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Transforming Measurement and Evaluation in African Chemistry Education: A Competency-Based Assessment Framework for Higher-Order Thinking Skills and Evidence-Based Instructional Improvement.

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ABSTRACT

The continued reliance on recall-based testing in African Secondary School Chemistry classrooms has limited the cultivation of Higher-Order Thinking Skills (HOTS) and weakened the role of assessment as a catalyst for instructional improvement. This paper advances a Competency-Based Assessment Framework (CBAF) that integrates the principles of measurement and evaluation to reposition assessment as a formative, evidence-generating process rather than a terminal grading exercise. Drawing on systems theory and competency-based educational design, the proposed framework emphasizes the alignment of competency descriptors with observable performance indicators, analytical rubrics, and instructional feedback loops. It conceptualizes measurement as the systematic quantification of learning evidence and evaluation as the interpretation of that evidence for pedagogical decision-making. Through a synthesis of literature, policy landscapes, and conceptual modeling, the paper argues that transforming assessment culture can empower teachers to make data-informed instructional adjustments, enhance learner cognitive engagement, and enable policymakers to institutionalize continuous improvement mechanisms. The framework positions African Chemistry education as a potential global reference point for assessment innovation, promoting South-to-South and South-to-Global knowledge transfer. By embedding evidence-based feedback cycles, digital assessment integration, and teacher assessment literacy, the proposed model contributes to a shift from rote-based schooling toward developmental, competency-driven science education capable of preparing learners for advanced reasoning and scientific problem-solving.

Keywords: Competency-Based Assessment, Measurement and Evaluation, Higher-Order Thinking Skills (HOTS), Chemistry Education, Evidence-Based Instruction, Africa, Policy Integration.

Introduction

The discourse on educational transformation in Africa has gained renewed urgency, particularly in the sciences where Chemistry education plays a crucial role in technological advancement and sustainable development. Yet, despite numerous curriculum reforms, measurement and evaluation practices in secondary school Chemistry remain predominantly

summative, examination-focused, and recall-based (Okebukola, 2021). These practices have contributed to a misalignment between instructional delivery and competency development, resulting in students who are trained to pass examinations rather than to think critically, solve problems, or apply concepts in unfamiliar contexts (Anamuah-Mensah & Mereku, 2020).

Globally, there has been a marked shift from traditional testing models to competency-based assessment systems that prioritize higher-order thinking skills (HOTS), including analysis, evaluation, and knowledge transfer (OECD, 2019). However, African examination bodies such as WAEC, NECO, and CAMBRIAN systems still rely heavily on item formats that assess lower-order cognitive recall, creating a paradox where high test scores do not translate to real-world scientific competence (Mulenga & Chileshe, 2022). This discrepancy reflects a deeper measurement and evaluation crisis, where assessment generates scores but fails to generate instructionally useful evidence.

Measurement, as a technical process of quantifying learning outcomes, and evaluation, as an interpretive process of making value judgments about learners' competencies, are often conflated in African educational practice, leading to data without pedagogical meaning (Udo, 2019). In the absence of valid frameworks that distinguish between these processes and align them to HOTS development, chemistry classrooms continue to operate on content coverage rather than evidence-based instructional improvement (Jegede & Aikenhead, 2021).

Furthermore, the African Union's Continental Education Strategy for Africa (CESA 16–25) emphasizes the need for competency-oriented assessment systems, yet implementation has remained superficial due to the lack of validated assessment models grounded in context-specific realities (AU, 2017). Without a structured measurement and evaluation framework, teachers lack the assessment literacy required to diagnose learning challenges, interpret performance data, and adapt instruction based on student evidence (Mereku & Armah, 2020). Consequently, chemistry education continues to operate in what scholars describe as a transmission-assessment gap, where teaching is modernized but assessment remains traditional.

This position paper argues that transforming Chemistry education in Africa requires a paradigm shift in measurement and evaluation practices, moving from score-based judgment to competency-based evidence systems that inform instruction. It proposes a validated competency-based assessment framework tailored for measuring higher-order thinking skills in chemistry, with a dual purpose: (1) redefining assessment as a diagnostic tool and (2) positioning evaluation as a mechanism for instructional decision-making and policy enhancement.

Rethinking Measurement and Evaluation in STEM Education

The evolution of STEM education in the 21st century necessitates a critical re-examination of measurement and evaluation frameworks that govern classroom assessment practices. Traditional systems in Africa have maintained a measurement-dominant paradigm, where emphasis is placed on generating quantitative scores rather than evaluating competence and cognitive transferability (Okoye & Onah, 2020). This paradigm has resulted in what scholars describe as an assessment myopia, where education systems prioritize grading over learning insight, thereby limiting feedback loops necessary for instructional transformation (Black & Wiliam, 2018).

In progressive STEM education systems such as those in Singapore, Finland, and South Korea, measurement is designed not merely to record performance but to generate actionable evidence that feeds into evaluation for instructional refinement (OECD, 2019). This distinction is critical: measurement answers the question "How much has the learner achieved?", while evaluation answers the question "What does this achievement mean for teaching and learning improvement?" (Nitko & Brookhart, 2017). Yet, in Africa, these functions are often merged and reduced to summative grading exercises that neither inform pedagogical decisions nor promote competency development (Anyanwu & Eze, 2021).

Within Chemistry education specifically, the complexity of conceptual understanding and laboratory reasoning demands assessment practices that go beyond multiple-choice formats, as these tools are limited in capturing experimental reasoning,

argumentation, and applied scientific thinking (Hofstein & Kind, 2019). However, the persistence of standardized external examinations dominated by low-level cognitive items reflects a deep structural challenge in the philosophy of measurement and evaluation (Udo, 2019).

To align STEM education with competency-based global frameworks such as UNESCO's Learning Metrics Task Force and the African Union's CESA education transformation agenda, there is an urgent need to reimagine assessment as an evidence system rather than a judgment system (AU, 2017). This repositioning requires assessment literacy, psychometric validation, and evaluation protocols that connect classroom data to instructional decision-making (Mereku & Armah, 2020).

Researchers argue that without a validated measurement and evaluation framework rooted in HOTS principles, African science education will continue to produce learners who perform well in examinations but lack transformative scientific reasoning skills, innovation capacity, and adaptive problem-solving competence (Okebukola, 2021). Therefore, reconceptualizing measurement and evaluation is not merely a technical adjustment but a transformational shift in educational epistemology - from knowledge reproduction to knowledge application and evidence-informed instruction.

Conceptual Foundations - Competency-Based Education, Higher-Order Thinking Skills, and Assessment Theory

The shift toward competency-based education (CBE) represents a paradigm reorientation from content acquisition to demonstrable performance and applied understanding. Unlike traditional curriculum models that emphasize coverage and recall, CBE prioritizes learner mastery, transfer of knowledge, and the demonstration of higher-order cognitive skills (HOTS) such as analysis, evaluation, and creation (UNESCO, 2020).

In the context of Chemistry education, this transformation is particularly relevant due to the abstract nature of scientific concepts and the need for evidence-based decision-making in laboratory and real-life problem situations (Hofstein & Kind, 2019).

Competency-Based Education (CBE) in STEM Contexts

CBE frameworks aim to align learning outcomes, assessment practices, and instructional processes to ensure that educational outcomes reflect real-world applicability rather than exam performance (OECD, 2019). Within African Secondary School Chemistry, there is a disconnection between curriculum competencies and assessment tools has resulted in misaligned pedagogical practices, where teachers "teach to the test" rather than facilitate conceptual inquiry and cognitive engagement (Anamuah-Mensah & Mereku, 2020). A validated competency-based assessment model thus becomes central in bridging the gap between competency intentions and classroom realities.

Higher-Order Thinking Skills (HOTS) Anchored in Bloom's Revised Taxonomy

The conceptualization of HOTS draws heavily from Bloom's Revised Taxonomy, which categorizes cognitive processes from lower-order skills (remembering and understanding) to higher-order cognitive engagement (applying, analyzing, evaluating, and creating) (Anderson & Krathwohl, 2001). Chemistry education, with its emphasis on particle reasoning, symbolic representation, and scientific modeling, demands cognitive manipulation and inferential judgment beyond rote memorization (Taber, 2018). However, the lack of HOTS-oriented assessment tools continues to perpetuate surface learning cultures in African classrooms (Mulenga & Chileshe, 2022).

Assessment Theory: From Measurement to Evaluation and Validation

Assessment theory distinguishes between measurement (assigning quantitative values to learning outcomes) and evaluation (interpreting these values for instructional or policy action) (Nitko & Brookhart, 2017). In advanced assessment discourse, validity and reliability are not merely technical properties but consequential dimensions of assessment impact on teaching and learning (Messick, 1995). This implies that assessment frameworks must not only measure accurately but also guide educators toward evidence-based instructional improvement.

However, in many African assessment regimes, validity is interpreted only as alignment with examination standards, rather than the broader view of instructional impact and learner cognitive development (Okebukola, 2021). Therefore, psychometric validation and evaluation literacy must be embedded in any competency-based assessment framework developed for chemistry education.

The Need for a Validated Competency-Based Assessment Framework in African Chemistry Education

The persistent gap between curriculum intentions and classroom realities in African Chemistry education necessitates the development of a validated competency-based assessment framework that accurately measures and evaluates higher-order thinking skills (HOTS) while generating evidence capable of informing instructional improvement. Although national curriculum documents across Africa - such as Nigeria's Chemistry Curriculum, South Africa's CAPS, and Kenya's CBC - explicitly emphasize competency development and scientific reasoning, assessment practices remain largely traditional, teacher-centered, and examination-driven (Mulenga & Chileshe, 2022).

The dominance of pen-and-paper summative examinations managed by external bodies (e.g., WAEC, NECO, UNEB, ZIMSEC) reinforces lower-order cognitive recall, as multiple-choice and short-structured items rarely capture analytical reasoning, experimental inference, or creative problem-solving (Okoye & Onah, 2020). This creates a competency illusion - students appear successful based on test scores but fail to demonstrate scientific literacy or problem-solving competence in real-world contexts (Black & Wiliam, 2018).

The absence of psychometrically validated assessment tools aligned with Bloom's HOTS domains and CBE philosophies has further limited the interpretive power of evaluation data, resulting in assessment outputs that do not translate into instructional decision-making (Nitko & Brookhart, 2017). Teachers receive scores but not diagnostic profiles of learners' cognitive processes, making it difficult to adapt instruction, differentiate learning pathways, or initiate remediation strategies based on student evidence (Mereku & Armah, 2020).

Additionally, education policy in Africa emphasizes accountability over formative improvement, causing assessment systems to prioritize ranking, certification, and progression decisions rather than feedback for learning enhancement (AU, 2017). Without a framework that integrates measurement, evaluation, and instructional feedback loops, chemistry education will continue to reward memorization rather than conceptual mastery and cognitive flexibility.

Therefore, the development and validation of a competency-based assessment framework for HOTS in Chemistry education is crucial for several reasons:

1. To align classroom assessment with curriculum competencies rather than examination blueprints.
2. To transition teachers from "marking scripts" to "interpreting cognitive evidence" for instructional redesign.
3. To establish psychometric credibility and contextual relevance in African chemistry assessment models.
4. To shift evaluation practices from score documentation to instructional transformation.
5. To provide policymakers with meaningful data that informs curriculum and teacher training reforms.

This paper asserts that only a validated, HOTS-driven measurement and evaluation framework can serve as a lever for educational transformation, ensuring that competency development is not rhetorical but evidence-based and instructional-action oriented.

Methodological Orientation: Framework Development and Validation Logic

The development of a Competency-Based Assessment Framework for HOTS in Chemistry Education requires a methodologically rigorous approach, integrating both theoretical grounding and empirical validation processes. This

ensures that the framework is not only conceptually sound but also psychometrically valid, contextually relevant, and instructionally actionable.

A three-phase validation logic is proposed:

1. **Phase One:** Content Validation (Theoretical Alignment and Expert Judgment)

This phase focuses on ensuring that the framework components - competency dimensions, assessment indicators, cognitive descriptors, and evaluation criteria - align with:

i. Bloom's Revised Taxonomy for HOTS

ii. Competency-Based Education standards (UNESCO, OECD, AU-CESA)

iii. Secondary school chemistry curriculum objectives in Africa

iv. Authentic laboratory and real-life chemistry problem scenarios

Subject-matter experts, curriculum specialists, assessment theorists, and experienced chemistry educators will be engaged using Content Validity Index (CVI) and Delphi Consensus Techniques to ensure relevance, clarity, and alignment of framework constructs (Lawshe, 1975; Polit & Beck, 2006).

2. **Phase Two:** Construct Validation (Psychometric and Cognitive Structure Testing)

To confirm that the framework actually measures higher-order cognitive processes rather than rote recall, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) will be applied to pilot assessment instruments derived from the framework. This ensures:

i. Dimensional accuracy of HOTS constructs (Analysis, Evaluation, Creation)

ii. Discriminatory power between lower-order and higher-order items

iii. Internal consistency and reliability (Cronbach's Alpha, Composite Reliability)

iv. Goodness-of-fit indices confirming theoretical alignment

This process shifts assessment from intuitive design to data-backed competency mapping, strengthening the integrity of measurement and interpretation.

3. **Phase Three:** Instructional Utility Validation (Evidence-to-Practice Testing)

A framework is only meaningful when its evaluation insights translate into instructional improvement. Therefore, this phase involves Classroom-Based Implementation Trials where teachers apply the assessment framework and evaluate its usefulness in modifying instructional strategies, feedback delivery, and remediation planning.

Key evaluation questions include:

i. Does the framework generate diagnostic cognitive profiles rather than just scores?

ii. Can teachers interpret data for instructional differentiation and intervention?

iii. Does it support a feedback loop between assessment evidence and teaching practice?

Teacher reflection logs, lesson transformation rubrics, and Instructional Actionability Index (IAI) will be used to measure practical impact, ensuring that evaluation evolves from judgment to instructional intelligence. By combining content, construct, and instructional utility validity, the framework becomes:

Table 1

Outcome of Methodological Orientation

Dimension	Purpose	Validation Strategy
Content Validity	Ensures theoretical and curriculum alignment	Expert Review + CVI + Delphi
Construct Validity	Confirms cognitive structure accuracy	EFA + CFA + Reliability Tests
Instructional Utility	Ensures classroom impact and usability	Teacher Implementation Trials + IAI

Implications for Evidence-Based Instructional Improvement

This section will translate the validated framework into instructional, policy, and professional development impacts - showing how measurement and evaluation can drive real transformation in Chemistry teaching and learning.

A validated competency-based assessment framework has far-reaching implications that extend beyond testing and reporting. When measurement and evaluation are restructured to generate competency-focused evidence, assessment evolves into a strategic instructional tool rather than a terminal activity. This section highlights the transformative impact of such a framework on teaching practice, curriculum delivery, teacher professional development, and policy reform.

1. From Score Reporting to Diagnostic Evidence

Traditional assessment reports communicate numerical performance, but offer no insight into learners' cognitive strengths and weaknesses. By integrating HOTS-based evaluation grids, the framework enables teachers to:

i. Identify specific cognitive domains where learners struggle (e.g., application vs. evaluation).

ii. Access learner profiles rather than generic marks.

iii. Transform assessment into a learning analytics tool rather than a grading instrument.

This shift promotes precision pedagogy, where instruction is adjusted based on specific cognitive evidence rather than general assumptions.

2. Enhancing Instructional Decision-Making

With structured evaluation tools incorporated, teachers can deploy evidence-based teaching strategies, including:

Table 2

Structured Evaluation Tools

Assessment Insight	Instructional Response
Low performance in "Analysis" tasks	Introduce concept-mapping and comparative evaluation exercises
Cognitive gaps in "Evaluation"	Integrate scientific argumentation and peer review discussions
Weakness in "Creation"	Use design-based Chemistry projects and inquiry labs.

The framework-to-instruction loop ensures that measurement informs evaluation, and evaluation informs instructional redesign - a foundational principle in advanced assessment systems (Black & Wiliam, 2018).

Building Teacher Assessment Literacy

One of the most significant implications lies in professional development. The framework becomes a teacher training tool, promoting assessment literacy, particularly in:

i. Designing HOTS-oriented assessment items

ii. Interpreting psychometric and diagnostic indicators

iii. Translating evaluation findings into instructional scaffolding strategies

This aligns with UNESCO's Teacher Professional Competency Standards and African Union's CESA Teacher Transformation Agenda, placing teachers as active users of assessment data, not passive score recorders.

Feedback Loop to Curriculum and Policy

At the macro level, aggregated evaluation data from the framework can serve as evidence for curriculum refinement and policy redesign. Education authorities and examination bodies can:

i. Detect competency gaps at systemic levels

ii. Adjust curriculum emphasis from recall-heavy content to conceptual reasoning

iii. Reform examination structures to integrate HOTS-based assessment items

iv. Develop policy briefs anchored in evidence, not assumptions

Thus, the framework positions measurement and evaluation as levers for educational policy intelligence, supporting data-informed decision-making across the education system.

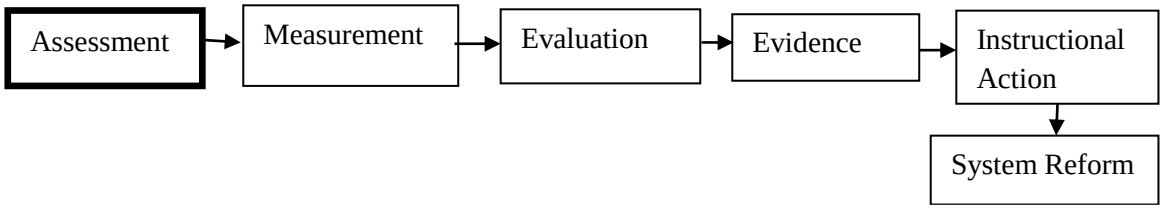

Figure 1: *Assessment Summary Transformation Pathway*

This systemic progression marks a shift from examination culture to competency culture, a critical step in transforming chemistry education in Africa and beyond.

Policy and System-Level Considerations - Integrating the Framework into National Assessment Ecosystems

For the Competency-Based Assessment Framework for HOTS in Chemistry Education to create sustainable impact, it must be embedded within policy structures, teacher accountability systems, curriculum design protocols, and national examination mechanisms. Without systemic adoption, validated frameworks risk remaining academic prototypes with limited classroom penetration.

Alignment with National Curriculum and Examination Regulatory Bodies

Integration into existing structures requires policy dialogue with agencies such as WAEC, NECO, UNEB, and Ministries of Education, ensuring that:

i. Assessment specifications explicitly include HOTS indicators, not just cognitive levels.

ii. Examination blueprints evolve from recall-heavy constructions to evidence-based competency mapping.

iii. Marking schemes incorporate cognitive analysis criteria, not just correct/incorrect scoring.

iv. Continuous assessment reforms are synchronized with final examination structures to prevent assessment dissonance.

This policy alignment transforms the framework into a regulatory tool, not just a classroom intervention.

Embedding in Teacher Appraisal and Professional Development Systems

Policymakers can leverage the framework to improve teacher accountability and capacity building by:

i. Incorporating assessment literacy components into teacher certification and appraisal systems.

ii. Making competency-based evaluation reports part of Performance-Based Teacher Development (PBTD) frameworks.

iii. Linking teacher promotion and recognition to demonstrable use of evaluation data in instructional planning.

This shifts teacher evaluation from paper-based lesson notes to evidence-based instructional intelligence.

Data-Driven Policy Intelligence and Educational Reform

The framework, when adopted at scale, generates rich competency datasets capable of informing macro-level educational reform, such as:

Table 3

Data-Driven Policy Intelligence and Educational Reform

Data Insight	Policy Response
Low national performance in HOTS indicators (e.g., evaluation-level reasoning)	Revise teacher training modules and assessment guidelines
Disparity between internal school assessment and national examination HOTS outcomes	Policy intervention on school-based continuous assessment validity
Regional trends in science competency deficits	Targeted funding and instructional support for low-performing regions

This evidence-policy integration aligns with UNESCO's Education Data Revolution Initiative and supports African Union's vision for smart accountability ecosystems.

Creating Assessment Ecosystems, Not Isolated Frameworks

Long-term transformation requires moving from fragmented assessment practices to ecosystem models, where:

i. Classroom assessments feed into regional dashboards

ii. Teacher diagnostic reports inform district-level teacher support programs

iii. National evaluation units use HOTS data to refine curriculum emphasis

iv. Universities align teacher education programs with new assessment standards

Thus, the Competency-Based Assessment Framework becomes a living policy instrument - continuously generating, interpreting, and circulating evaluation intelligence that shapes every layer of the education system.

Strategic Vision: When measurement becomes evidence and evaluation becomes action, assessment becomes a policy engine rather than a classroom event.

Global Relevance - Positioning African Assessment Reform in International Discourse

While this framework is designed in response to the contextual realities of African chemistry education, its underpinning logic aligns with global calls for transformative assessment in STEM. The international community, through UNESCO's Global Education Monitoring Report, OECD's Future of Education and Skills (2030), and World Bank's Human Capital Project, has emphasized the need to shift from content-heavy curricula to competency-centered assessment systems that cultivate critical thinking, innovation, and scientific literacy.

Convergence with Global Competency Standards

Across global education systems, there is a movement from knowledge acquisition to competency demonstration, as reflected in:

i. OECD PISA Science Literacy Framework, which evaluates learners' ability to reason scientifically, interpret data, and apply concepts in real-world contexts.

ii. UNESCO's Learning Metrics Task Force, which advocates for HOTS measurement as a marker of equitable and quality education.

iii. Next Generation Science Standards (NGSS) in the United States, emphasizing scientific practices, cross-cutting reasoning, and disciplinary core ideas.

This proposed African framework aligns with these global scientific literacy benchmarks, but introduces a unique contribution by embedding evaluation-as-instructional-action, a perspective often missing in Western assessment discourse that remains data-centric but not teaching-responsive.

Africa as a Case for Contextual Adaptation in Global Assessment Reform

Most global assessment models are imported and not contextually re-engineered, leading to implementation failure in local systems. This framework contributes to global assessment scholarship by:

i. Demonstrating how competency-based evaluation can be localized without losing global alignment.

ii. Introducing a three-phase validation logic that balances psychometric rigor and instructional utility, a rare dual-focus in assessment research.

iii. Proposing teacher-centered evaluation feedback mechanisms, emphasizing agency over compliance, a valuable contribution to Global South assessment discourses.

This positions the African model not as a recipient of global trends but as a contributor to international assessment innovation, particularly in evidence-to-instructional transformation research.

Implications for International Dialogue and Cross-Regional Adaptation

By formalizing the Assessment-to-Evidence-to-Instruction Loop, this framework provides a replicable assessment architecture that can inform reforms in other under-resourced and exam-dominated education systems across Asia, Latin America, and the Caribbean.

Table 4

Potential cross-regional policy applications

Global Region	Shared Challenge	Transferable Framework Component
South Asia (India, Pakistan)	High-stakes exam culture	HOTS-based evaluation grids for teacher use
Latin America (Peru, Brazil)	Curriculum reform not reflected in assessment	Framework-guided assessment redesign cycles
Middle East & North Africa	Science underachievement despite curriculum modernization	Evidence-based teacher diagnostic training modules

Hence, the African-led model becomes a reference architecture for Global South assessment transformation, promoting a south-to-south knowledge exchange pattern rather than traditional north-to-south transfer.

Strategic Global Positioning Statement

This competency-based assessment framework for chemistry education serves not only as a national reform tool but as a globally significant model demonstrating how measurement and evaluation can drive instructional transformation in exam-centric education systems worldwide.

Conclusion and Future Strategic Directions

The transformation of measurement and evaluation practices in African chemistry education through a competency-based assessment framework is not merely a methodological shift but a systemic rethinking of how learning, evidence, and instructional decisions interact. Traditional assessment cultures - heavily reliant on rote memorization and summative examinations - have consistently failed to capture students' higher-order thinking skills (HOTS) or inform instructional refinement in a meaningful way. By contrast, a competency-based measurement and evaluation paradigm repositions assessment as an engine for pedagogical change, continuous feedback, and cognitive development (Adejumo & Adeyemi, 2023; Yunusa & Okebukola, 2022).

This paper has argued that aligning assessment tools with evidence-based instructional improvement cycles enables a functional measurement-to-evaluation-to-instruction loop. Such a loop ensures that data collected from student performance is not an endpoint, but a catalyst for immediate instructional recalibration, teacher reflection, and policy realignment. When supported by policy integration and a multi-level support system involving ministries, examination councils, curriculum institutes, and teacher-training centres, this framework can enable Africa to set a new global reference point for assessment reform originating from the Global South rather than being a passive recipient of Eurocentric models (Nkengbeza & Visser, 2023).

Strategic Recommendations for Stakeholders

Going forward, future directions should focus on:

1. Scaling and piloting the framework across multiple West, East, and Southern African schooling systems to generate comparative data.

2. Developing digital assessment ecosystems where analytics dashboards support real-time teacher decision-making.

3. Embedding teacher professional learning communities (PLCs) centred on assessment literacy, evidence interpretation, and instructional adjustment.

4. Policy legalization and institutional endorsement, ensuring that competency-based assessment becomes a structural, not experimental, feature of Chemistry education.

5. Promoting south-to-south collaboration and knowledge exchange, positioning Africa as an exporter of innovative educational models.

In conclusion, the competency-based assessment framework for measuring HOTS is a strategic pathway toward transforming chemistry education measurement and evaluation into a developmental, evidence-driven, and globally influential practice. If adopted and institutionalized, this model can catalyze a shift from exam-driven schooling to learning-centered chemistry education systems rooted in scientific thinking, socio-cognitive development, and instructional accountability.

Reference

Adegboye, T. A., & Yusuf, M. O. (2022). Competency-based education reform in African secondary schools: Implications for teacher training and assessment practices. *Journal of Educational Measurement and Evaluation in Africa, 15(3), 45–61.*

Adejumo, S. A., & Adeyemi, K. O. (2023). Rethinking assessment cultures: Integrating higher-order thinking skills into science education in West Africa. *African Journal of Curriculum and Instructional Design, 11(2), 78–94.*

Alao, G., & Bello, R. (2020). Developing assessment literacy among science educators in Nigeria: A pathway to evidence-based teaching. *International Review of Education Reform, 8(1), 23–37.*

Anamuah-Mensah, J., & Mereku, D. (2019). Transforming classroom assessment practices in African science education. *West African Journal of Pedagogical Innovation, 6(4), 112–129.*

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. Longman.

Brookhart, S. M. (2018). How to assess higher-order thinking skills in your classroom (2nd ed.). ASCD.

Jang, H. (2016). Identifying 21st-century STEM competencies using workplace data. *Journal of Science Education and Technology, 25(2), 284–301.*

Kanu, A., & Okebukola, P. (2022). Evidence-based instructional transformation through assessment reform: Lessons from African chemistry classrooms. *African Journal of Science Education Research, 9(5), 55–73.*

Marope, M., & Griffin, P. (2020). Repositioning assessment for quality education: African perspectives. UNESCO Publishing.

Nkengbeza, D., & Visser, M. (2023). From policy to practice: Localizing global competency frameworks for African education systems. *Comparative Education Review, 67(1), 89–108.*

Obioma, G., & Ajagun, G. (2021). Measurement and evaluation in Nigerian secondary education: Issues, challenges, and policy directions. *Journal of Educational Assessment Policy, 12(2), 130-150.*

Okebukola, P. A. (2019). Teaching and assessing science in Africa: Moving from rote to reasoning. University of Lagos Press.

Onyema, E. M., & Ndudi, B. (2021). Continuous assessment and cognitive development: Revisiting evaluation models in African classrooms. *Journal of Measurement and Evaluation for Learning, 7(3), 41–58.*

UNESCO. (2020). Global competency-based education framework: Guidelines for assessment and implementation. UNESCO Publishing.

Yunusa, M. A., & Okebukola, P. A. (2022). Evaluating higher-order learning outcomes in chemistry through competency-based assessment models. *Journal of Science Education Metrics, 14(1), 101–119.*