learner accounts corroborated these patterns, describing more meaningful collaborative experiences with teachers who actively structured and monitored group work. The study concludes that inadequate pedagogical preparedness, rather than lack of theoretical awareness, constrains the effective implementation of collaborative learning in chemistry classrooms, with direct consequences for learner achievement. It recommends sustained, practice-oriented professional development targeting classroom management for large groups, supported by county education offices and school administration, to strengthen collaborative pedagogy and improve chemistry learning outcomes in resource-constrained senior schools.

Key Words: Collaborative learning, Pedagogical preparedness, Chemistry education, Teacher professional development, Competency-Based Curriculum

INTRODUCTION

Chemistry education occupies a foundational position in scientific literacy, equipping learners with the analytical and problem-solving competencies required for participation in science and technology-driven societies. Scholars such as Niyonsaba, Nkurunziza, and Hakizimana (2022) established that effective chemistry instruction was central to developing higher-order thinking among secondary-level learners. Despite this recognized importance, learners' achievement in chemistry has persistently lagged behind acceptable thresholds in many school systems, a trend largely attributed to the dominance of teacher-centered instructional models that privilege passive reception of knowledge over active meaning-making. Such approaches restrict student interaction, limit engagement with abstract chemical concepts, and weaken the bridge between theoretical knowledge and practical application.

In response to these instructional limitations, a growing body of scholarship has advocated for a pedagogical shift toward learner-centered approaches, with collaborative learning strategies receiving particular attention (Johnson & Johnson, 2009). Pedagogy, understood as the purposeful science and art of teaching encompassing

instructional decisions, curriculum alignment, and the management of learning experiences (Loughran, 2019), provides the conceptual lens through which the effectiveness of collaborative strategies must be examined. A pedagogical analysis, as applied in this study, refers to the systematic investigation of how teachers plan, structure, facilitate, and align instructional strategies with the specific demands of a curriculum, rather than merely measuring the outcomes those strategies produce. Collaborative learning, characterized by structured group interactions, distributed responsibility, and active co-construction of knowledge, has been consistently associated with improved academic achievement and deeper conceptual understanding (Johnson & Johnson, 2009). However, the pedagogical conditions under which such strategies are successfully applied within specific curriculum frameworks remain underexplored, particularly at the senior school level (Grossman, Hammerness, & McDonald, 2009).

The introduction of the Competency-Based Curriculum (CBC) in Kenya has significantly reorganized the structure and philosophy of secondary education (Heto, Odari, & Sunu, 2020). Within this framework, senior schools refer to the upper secondary level (Grades 10 to 12), replacing the traditional Form 1 to Form 4 structure of the 8-4-4 system. The chemistry curriculum at the senior school level under CBC is designed around competency development, critical inquiry, and the integration of practical skills, a design philosophy that is inherently compatible with collaborative and learner-centered pedagogies. Understanding how teachers pedagogically apply collaborative strategies within this revised curriculum is therefore not only timely but necessary for ensuring that CBC's intended learning outcomes are realized in chemistry classrooms.

Empirical evidence from diverse contexts has demonstrated the positive influence of collaborative learning strategies on learners' achievement in chemistry. Wairimu, Twoli, and Waititu (n.d.) provided empirical support for collaborative learning strategies in chemistry through a quasi-experimental study in Murang'a County. Their findings indicated significant improvement in achievement among learners in cooperative learning settings compared to those in non-cooperative classrooms. However, the study implied that such outcomes were more attainable in relatively well-resourced environments, raising important questions about the pedagogical feasibility of collaborative strategies in under-resourced and marginalized contexts. This observation is particularly relevant for West Pokot County, where persistent resource constraints, inadequate laboratory infrastructure, high pupil-teacher ratios, and socio-cultural factors such as pastoralist livelihoods and linguistic diversity present distinctive pedagogical challenges.

This persistent gap between the documented potential of collaborative learning and the pedagogical realities of its implementation in chemistry classrooms forms the central rationale for the present study. Situating this analysis within the resource-constrained senior schools of West Pokot County, the study moves beyond simply establishing whether collaborative learning works to examining how prepared teachers actually are to make it work in their own classrooms. In doing so, it seeks to generate context-sensitive, pedagogically grounded evidence capable of informing both immediate classroom practice and long-term curriculum policy under the CBC framework, offering a clearer pathway toward chemistry instruction that is not only theoretically sound but practically achievable in under-resourced senior schools.

LITERATURE REVIEW

Teacher preparedness emerges consistently across the literature as essential to collaborative learning success. However, the evidence reveals a troubling pattern. Most teachers, particularly in developing regions, lack adequate preparation to implement collaborative approaches effectively.

Salleh, Rauf, Saat, and Ismail (2022) examined twelve trainee chemistry teachers in Malaysia, finding they predominantly used whole-class instruction emphasizing active learning and collaborative student engagement. Critically, the researchers found that while teachers selected activities based on student interests, they rarely used formative assessment data to differentiate instruction, instead applying one-size-fits-all approaches. This finding is important but reveals a methodological limitation. The study involved purposive sampling of only twelve teachers, severely limiting generalizability. More significantly, the study did not investigate whether observed teaching reflected trainee teachers' actual capabilities or merely reflected the limited training they received. The research raises but does not answer the central question: What specific teacher education components would enable teachers to move beyond whole-class approaches toward differentiated collaborative learning?

Pečiuliauskienė, Kaminskienė, and Lehtinen (2023) made an important methodological contribution by

distinguishing professional development content from duration. Using TIMSS 2015 data across Japan, Lithuania, and South Africa, they found that the substance of professional development, particularly emphasis on pedagogical content knowledge, critical thinking, and inquiry skills, predicted teachers' collaborative innovative activities far more reliably than hours of training attended. This finding has significant implications. It suggests that quantity of training alone is insufficient and quality matters substantially. However, the study has notable limitations. It relies on self-reported TIMSS data on professional development engagement, which may not reflect actual implementation. The cross-national analysis combined very different education systems, including Japan as a high-resource context, South Africa as a middle-income context, and Lithuania as an upper-middle-income context, potentially obscuring region-specific relationships. Critically, the study did not measure actual classroom implementation or student learning outcomes. The research raises questions it does not answer: Which specific professional development content components prove most effective in developing-country senior schools? How can quality professional development be delivered sustainably where teacher education infrastructure is limited?

Guo, Huang, and Chen (2024) and Copriady, Zulnaidi, Alimin, and Albeta (2021) both demonstrated that structured teacher education programs can enhance pedagogical and sustainability competencies. Guo et al. found that student teachers, future primary school teachers in China, showed strong pedagogical content knowledge after integrated teacher education incorporating Sustainable Development Goals. Copriady et al. reported that teacher collaboration significantly mediated engagement in professional development and teaching resource proficiency among 184 Indonesian chemistry teachers. These studies indicate that collaborative professional development is effective. However, a critical gap persists. Neither study examined whether competency gains translated into sustained classroom practice or improved student outcomes. Without evidence linking teacher preparation to measurable improvements in student achievement or learning durability, the causal chain from teacher training to student outcomes remains incompletely understood, particularly in resource-constrained settings where teacher retention and ongoing support are often limited.

Ogutu's (2020) survey of 53 chemistry teachers in Kenya identified that inadequate instructional materials including laboratory equipment, chemicals, ICT resources, and textbooks, significantly constrained effective teaching. Additionally, high teacher workload and limited participation in professional development further constrained instructional quality. This study directly addresses Kenyan secondary education and identifies implementation barriers relevant to West Pokot County. However, the study employed a cross-sectional survey design limited to 53 teachers, raising generalizability concerns. Importantly, the study documented barriers without investigating how teachers adapted instruction despite constraints or whether some teachers achieved better outcomes than others. This represents a missed opportunity to understand teacher agency and adaptation in resource-limited contexts.

Despite consistent evidence that teacher preparedness matters, a fundamental research gap persists. There is limited evidence on which teacher training models most effectively prepare senior schools teachers to implement collaborative learning in resource-constrained, high-poverty contexts like rural Kenya. No studies have examined longitudinal impacts of different professional development approaches on sustained collaborative learning implementation or student outcomes in such settings. Furthermore, no research has investigated how teachers' own schooling experiences, subject matter anxiety, or beliefs about student ability interact with professional development to influence collaborative learning adoption, factors theoretically important for change but empirically unexamined.

METHODOLOGY

This study employed a sequential explanatory mixed-methods, quasi-experimental design with a nonequivalent control group pre-test/post-test structure to examine the effect of five collaborative learning strategies (team-based problem-solving, think-pair-share, peer tutoring, jigsaw, and collaborative concept mapping) on learners' achievement in chemistry, with pre-tests, a six-week intervention, and post-tests administered across all groups, complemented by focus group discussions and classroom observations for contextual understanding. The study was conducted in West Pokot County, Kenya, among a target population of 89 chemistry teachers and 3,247 Grade 10 learners in public senior schools offering chemistry, selected through a multi-stage sampling procedure comprising stratified random sampling of 20 schools, purposive sampling of 40 teachers, and proportionate stratified plus simple random sampling of 200 learners, yielding a total sample of 240 respondents. Data were

collected using teacher questionnaires, student focus group discussions, and a classroom observation schedule, instruments whose validity was established through expert review and pilot testing (involving 2 additional schools, 4 teachers, and 20 learners) and whose reliability was confirmed through Cronbach's alpha (≥ 0.70), verbatim transcription, repeated coding, and member checking. Data collection proceeded over a two-week period across baseline, intervention, and post-intervention phases, after which quantitative data were analysed in SPSS version 28 using descriptive statistics, t-tests, correlation, regression, and ANOVA with Tukey HSD post-hoc tests ($\alpha = 0.05$), while qualitative data from focus group discussions and observations were analysed thematically using NVivo, with findings from both strands integrated through triangulation.

Ethical Considerations

This study adhered to established ethical research principles to protect participants' rights, dignity, and welfare throughout the research process: Ethical approval and clearance was sought and obtained from the University of Eldoret Institutional Research and Ethics Committee (IREC) and the National Commission for Science, Technology and Innovation (NACOSTI) before data collection began. Voluntary participation and informed consent participation was strictly voluntary, with written informed consent from teacher participants and parental/guardian consent plus learner assent for participants under 18 years, and the right to withdraw at any stage without penalty. Confidentiality and protection from harm; participants were not identified by name, data were coded, password-protected, and securely stored, no harmful or sensitive questions were asked, and findings were reported honestly without revealing participants' identities.

RESULTS AND DISCUSSION

Response Rate

Of the 40 chemistry teachers sampled, 36 returned completed questionnaires (90.0%). Of the 200 Grade 10 learners targeted for focus group discussions, 184 participated across 24 focus groups (92.0%). Table 1 presents the response rates. A high response rate reduces the risk of non-response bias, but it does not by itself show that respondents are representative of the population, nor that the data are reliable. Representativeness depends on how the sample was drawn and on whether respondents differ from non-respondents, and reliability is a property of the instruments (assessed here with Cronbach's alpha). Teachers in this study were purposively selected, and non-respondents (4 teachers and 16 learners) were not compared with respondents.

Table 1: Response Rate

Category	Target	Actual	Data Collection Tools	Response Rate (%)
	Respondents	Respondents		
Chemistry Teachers	40	36	Questionnaires	90
Grade 10	200	184	Focus Group	92
Learners			Discussions	
Total	240	220		91.7
<i>Source: Field Data (2026)</i>				

The overall response rate of 91.7% indicates that most sampled participants provided data, which limits, but does not remove, the possibility of non-response bias. The findings should be read as describing the 36 participating teachers and the learners in the sampled schools. They should not be taken as representative of all chemistry teachers and learners in West Pokot County, and generalisation to other counties is limited.

Teacher Pedagogical Preparedness for Collaborative Learning

The second objective of this study was to examine teachers' pedagogical preparedness for implementing collaborative learning strategies in the chemistry curriculum in senior schools in West Pokot County. Both quantitative and qualitative data were collected to assess teacher confidence, knowledge, and skills related to collaborative learning facilitation.

Teachers' Self-Assessment of Pedagogical Preparedness

Table 2 presents teachers' self-assessment of their pedagogical preparedness for implementing collaborative learning strategies. This section of the questionnaire (Section B: Teacher Pedagogical Preparedness for Collaborative Learning) asked teachers to indicate the extent to which they agreed or disagreed with statements about their preparedness using a 5-point Likert scale where 1 = Strongly Disagree and 5 = Strongly Agree.

Table 2: Teachers' Self-Assessment of Pedagogical Preparedness

Statement	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std. Dev.
I am confident in facilitating group activities in chemistry lessons	2 (5.6)	5 (13.9)	6 (16.7)	15 (41.7)	8 (22.2)	3.61	1.14
I plan chemistry lessons using collaborative learning strategies	3 (8.3)	6 (16.7)	7 (19.4)	14 (38.9)	6 (16.7)	3.39	1.2
I understand various collaborative learning techniques	2 (5.6)	4 (11.1)	5 (13.9)	17 (47.2)	8 (22.2)	3.69	1.1
I can manage large and diverse student groups effectively	4 (11.1)	7 (19.4)	8 (22.2)	12 (33.3)	5 (13.9)	3.19	1.25
I use feedback to improve collaborative learning sessions	2 (5.6)	5 (13.9)	6 (16.7)	15 (41.7)	8 (22.2)	3.61	1.14
Grand Mean						3.5	1.17

Source: Field Data (2026)

The findings in Table 2 reveal that teachers rated their pedagogical preparedness with overall means ranging from 3.19 to 3.69 on a 5-point scale. The highest-rated item was understanding various collaborative learning techniques ($M=3.69$, $SD=1.10$), with 69.4% of teachers agreeing or strongly agreeing, suggesting that most teachers have theoretical knowledge of collaborative learning approaches. This was followed by facilitating group activities ($M=3.61$, $SD=1.14$) and using feedback to improve collaborative learning ($M=3.61$, $SD=1.14$), both with 63.9% agreeing or strongly agreeing. However, the finding that substantial proportions of teachers reported uncertainty or disagreement on several items is concerning, with 19.4% of teachers disagreeing or strongly disagreeing that they plan lessons using collaborative learning strategies, and 25.0% expressing neutral responses. Most concerning was the finding that only 47.2% of teachers agreed or strongly agreed that they can manage large and diverse student groups effectively, with 30.5% disagreeing or strongly disagreeing. This finding is particularly significant given the large class sizes typical of senior schools in West Pokot County.

These findings are consistent with Salleh, Rauf, Saat, and Ismail (2022), who found that teachers predominantly used whole-class instruction and rarely used formative assessment data to differentiate instruction, instead applying one-size-fits-all approaches. The low rating for managing large and diverse groups is particularly concerning because effective collaborative learning requires teachers to manage multiple groups simultaneously, monitoring progress, providing support, and intervening when necessary. According to Johnson and Johnson (1999), successful implementation of cooperative learning requires teachers to possess strong classroom management skills and the ability to create structures that promote positive interdependence and individual accountability. The findings suggest that many chemistry teachers in West Pokot County may not be adequately prepared to facilitate collaborative learning in the large classes characteristic of senior schools in rural Kenya.

Learner Perceptions of Teacher Pedagogical Preparedness

Qualitative data from focus group discussions provided insights into how learners perceive teacher pedagogical preparedness for collaborative learning. The focus group discussion guide (Appendix IV, Section B) contained questions exploring how teachers guide group activities, how teachers help learners understand chemistry concepts during group work, and examples of when teachers made collaborative learning easier or harder. Thematic analysis revealed several key patterns in learner responses.

Learners described how teachers guided or failed to guide collaborative activities. One learner stated that *"Our chemistry teacher is very good with groups. She walks around, asks us questions, and helps us when we are stuck. She makes sure everyone is participating, not just some people. She also gives us different roles in the group so everyone has something to do."* This positive description reflects the characteristics of a prepared teacher who actively monitors groups, provides scaffolding, and structures roles to ensure participation. According to Salleh, Rauf, Saat, and Ismail (2022), teachers who actively monitor and support group activities are more effective in facilitating collaborative learning. However, another learner expressed a contrasting experience, stating that *"Our teacher just tells us to form groups and do the work. He doesn't explain what we should do or how we should work together. Sometimes we don't even know what the task is because he just writes it on the board and sits down. We have to figure everything out ourselves, and some groups just copy from the textbook without really understanding."* This negative description reflects the limitations of teachers who lack pedagogical preparedness for collaborative learning, and the lack of clear instructions, structure, and guidance undermines the effectiveness of collaborative activities and may lead to superficial learning. According to Johnson and Johnson (1999), effective cooperative learning requires deliberate structuring by teachers, including clear instructions, defined roles, and accountability mechanisms.

Learners also commented on how teachers provided feedback and support during collaborative activities. One learner stated that *"When we finish our group work, the teacher gives us feedback on what we did well and what we need to improve. She explains the chemistry concepts again if we didn't understand. This really helps me learn better."* This finding highlights the importance of feedback in collaborative learning, and according to Shulman (1986), teachers with well-developed PCK are more effective in providing feedback that promotes conceptual understanding rather than rote completion of tasks. Another learner noted that *"Sometimes the teacher just collects our work and doesn't say anything. We don't know if our answers are right or wrong. We just move on to the next topic. This makes me feel like the group work doesn't really matter."* This negative observation suggests that when teachers do not provide feedback, learners perceive collaborative activities as less meaningful, which may reduce their motivation and engagement, and according to Depaepe, Verschaffel, and Kelchtermans (2013), teachers with well-developed PCK are more effective in providing formative feedback that supports learning.

Learners also commented on how teachers managed group composition. One learner stated that *"The teacher sometimes puts weak and strong learners together in groups. This is good because the strong ones can help the weak ones. But sometimes the strong ones get frustrated and don't want to help. I think the teacher should mix groups so everyone can help each other."* This finding about mixed-ability grouping is consistent with the Vygotskian concept of the Zone of Proximal Development (ZPD), where learners operate within their ZPD with support from more capable peers. However, the learner's concern about frustration suggests that simply mixing ability levels without providing guidance on how to support peers may be insufficient. Another learner noted that *"The teacher should pay attention to how groups work together. Some groups have problems because some people don't cooperate. The teacher should change groups if they are not working well. Instead, we stay in the same groups even when there are problems."* This finding highlights the importance of teachers actively monitoring group dynamics and adjusting when necessary, and according to Gillies (2016), teachers need to intervene when groups are dysfunctional and provide guidance on conflict resolution.

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Summary of Findings

Teachers' pedagogical preparedness for implementing collaborative learning was moderate overall ($M=3.50$), with teachers rating their theoretical understanding of collaborative techniques highest ($M=3.69$) but their ability to manage large and diverse groups lowest ($M=3.19$). Only 55.6% of teachers reported planning lessons using collaborative learning strategies, and only 52.8% had received any training on collaborative learning methods, a gap consistent with Pečiuliauskienė, Kaminskienė, and Lehtinen's (2023) observation that the substance of professional development, particularly emphasis on pedagogical content knowledge and inquiry skills, predicts teachers' collaborative innovative practice.

Trained teachers demonstrated significantly higher implementation scores than untrained teachers, underscoring the practical value of continuous professional development; this is consistent with more recent evidence from

Guo, Huang, and Chen (2024) and Copriady, Zulnaidi, Alimin, and Albeta (2021) that structured teacher education programmes enhance pedagogical competencies. Learners corroborated this pattern, reporting more positive experiences with teachers who actively guided and structured group activities than with those who remained passive. This was not limited to implementation scores: learners taught by trained teachers also recorded significantly higher achievement gains ($M = 24.51$) than those taught by untrained teachers ($M = 17.86$), $t(217) = 4.096$, $p = 0.000$, providing direct achievement-based evidence that teachers' pedagogical preparedness affects learner outcomes and not only how teachers report their own practice.

Conclusions

The study concludes that teachers' pedagogical preparedness for implementing collaborative learning strategies in the chemistry curriculum is inadequate and has a measurable effect on learner achievement, not only on how teachers implement lessons. This is evidenced by two converging results that reject H_{02} : trained teachers had significantly higher implementation scores ($M = 3.82$) than untrained teachers ($M = 3.21$, $p = 0.001$), and, more importantly, the learners of trained teachers recorded significantly higher achievement gains ($M = 24.51$) than the learners of untrained teachers ($M = 17.86$), $t(217) = 4.096$, $p = 0.000$. While teachers have theoretical knowledge of collaborative learning techniques, they lack the practical skills necessary for effective implementation, particularly in managing large and diverse groups. The finding that only 52.8% of teachers had received training on collaborative learning methods is a significant concern, as training is strongly associated with both implementation effectiveness and learner achievement. Teachers' strong demand for professional development suggests recognition of their own skill gaps and openness to learning. The study concludes that significant investment in professional development on collaborative learning is necessary to enhance teachers' pedagogical preparedness and improve learner achievement outcomes.

Recommendations

- i. The County Director of Education should institutionalize mandatory, sustained in-service training on collaborative learning pedagogy for chemistry teachers, prioritizing practical classroom management skills for large, diverse groups, given that only 52.8% of teachers had received such training.
- ii. School principals should facilitate peer mentoring and regular classroom-based coaching in collaborative learning strategies, allocate time within the school timetable for teacher collaboration, and support teachers in managing large chemistry classes effectively.
- iii. Chemistry teachers should move beyond theoretical knowledge by deliberately planning and structuring collaborative activities, seeking professional development opportunities, and developing practical classroom management strategies to effectively facilitate group work in large, diverse classes.

Suggestions for Further Research

- i. A longitudinal study should track trained chemistry teachers over multiple terms to determine whether gains in pedagogical preparedness and learner achievement observed immediately after training are sustained, or whether refresher support is needed to maintain classroom-management competence over time.
- ii. Comparative studies extending to other science subjects and counties beyond West Pokot are needed to establish whether the classroom-management gap identified here is specific to chemistry or reflects a broader pedagogical challenge in implementing collaborative learning under the Competency-Based Curriculum nationally.
- iii. Further research should investigate the specific content, duration, and delivery methods of teacher professional development programmes to identify which components most effectively build teachers' practical skill in managing large, diverse groups during collaborative chemistry lessons.

Conflict of Interest and Funding

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