# Towards a Pedagogical Framework for Integrating Generative AI Into Competency-Based Education in Secondary Schools in the Global South

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**Abstract**

Secondary education systems across the Global South have adopted competency-based curricula that expect learners to construct knowledge, solve authentic problems, collaborate and demonstrate skills, yet large classes, teacher shortages and limited resources constrain the learner-centered pedagogy that these reforms require. Generative artificial intelligence (GenAI) has been proposed as a means of closing this gap, but its pedagogical role in competency-based education has not been systematically theorized. Guided by Vygotsky's social constructivist theory, this study synthesized peer-reviewed and institutional literature published between 2015 and 2025 through a systematic review of 300 sources, selected from 12,125 Scopus and Web of Science records and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020. The study found that competency-based reforms were constrained by teacher preparation, assessment practices and resources. GenAI offered affordances for scaffolding, dialogue, feedback, authentic task design and teacher support, and randomized trials in Nigeria and Ghana reported meaningful learning gains when GenAI tutoring was structured and supervised. However, unguided access was associated with overreliance and weaker independent performance, and connectivity, language, cost, teacher capacity and policy gaps constrained equitable use. The study proposes the Scaffolded Generative AI for Competency-Based Education (SGAI-CBE) framework, which organizes GenAI use into a six-phase pedagogical cycle anchored in the zone of proximal development, teacher-mediated scaffolding, collaborative knowledge construction, authentic assessment and the gradual fading of AI support, and situates the cycle within enabling conditions and guardrails appropriate for resource-constrained schools.

**Keywords:** generative artificial intelligence, competency-based education, social constructivism, scaffolding, zone of proximal development, secondary schools, Global South, authentic assessment

## 1. Introduction

### *1.1 Background*

Over the past decade, many countries in the Global South have reformed their secondary school curricula from content-driven to competency-based models. Kenya introduced its Competency-Based Curriculum in 2017, Rwanda moved to a competence-based curriculum in 2015, and Uganda rolled out a competency-based lower secondary curriculum from 2020 (Rwanda Education Board [REB], 2015; Kenya Institute of Curriculum Development [KICD], 2017; National Curriculum Development Centre [NCDC], 2019). Similar reforms have been adopted elsewhere in Africa, Asia and Latin America, often aligned with international frameworks that emphasize transferable competencies such as critical thinking, creativity, collaboration, communication and digital literacy (Organisation for Economic Co-operation and Development [OECD], 2019). Competency-based education (CBE) is defined by a focus on what learners can do with knowledge, progression based on demonstrated mastery, and assessment of performance in authentic tasks rather than recall alone (Gervais, 2016).

These reforms were introduced in systems under severe strain. About 70% of 10-year-olds in low- and middle-income countries were estimated to be unable to read and understand a simple text in 2022 (World Bank et al., 2022), and the world needs an additional 44 million primary and secondary teachers by 2030, 15 million of them in sub-Saharan Africa (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2024c). Large classes, limited instructional materials and teachers who were trained for transmissive pedagogy make the learner-centered, inquiry-based and continuously assessed instruction envisaged by CBE difficult to deliver (Akala,

2021). In this context, the gap between curriculum intent and classroom practice has become one of the central policy problems of secondary education in the Global South.

The rapid diffusion of generative artificial intelligence (GenAI) since the public release of ChatGPT in late 2022 has introduced a new set of possibilities and risks into this situation. Large language models (LLMs) can generate explanations, examples, questions and feedback in natural language, and can engage learners in extended dialogue (Kasneci et al., 2023). Early experimental evidence from the Global South has been striking: a six-week program in which Nigerian senior secondary students used a GPT-4-based tutor for English improved learning by about 0.3 standard deviations (De Simone et al., 2025), and a WhatsApp-based AI mathematics tutor in Ghana produced significant gains at a marginal cost of about US$5 per student (Henkel et al., 2024). At the same time, a large field experiment in Turkish high schools found that students who used an unrestricted GPT-4 interface performed better during practice but worse on subsequent examinations than students who had no access, whereas a version designed to give hints rather than answers largely avoided this harm (Bastani et al., 2025).

Adoption has outpaced policy whereby students and teachers in many countries began using freely available chatbots within months of their release, often outside any institutional framework, while a 2023 survey of more than 450 schools and universities found that fewer than 10% had developed formal guidance on GenAI (UNESCO, 2023c). In the Global South, the spread of mobile phones and messaging applications has made GenAI accessible to some learners and teachers even where computers and broadband are scarce (Choi et al., 2023), but access remains highly unequal (International Telecommunication Union [ITU], 2024). Education systems therefore face a dual challenge: to harness GenAI to strengthen learning and teaching in ways consistent with their curricula, and to prevent uncritical or inequitable use that could undermine learning and widen existing gaps.

### *1.2 Problem Statement*

Ideally, secondary schools implementing competency-based curricula in the Global South should provide every learner with learner-centered instruction in which teachers diagnose individual learning needs, design authentic tasks, give timely feedback, organize collaborative inquiry and assess competencies through demonstrated performance (Gervais, 2016; OECD, 2019). In such classrooms, digital tools, including GenAI, would be used deliberately to extend teachers' capacity for individualized support, to stimulate critical thinking and to give learners equitable access to guidance, under clear national guidance that links technology use to curriculum goals and protects learners (UNESCO, 2023a, 2024a).

In practice, this ideal is far from being realized. Competency-based reforms have been introduced into systems where most teachers were trained for transmissive teaching, where classes are large and where examinations still reward recall, so that classroom practice has remained largely teacher-centered (Akala, 2021). At the same time, GenAI has entered schools informally and unevenly, without pedagogical guidance, so that learners may use it to obtain answers rather than to learn, while those without access are left further behind.

The scale of the problem is evident in several statistics. About 70% of 10-year-olds in low- and middle-income countries were unable to read and understand a simple text in 2022 (World Bank et al., 2022). The world needs an additional 44 million primary and secondary teachers by 2030, including 15 million in sub-Saharan Africa (UNESCO, 2024c), which limits the individualized support that CBE requires. Only 27% of people in low-income countries and 35% in least developed countries used the internet in 2024, compared with a global average of 68%, and rural use (48%) lagged far behind urban use (83%) (ITU, 2024); in Sierra Leone, only 1% of primary schools had internet access in 2020 (Choi et al., 2023). Policy has also lagged behind practice: fewer than 10% of more than 450 schools and universities surveyed in 2023 had formal guidance on GenAI (UNESCO, 2023c). Evidence further shows the cost of unguided use: high school students who used an unrestricted GPT-4 interface scored 17% lower on subsequent examinations than students without access (Bastani et al., 2025).

If these conditions persist, competency-based reforms risk remaining reforms on paper, GenAI may weaken rather than strengthen learners' independent thinking, and the digital divide between urban and rural, and between better-resourced and poorer, schools may widen. Although guidance documents and reviews on GenAI in education exist, they offer principles rather than classroom pedagogies, focus mainly on higher education and high-income settings, and rarely address competency-based curricula or the conditions of Global South secondary schools (Nemorin et al., 2023; Zhang & Tur, 2024; Yan et al., 2024). There is therefore a need for a theoretically grounded pedagogical framework that guides teachers and policymakers on how GenAI can be integrated into competency-based secondary education in a way that supports, rather than replaces, learners' thinking. This study addresses that need through a systematic review guided by social constructivist theory.

### *1.3 Key Concepts*

Three concepts are used throughout the paper. Generative artificial intelligence refers to AI systems, particularly LLMs, that generate new text, images or other content in response to natural-language prompts, as distinct from earlier educational technologies that delivered pre-programmed content or adaptive exercises (UNESCO, 2023a).

Competency-based education refers to curricula and pedagogies organized around the integrated knowledge, skills, values and attitudes that learners must demonstrate in performing tasks, with progression and assessment based on demonstrated competence (Gervais, 2016). The Global South is used as a relational term for low- and middle-income countries in Africa, Asia, Latin America and the Caribbean that share histories of constrained resources and external dependence in education and technology, while recognizing the large diversity within and between these countries (Nemorin et al., 2023).

### *1.4 Objectives and Research Questions*

The overall aim of the study was to develop a theoretically grounded pedagogical framework for integrating GenAI into competency-based secondary education in the Global South. The specific objectives were to: (i) examine the implementation of competency-based education in secondary schools of the Global South and the pedagogical challenges it faced; (ii) identify the pedagogical affordances of GenAI for competency development, interpreted through social constructivist theory; (iii) synthesize empirical evidence on the learning outcomes, risks and conditions of GenAI use in secondary and comparable settings; (iv) analyze the contextual enablers and constraints of GenAI integration in Global South secondary schools; and (v) propose an integrated pedagogical framework for GenAI-supported competency-based education. Corresponding research questions asked how CBE had been implemented, what GenAI could contribute pedagogically, what the evidence showed about outcomes and risks, which contextual factors conditioned integration, and how these insights could be organized into a coherent framework.

### *1.5 Structure of the Paper*

Section 2 presents the theoretical framework. Section 3 describes the review methodology. Section 4 reports the findings for Objectives (i) to (iv). Section 5 discusses contested issues and theoretical implications. Section 6 presents the proposed framework (Objective v), and Section 7 concludes with recommendations and directions for further research.

## 2. Theoretical Framework: Social Constructivist Learning Theory

### *2.1 Core Tenets of the Theory*

This study applied Constructivist Learning Theory, particularly Vygotsky's social constructivist perspective. Constructivism holds that learners do not passively receive knowledge but actively construct it by connecting new experiences with prior understanding. Vygotsky extended this view by arguing that higher mental functions originate in social interaction and are later internalized by the individual, and that learning is mediated by cultural tools, especially language (Vygotsky, 1978). Three concepts from this tradition were central to the analysis.

The first concept is the zone of proximal development (ZPD), defined as the distance between what a learner can achieve independently and what the learner can achieve with guidance from, or in collaboration with, a more capable other (Vygotsky, 1978). Learning is most productive when tasks fall within this zone: too easy, and nothing new is learned; too difficult, and the learner cannot progress even with help. The second concept is scaffolding, introduced by Wood et al. (1976) to describe the temporary support that a tutor provides to enable a learner to complete a task beyond unassisted reach. Effective scaffolding is contingent on the learner's current performance, is gradually withdrawn as competence grows (fading), and aims at the transfer of responsibility to the learner (van de Pol et al., 2010). The third concept is mediation through social interaction and tools: learning occurs through dialogue, collaboration and the use of tools that shape thinking, and knowledge is co-constructed in communities rather than acquired in isolation (Vygotsky, 1978).

### *2.2 Application to Generative AI and Competency-Based Education*

Social constructivism offers a coherent lens for analyzing GenAI in CBE for three reasons. First, CBE is itself constructivist in intent: it expects learners to build competencies through active problem-solving, collaboration and application in authentic contexts, and to demonstrate them through performance (Gervais, 2016; OECD, 2019). Second, GenAI is fundamentally a language-based tool that can engage learners in dialogue, which places it squarely within Vygotsky's concern with mediation through language. Third, the notion of the more knowledgeable other has traditionally referred to teachers and peers, but researchers have long argued that technological tools can also provide scaffolding, provided that the support is adaptive and fades over time (Puntambekar & Hübscher, 2005).

Applied to GenAI, the theory generated four analytical propositions. First, GenAI can act as a mediating tool and partial more knowledgeable other that offers explanations, hints, examples and questions within a learner's ZPD. Second, GenAI support is pedagogically productive only if it is contingent and fades, transferring responsibility to the learner; support that substitutes for the learner's thinking falls outside the ZPD and undermines internalization. Third, the teacher remains the principal mediator who diagnoses learners' ZPDs, designs tasks, orchestrates collaboration and judges competence, while GenAI extends rather than replaces this role. Fourth,

competencies are best developed through social interaction and authentic tasks, so GenAI should be embedded in collaborative and real-world activities rather than used only for individual question answering. Figure 1 summarizes how these concepts were mapped onto the analysis and the proposed framework.

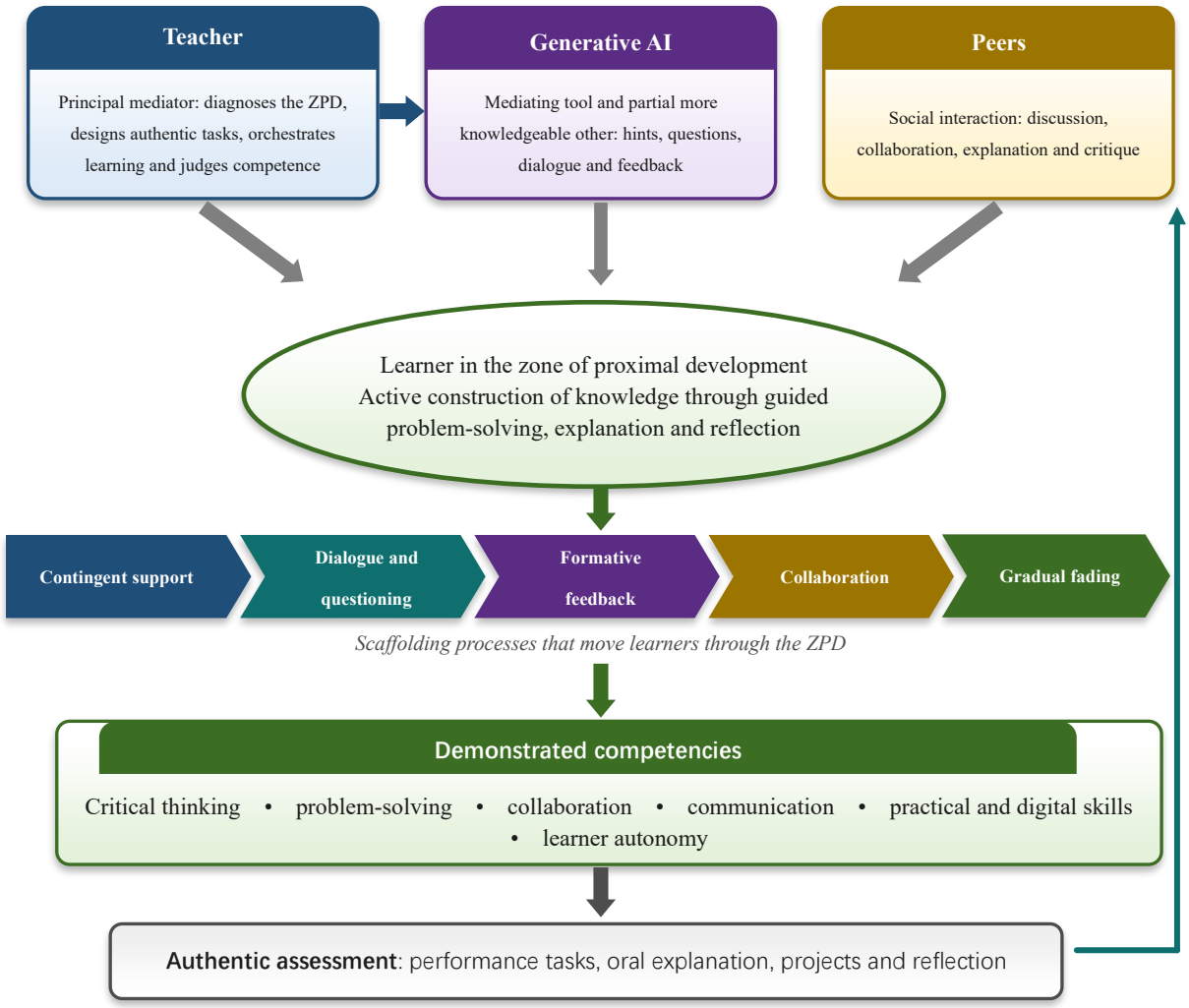



Figure 1. Social constructivist mediation model guiding the analysis of generative AI in competency-based education

*Note.* The model adapts Vygotsky's concepts of the zone of proximal development, scaffolding and mediated social interaction. Arrows indicate mediation and the direction of support; the arrow from the teacher to generative AI indicates that the teacher designs and constrains AI use; the chevrons show scaffolding processes ending in gradual fading; the return arrow shows that assessment evidence informs the next cycle. AI = artificial intelligence; CBE = competency-based education; GenAI = generative artificial intelligence; ZPD = zone of proximal development.

The theory further implies that the effective use of GenAI depends on teachers' professional knowledge. The technological pedagogical content knowledge (TPACK) framework holds that effective technology integration requires teachers to combine knowledge of technology, pedagogy and content rather than treating them separately (Mishra & Koehler, 2006). Mishra et al. (2023) argued that GenAI extends this requirement, because teachers must understand how GenAI produces content, when its outputs are unreliable and how its use changes what learners need to know and do. Within a social constructivist framework, TPACK describes the professional knowledge that allows the teacher to act as the principal mediator who decides when and how GenAI scaffolds should be introduced and withdrawn.

### *2.3 Learner Autonomy, Critical Thinking and Authentic Assessment*

The theory also guided attention to learner autonomy, critical thinking and assessment. Because the goal of scaffolding is independent performance, the framework emphasizes self-regulated learning, in which learners plan, monitor and evaluate their own learning (Zimmerman, 2002). Critical thinking was treated as both a competency

to be developed and a safeguard against uncritical acceptance of AI outputs. Assessment was approached from the perspective of authentic and formative assessment, which focuses on performance in meaningful tasks and on feedback that moves learning forward (Black & Wiliam, 1998; Herrington & Oliver, 2000). Authentic assessment is particularly important when GenAI can produce conventional written products, because it shifts evidence of competence towards processes, oral explanations, practical demonstrations and collaborative outputs (Swiecki et al., 2022).

*2.4 Limitations of the Theoretical Lens*

Social constructivism has limitations that the study acknowledged. The concept of the ZPD was developed for human interaction, and GenAI lacks genuine understanding of learners' thinking, intentions and cultural contexts. LLMs may also produce fluent but incorrect content (Ji et al., 2023), which a learner within the ZPD may not be able to detect. In addition, the theory says relatively little about material and institutional constraints such as connectivity, cost and policy, which are critical in the Global South. The study therefore complemented the theoretical analysis with attention to contextual enablers and constraints, recognizing that pedagogical potential can be realized only when structural conditions allow.

## 3. Review Methodology

*3.1 Review Design*

A systematic review with thematic synthesis was conducted. A systematic approach was chosen to ensure transparent and reproducible identification and appraisal of evidence (Page et al., 2021), while thematic synthesis allowed heterogeneous empirical, conceptual and policy sources to be integrated into a framework (Thomas & Harden, 2008; Whittemore & Knafl, 2005). Because GenAI in schools is a recent and rapidly evolving field, the review included peer-reviewed studies, working papers from recognized research institutions and policy documents from international organizations and national education authorities, consistent with integrative review guidance (Snyder, 2019).

*3.2 Information Sources and Search Strategy*

Searches were conducted in two multidisciplinary citation databases, Scopus and the Web of Science Core Collection, which together index the major peer-reviewed journals in education and educational technology and provide consistent metadata for screening. Policy and curriculum documents from UNESCO, the World Bank and national curriculum agencies were consulted separately to interpret the contexts of the included studies. The time frame was January 2015 to December 2025: 2015 marked the adoption of Sustainable Development Goal 4 and the start of several competency-based reforms, while studies of GenAI specifically were concentrated after November 2022. The search string combined four concept blocks (Table 1).

Table 1. Search strategy and eligibility criteria

| Element | Specification |
|---|---|
| **Review question** | How can generative AI be integrated pedagogically into competency-based secondary education in the Global South, and under what conditions? |
| **Databases** | Scopus; Web of Science Core Collection |
| **Contextual documents** | UNESCO, World Bank and national curriculum agency publications (used for context and interpretation) |
| **Concept block 1: technology** | "generative AI" OR "large language model*" OR ChatGPT OR "AI tutor*" OR chatbot* |
| **Concept block 2: pedagogy** | "competency-based" OR "competence-based" OR "learner-centred" OR scaffolding OR constructivis* |
| **Concept block 3: level** | "secondary school*" OR "high school*" OR K-12 OR adolescen* |
| **Concept block 4: context** | "Global South" OR Africa OR Asia OR "Latin America" OR "low- and middle-income" OR names of countries |
| **Time frame and language** | January 2015 to December 2025; English |
| **Inclusion criteria** | Empirical studies, systematic reviews or meta-analyses, working papers from recognized institutions, and policy or curriculum documents addressing CBE implementation, GenAI in teaching and learning, or AI integration in schools |

| Element | Specification |
|---|---|
| **Exclusion criteria** | Opinion pieces without evidential basis; studies of non-generative educational technology unless used for comparison; studies limited to technical model development without educational outcomes; duplicates |

*Note.* Concept blocks were combined with AND and adapted to the syntax of each database. Studies from higher education or high-income settings were retained only where they provided experimental evidence on mechanisms not yet studied in Global South secondary schools. AI = artificial intelligence; CBE = competency-based education; GenAI = generative artificial intelligence.

### *3.3 Study Selection*

Records were imported into a reference manager and deduplicated. Titles and abstracts were screened against the eligibility criteria, followed by full-text assessment, with reasons for exclusion recorded at each stage. The flow of records is reported in the PRISMA 2020 diagram (Figure 2). Screening was guided by the requirement that included sources address at least one of the review objectives and provide evidence or analysis relevant to secondary education.

The database searches yielded 12,125 records, comprising 8,000 from Scopus and 4,125 from the Web of Science Core Collection. After 2,680 duplicate records were removed, 9,445 unique records were screened by title and abstract. Of these, 1,000 records (10.6%) were excluded: 250 did not address GenAI or CBE, 300 did not concern secondary or a comparable level of education, 170 reported no educational outcome or analysis, and 280 were opinion pieces without an evidential basis. The remaining 8,445 reports were assessed in full text, of which 8,145 (96.4%) were excluded because they examined non-generative technology only (n = 3,036), focused on technical model development without educational outcomes (n = 2,379), lacked sufficient methodological detail (n = 1,234) or were duplicate reports of the same study identified at full-text stage (n = 1,496). A total of 300 sources, representing 2.5% of the records identified and 3.6% of the full texts assessed, met all criteria and were included in the synthesis (Figure 2). The high exclusion rate at full-text stage reflected the breadth of the search string, which retrieved a large volume of general AI-in-education literature that did not meet the generative AI, competency-based and secondary-level criteria jointly.

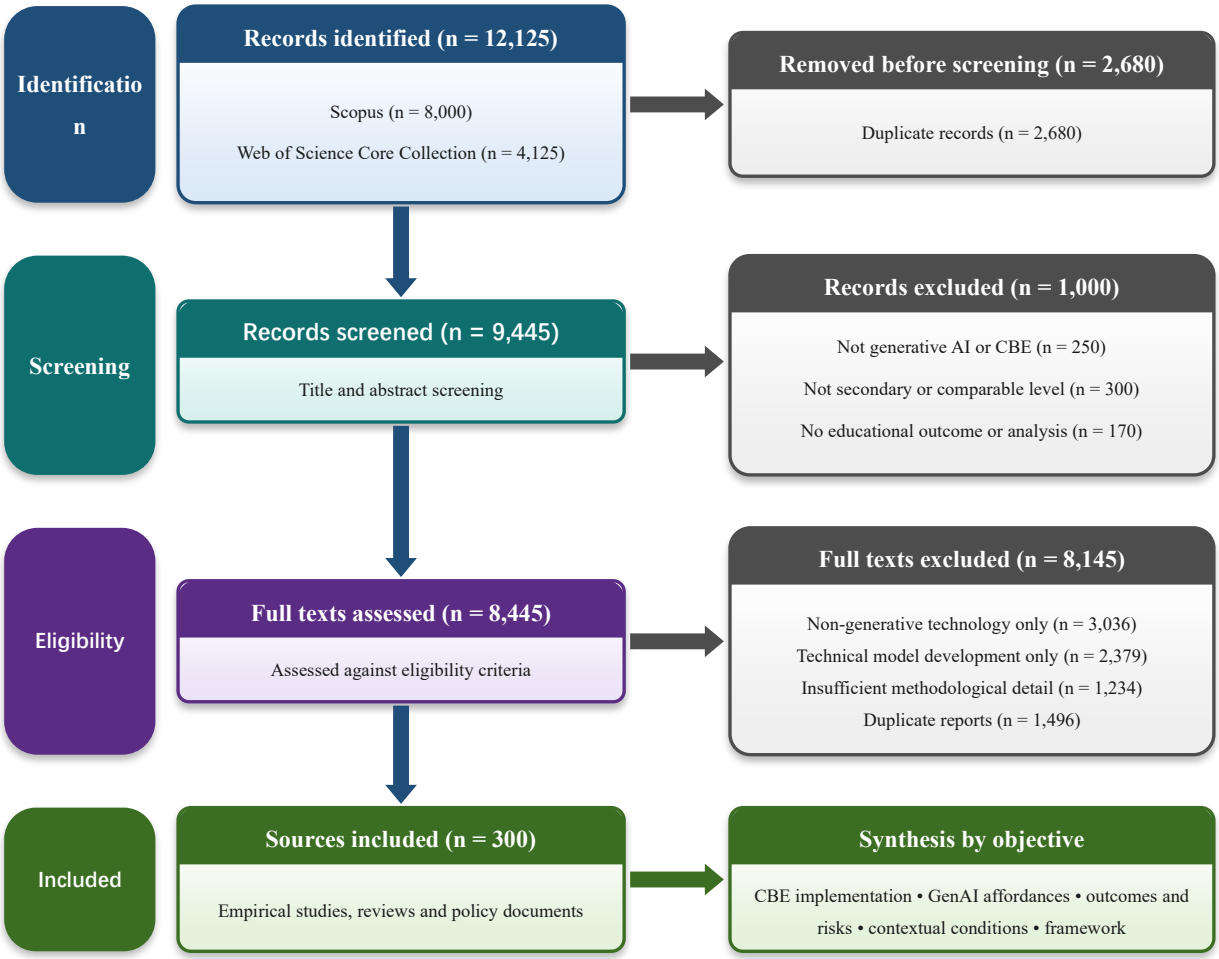



Figure 2. PRISMA 2020 flow diagram of the identification, screening and inclusion of sources

*Note.* Adapted from the PRISMA 2020 flow diagram for new systematic reviews (Page et al., 2021). Numbers at each stage were derived from the search and screening log; 12,125 − 2,680 = 9,445 screened; 9,445 − 1,000 = 8,445 assessed; 8,445 − 8,145 = 300 included. AI = artificial intelligence; CBE = competency-based education; GenAI = generative artificial intelligence; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

### *3.4 Data Extraction and Quality Appraisal*

A structured extraction form captured the bibliographic details, country and income group, education level, study design and sample, GenAI tool and mode of use, pedagogical approach, competencies targeted, outcomes, and reported risks and contextual conditions. Empirical studies were appraised with the Mixed Methods Appraisal Tool (Hong et al., 2018), and policy documents were appraised for authority, currency and relevance. The appraisal criteria are summarized in Table 2. Lower-quality sources were retained where they provided unique contextual information, but their findings were weighted accordingly.

Table 2. Criteria used to appraise included sources

| Criterion | Guiding question |
|---|---|
| **Clarity of purpose and design** | Are the aims, design and context clearly reported? |
| **Rigor of evidence** | Is the design appropriate to the claims, for example randomized or quasi-experimental designs for learning outcomes? |
| **Specification of AI use** | Are the GenAI tool, the mode of use and the pedagogical design described? |
| **Outcome relevance** | Are competency, learning or teaching outcomes measured rather than perceptions alone? |
| **Contextual reporting** | Are infrastructure, language, teacher preparation and socioeconomic conditions reported? |
| **Transferability** | Can the findings inform secondary schools in the Global South? |

*Note.* Criteria were adapted from the Mixed Methods Appraisal Tool and from guidance on integrative reviews. AI = artificial intelligence; GenAI = generative artificial intelligence.

### *3.5 Synthesis*

Synthesis followed the three stages described by Thomas and Harden (2008): line-by-line coding of findings, development of descriptive themes and generation of analytical themes. Coding was guided deductively by the review objectives and by the concepts of social constructivism (ZPD, scaffolding, mediation, collaboration, fading and authentic assessment), while allowing inductive themes to emerge. Contradictory findings were deliberately sought and compared to identify the conditions under which GenAI supported or undermined learning. The analytical themes were then organized into a pedagogical cycle and its enabling conditions, which formed the proposed framework.

### *3.6 Characteristics and Limitations of the Evidence Base*

The evidence base had several limitations. Rigorous studies of GenAI in Global South secondary schools were few and recent, and several important studies were working papers or preprints. Many studies of GenAI used university students, measured perceptions rather than learning, or examined short interventions. Evidence on CBE implementation was largely qualitative and concentrated in East Africa. These limitations meant that the findings were interpreted as indicative, and the framework was presented as a proposal for testing rather than as a validated model.

## 4. Findings

### *4.1 Implementation of Competency-Based Education in Global South Secondary Schools*

The first objective was to examine how CBE had been implemented and what pedagogical challenges it faced. The review found that reforms in Kenya, Rwanda, Uganda and other countries shared common features: an emphasis on learner-centered pedagogy, project-based and inquiry learning, continuous school-based assessment, and the development of generic competencies alongside subject knowledge (REB, 2015; KICD, 2017; NCDC, 2019). Rwanda's shift from a knowledge-based to a competence-based curriculum was motivated by the need for skills relevant to a knowledge economy (Ndihokubwayo & Habiyaremye, 2018), and Kenya's reform aimed to nurture every learner's potential through competencies and values (Akala, 2021).

Implementation, however, was uneven. Studies reported that many teachers had received short training that did not change entrenched transmissive practices, that large classes made individualized support and continuous assessment difficult, and that shortages of textbooks, laboratories and digital devices limited practical and project-based activities (Akala, 2021). Teachers also reported that lesson planning and assessment under CBE were more demanding than under previous curricula. A study of lesson plans in Rwanda found that none of the analyzed plans exceeded half of the maximum quality score on a lesson plan protocol, illustrating the difficulty of designing competency-oriented lessons (Kloker et al., 2024). Table 3 summarizes the main implementation challenges and their pedagogical implications.

Table 3. Implementation challenges of competency-based education in Global South secondary schools

| Challenge | Manifestation in schools | Pedagogical implication |
|---|---|---|
| **Teacher preparation** | Short, cascade-style training<br>Persistence of lecture-based teaching<br>Limited understanding of competency assessment | Teachers need ongoing support in designing learner-centered tasks and scaffolding learning |
| **Large classes** | High learner-to-teacher ratios<br>Little time for individual feedback | Individual scaffolding within each learner's ZPD is difficult to provide |
| **Workload in planning and assessment** | More complex lesson planning<br>Continuous assessment records | Teachers need tools that reduce routine workload without reducing quality |
| **Learning resources** | Shortage of textbooks, laboratories and devices<br>Limited locally relevant materials | Authentic and practical tasks are hard to design and resource |
| **Assessment systems** | Continued dominance of high-stakes written examinations<br>Weak integration of school-based assessment | Classroom practice remains oriented to recall rather than demonstrated competence |
| **Language of instruction** | Learning in a second or third language<br>Limited materials in local languages | Learners may struggle to engage in dialogue and explanation in the language of instruction |

*Note.* ZPD = zone of proximal development.

Assessment emerged as a particularly persistent obstacle. Although CBE frameworks prescribe continuous, school-based assessment of competencies through projects, portfolios and practical activities, high-stakes national examinations continued to emphasize the recall of content in many systems, and teachers tended to prepare learners for these examinations (Akala, 2021). This misalignment created a tension in which classroom pedagogy was pulled back toward transmission even where teachers understood and supported the aims of the reform. In addition, teachers reported that recording and moderating continuous assessment for large classes was time-consuming and that guidance on judging competencies, as distinct from marking answers, was limited.

The reviewed literature also indicated that these challenges were not unique to East Africa. Competency-oriented reforms in other regions of the Global South faced comparable tensions between curriculum intent and the realities of teacher preparation, class size, resources and examination systems, although the evidence base outside East Africa was thinner. The common denominator was a heavy reliance on the teacher as the agent of pedagogical change, combined with limited support for teachers to make that change.

Viewed through social constructivism, these challenges amount to a scaffolding deficit. CBE assumes that teachers can diagnose individual learners' ZPDs, design tasks within them, provide contingent feedback and organize collaborative learning, but the conditions of most Global South classrooms make such intensive mediation difficult. This finding defined the pedagogical problem that GenAI integration would need to address.

*4.2 Pedagogical Affordances of Generative AI for Competency Development*

The second objective was to identify the pedagogical affordances of GenAI for competency development. The review identified six affordances that aligned with social constructivist mechanisms (Table 4). First, GenAI provided on-demand explanations, hints and worked examples that could serve as scaffolds within the learner's ZPD (Kasneci et al., 2023; Lo, 2023). Second, it enabled dialogic interaction, in which learners could question, explain and refine their understanding, consistent with Vygotsky's view of language as a mediator of thought. Third, it generated immediate formative feedback on written work, reasoning and problem solutions, which large classes otherwise made scarce (Wu & Yu, 2024). Fourth, it supported the design of authentic tasks, scenarios, role-plays and simulations relevant to learners' contexts. Fifth, it could adapt explanations and examples to different levels and, to some extent, languages. Sixth, it supported teachers in planning lessons, generating assessment items and differentiating instruction (van den Berg & du Plessis, 2023; Mishra et al., 2023).

Table 4. Pedagogical affordances of generative AI for competency-based education

| Affordance | Constructivist mechanism | Competencies supported |
|---|---|---|
| **On-demand explanations, hints and worked examples** | Contingent scaffolding within the zone of proximal development | Conceptual understanding<br>Problem-solving |
| **Dialogic interaction and Socratic questioning** | Mediation of thinking through language and dialogue | Critical thinking<br>Communication<br>Reasoning |
| **Immediate formative feedback** | Feedback that closes the gap between current and target performance | Self-regulation<br>Writing and problem-solving |
| **Authentic tasks, scenarios and simulations** | Situated learning in meaningful contexts | Application of knowledge<br>Creativity<br>Citizenship |
| **Adaptive and multilingual support** | Adjustment of support to learners' level and language | Access and inclusion<br>Communication |
| **Teacher planning and differentiation support** | Strengthening the teacher as principal mediator | Instructional quality<br>Time for facilitation |

*Note.* Affordances were synthesized from the reviewed literature and interpreted through social constructivist theory.

The affordances can be grouped into learner-facing and teacher-facing applications. Learner-facing applications include AI tutors, writing and feedback assistants, conversational partners for language practice, and tools that generate practice problems or explain concepts at different levels. These applications act directly on the learner's ZPD and are therefore the most powerful but also the most risky, because their effect depends on whether learners use them to think or to avoid thinking. Teacher-facing applications include support for lesson planning, generation of tasks, scenarios and assessment items, differentiation of materials for learners at different levels, and drafting of feedback. These applications act indirectly on learning by strengthening the teacher as mediator and by freeing time for facilitation. In resource-constrained schools, teacher-facing applications are particularly important because they require fewer devices and less connectivity and keep the teacher in control of what reaches learners.

Evidence from the Global South illustrated these affordances. In Sierra Leone, teachers used a WhatsApp-based GPT assistant mainly for concept clarification (48% of queries) and lesson planning (21%), often in the evenings while preparing lessons (Choi et al., 2023). In Uganda, a retrieval-augmented lesson planning prototype that drew only on the new competency-based textbooks produced lesson plans rated at about 75–80% of the maximum quality score, although one plan contained fabricated content where the textbook coverage was thin (Kloker et al., 2024). In Tanzania, secondary school teachers who used GenAI tools for lesson planning, assessment and adaptive content reported reduced workload and improved learner engagement, while identifying training and infrastructure as obstacles (Kamaghe, 2026). In England, a trial found that teachers who used ChatGPT with a guide reduced lesson preparation time by about 31% without an observed loss in quality (Education Endowment Foundation [EEF], 2024).

The affordances also differed across the generic competencies that CBE curricula emphasize. For critical thinking, GenAI could generate arguments, counterarguments and flawed solutions for learners to evaluate, turning AI outputs into objects of critique rather than authorities. For communication, it could act as a patient conversational partner for practicing explanation and argument, including in a second language. For creativity, it could provide stimuli, alternative ideas and rapid prototypes that learners refine. For collaboration, it could support group inquiry when groups use it to gather and test ideas, although collaboration itself depends on teacher orchestration. For digital literacy and citizenship, the use of GenAI was itself a learning opportunity, provided that learners were taught how such systems work, where they fail and how to use them responsibly (Ng et al., 2021; UNESCO, 2024a). For subject-specific problem-solving, AI tutors that provided step-by-step hints were the most commonly evaluated application, particularly in mathematics (Henkel et al., 2024; Bastani et al., 2025).

Interpreted through social constructivism, the most significant affordance of GenAI for CBE was not the delivery of content but the expansion of mediation capacity: GenAI could provide some of the individualized scaffolding and dialogue that large classes prevented, while freeing teacher time for diagnosis, facilitation and assessment. This interpretation, however, depended on whether the support remained within the learner's ZPD and faded over

time, a condition examined under the next objective.

*4.3 Evidence on Learning Outcomes, Risks and Conditions*

The third objective was to synthesize evidence on the learning outcomes and risks of GenAI use. The review found that the evidence was mixed but patterned. On the positive side, meta-analyses reported that chatbots and ChatGPT were associated with improved learning performance, motivation and higher-order thinking, particularly when they were integrated into regular instruction rather than used as add-ons (Wu & Yu, 2024; Deng et al., 2025). In a randomized trial in a university physics course, students using an AI tutor designed according to research-based pedagogical principles learned more in less time than students in in-class active learning sessions (Kestin et al., 2025). In the Global South, the Nigerian trial reported gains of 0.31 standard deviations on a combined assessment and 0.23 standard deviations in English after six weeks, with the largest gains among female students (De Simone et al., 2025), and the Ghanaian trial reported an effect size of 0.36 on mathematics achievement (Henkel et al., 2024).

On the negative side, several studies reported that GenAI could substitute for rather than support learners' thinking. In the Turkish high school experiment, students with access to an unrestricted GPT-4 interface improved their practice scores by 48% but scored 17% lower on subsequent examinations without AI than students who had no access, whereas a tutor version that provided hints and was designed to protect learning largely mitigated this harm (Bastani et al., 2025). A randomized experiment with 1,625 students found that learners tended to rely on AI assistance rather than learn from it, and that their performance declined when the assistance was removed (Darvishi et al., 2024). A survey study also reported a negative association between frequent AI use and critical thinking, mediated by cognitive offloading (Gerlich, 2025). Other risks included inaccurate or fabricated content (Ji et al., 2023), bias and underrepresentation of non-Western contexts and languages (Bender et al., 2021; Joshi et al., 2020), threats to academic integrity (Cotton et al., 2024) and privacy concerns (UNESCO, 2023a). Table 5 summarizes the conditions that the reviewed studies associated with positive and negative outcomes.

Table 5. Conditions associated with positive and negative learning outcomes of generative AI use

| Condition | Associated with positive outcomes | Associated with negative outcomes |
|---|---|---|
| **Design of AI support** | Hints, prompts and Socratic questioning | Direct provision of complete answers |
| | Pedagogically constrained tutors | Unrestricted general-purpose chat |
| **Teacher role** | Teacher-designed tasks and supervision | Unsupervised, ad hoc use |
| | Integration into regular lessons | Use as an add-on to instruction |
| **Learner activity** | Learners explain, justify and revise their own work | Copying outputs |
| | Collaboration around AI outputs | Passive consumption of explanations |
| **Fading of support** | Gradual reduction of AI assistance | Continuous dependence |
| | Independent practice and assessment without AI | No independent practice |
| **Assessment** | Authentic, process-based and oral assessment | Take-home written products only |
| | Formative feedback | Assessment of answers rather than reasoning |
| **Critical evaluation** | Explicit verification of AI outputs | Uncritical acceptance of fluent but inaccurate content |
| | AI literacy instruction | |

*Note.* Conditions were synthesized from experimental, quasi-experimental and survey evidence in the reviewed literature. AI = artificial intelligence.

Moderating factors were also reported. The meta-analysis by Wu and Yu (2024) found that the effects of chatbots on learning outcomes were stronger in short interventions than in longer ones, which may reflect novelty effects that fade over time, and that most studies were conducted in higher education and in language learning. Deng et al. (2025) reported that the strongest effects occurred when ChatGPT was integrated into regular classroom practice rather than used as an add-on. The Nigerian trial found benefits across the distribution of prior achievement, with larger effects for higher-achieving students, and the largest gains for girls (De Simone et al., 2025). Systematic reviews of GenAI in K-12 education noted that most studies were exploratory and short-term, and that robust evidence on long-term learning and on the development of transferable competencies remained limited (Zhang &

Tur, 2024; Yan et al., 2024).

Read together, the evidence supported a clear analytical conclusion: GenAI improved learning when it functioned as a scaffold, providing contingent support that kept the learner cognitively active and that was gradually withdrawn, and it harmed learning when it functioned as a substitute that performed the task for the learner. This distinction corresponds closely to the difference between support within and beyond the ZPD in Vygotsky's theory, and it implies that the pedagogical design of GenAI use, rather than access alone, determines its effect on competency development.

*4.4 Contextual Enablers and Constraints in the Global South*

The fourth objective was to analyze the contextual factors that condition GenAI integration in Global South secondary schools. Infrastructure was the most fundamental constraint. In 2024, about 2.6 billion people remained offline, and only 27% of the population of low-income countries and 35% of the population of least developed countries used the internet, with a large gap between urban (83%) and rural (48%) areas and a persistent gender gap (ITU, 2024). An earlier assessment found that two-thirds of school-age children worldwide lacked internet access at home (United Nations Children's Fund [UNICEF] & ITU, 2020). In Sierra Leone, only 1% of primary schools had internet access and 6% had electricity in 2020, which led developers to deliver GenAI support through WhatsApp, a low-bandwidth channel already used by teachers (Choi et al., 2023).

Language, cost and capacity constituted further constraints. LLMs perform best in high-resource languages, and many African and Asian languages are poorly represented in training data (Joshi et al., 2020), which disadvantages learners who think and communicate in these languages. Costs of devices, data and subscriptions limit access in low-income households, potentially widening inequalities between urban and rural, and between private and public, schools (UNESCO, 2023b). Teachers' readiness to integrate AI depended on their AI literacy, confidence and perceived usefulness (Ayanwale et al., 2022), and AI literacy frameworks for students and teachers have only recently been developed (Ng et al., 2021; UNESCO, 2024a, 2024b). At the policy level, a 2023 survey found that fewer than 10% of schools and universities had formal guidance on GenAI (UNESCO, 2023c), and although continental and national AI strategies had emerged in Africa (African Union, 2024; Ministry of ICT and Innovation, 2023; Ministry of Information, Communications and the Digital Economy, 2025), they gave limited attention to classroom pedagogy.

Teacher readiness and ethical safeguards formed a further cluster of conditions. Studies of teachers in Nigeria and elsewhere found that their intention to integrate AI depended on their AI literacy, confidence and perceptions of usefulness and relevance to their learners (Ayanwale et al., 2022). Teachers in Tanzania and Sierra Leone required training and time before they could use GenAI effectively, and many initially used chatbots like search engines rather than as interactive partners (Choi et al., 2023; Kamaghe, 2026). Ethical concerns included the protection of minors' data, age-appropriateness and the risk of exposure to inaccurate or inappropriate content; UNESCO guidance recommended a minimum age of 13 for independent use of GenAI tools in the classroom and called for data protection and validation of tools before use (UNESCO, 2023a). These conditions imply that integration in secondary schools must be mediated and governed rather than left to individual learners.

The review also identified enablers. Widespread mobile phone ownership and messaging platforms allowed low-cost delivery of AI tutoring and teacher support (Henkel et al., 2024; Choi et al., 2023). Curriculum-aligned and retrieval-based systems reduced hallucination risks and improved relevance (Kloker et al., 2024). Structured programs that combined AI tutoring with teacher supervision, as in Nigeria, demonstrated that GenAI could be integrated into school routines at low cost (De Simone et al., 2025). Table 6 summarizes these enablers and constraints.

Table 6. Contextual enablers and constraints of generative AI integration in Global South secondary schools

| Dimension | Constraints | Enablers and responses |
|---|---|---|
| **Infrastructure and connectivity** | Low internet use in low-income and rural areas | Low-bandwidth channels such as messaging platforms |
| | Unreliable electricity | Shared devices and teacher-mediated use |
| | Few devices per learner | Offline and cached resources |
| **Language** | Weak AI performance in many local languages | Multilingual prompting and translation support |
| | Learning in second languages | Development of local-language datasets |
| **Cost and equity** | Device, data and subscription costs | Free or subsidized education tools |
| | Urban–rural and gender gaps | Public provision through schools |
| **Teacher capacity** | Limited AI literacy and training | Continuous professional development |
| | Heavy workloads | AI-assisted planning that saves time |
| **Curriculum alignment and accuracy** | Generic outputs not aligned to national syllabi | Curriculum-grounded, retrieval-based tools |
| | Fabricated content | Teacher verification |
| **Policy and governance** | Absence of school-level guidance | National guidance aligned with international frameworks |
| | Data protection and age-appropriateness concerns | Privacy-preserving procurement |

*Note.* Enablers and constraints were synthesized from empirical, policy and institutional sources in the reviewed literature. AI = artificial intelligence.

Overall, the findings indicated that the pedagogical potential of GenAI for CBE could be realized in the Global South only if integration was designed for low-resource conditions, mediated by teachers and embedded in supportive policy. Approaches that assumed one device per learner, continuous connectivity or English-language fluency were unlikely to be equitable or sustainable.

### *4.5 Synthesis Across Objectives*

Read together, the findings across the four objectives revealed a consistent pattern. CBE reforms in the Global South created a demand for intensive pedagogical mediation that teachers, under current conditions, could not fully meet. GenAI offered affordances that could partly meet this demand by providing scaffolding, dialogue, feedback and teacher support. The empirical evidence showed that these affordances translated into learning gains only when GenAI was used as a contingent and fading scaffold within teacher-designed activities, and that unguided use could weaken independent learning. Finally, the contextual analysis showed that infrastructure, language, cost, teacher capacity and policy determined whether such pedagogically sound use was feasible and equitable. The synthesis therefore pointed not to a technology solution but to a pedagogical design problem situated within structural constraints, which the framework in Section 6 addresses.

## 5. Discussion

### *5.1 Generative AI as Scaffold or Substitute*

The central finding of this review was that the educational effect of GenAI depended on whether it acted as a scaffold or a substitute. This finding is consistent with earlier research on technology-supported learning, which showed that adaptive technologies improved learning when they were designed around learners' current levels and active practice (Muralidharan et al., 2019), and with scaffolding research, which emphasizes contingency, fading and transfer of responsibility (van de Pol et al., 2010). The contrasting results of the Nigerian and Turkish studies are particularly instructive. In Nigeria, students used GenAI in supervised sessions designed around curriculum tasks, and learning improved substantially (De Simone et al., 2025). In Turkey, students with unrestricted access used the tool to obtain answers, improving practice performance but weakening independent learning (Bastani et al., 2025). The same technology produced opposite effects under different pedagogical designs.

From a social constructivist perspective, this contrast can be explained by the location of support relative to the ZPD. Support that requires the learner to reason, explain and attempt problems keeps learning within the zone, whereas support that completes the task removes the cognitive work through which internalization occurs. The concern about cognitive offloading (Gerlich, 2025) and dependence on AI assistance (Darvishi et al., 2024) can

thus be understood not as an inherent property of GenAI but as the consequence of scaffolds that do not fade. This interpretation has a practical implication: the question for schools is not whether learners should use GenAI, but how its support should be structured, monitored and withdrawn.

*5.2 Reconciling Contrasting Claims*

The review identified several contested claims in the literature (Table 7). Proponents argued that GenAI could personalize learning at scale and help close learning gaps in under-resourced systems (Kasneci et al., 2023; De Simone et al., 2025). Critics warned that AI in education is often driven by hype, commercial interests and techno-solutionism, and that it may deepen inequality or displace teachers (Selwyn, 2022; Williamson & Eynon, 2020; Nemorin et al., 2023). Both positions find support in the evidence. Gains were documented when tools were curriculum-aligned, low-cost and teacher-mediated, but these conditions were not the norm, and evidence from the most disadvantaged rural schools remained scarce.

Table 7. Contested claims about generative AI in competency-based secondary education and the balance of evidence

| Claim | Supporting arguments | Counter-arguments | Balance of evidence |
|---|---|---|---|
| **GenAI personalizes learning and closes learning gaps** | Learning gains in structured trials<br>Low marginal cost | Gains depend on design and supervision<br>Access is unequal | Promising where structured, teacher-mediated and accessible; unproven at scale in rural schools |
| **GenAI develops critical thinking** | Dialogue and questioning can stimulate reasoning | Cognitive offloading and overreliance | Depends on whether learners must explain, verify and justify |
| **GenAI reduces teacher workload** | Time savings in lesson planning<br>Support for differentiation | Outputs require checking<br>Training takes time | Time savings are real but must be reinvested in facilitation |
| **GenAI can replace scarce teachers** | AI tutors can provide individual support | Diagnosis, motivation, collaboration and judgement remain human tasks | GenAI complements but does not replace teachers |
| **GenAI undermines assessment integrity** | AI can produce assignments | Authentic and process-based assessment reduces the risk | Assessment redesign is required rather than prohibition |
| **GenAI is culturally and linguistically neutral** | Wide general knowledge | Bias and weak local-language performance | Local adaptation and critical use are necessary |

*Note.* The table synthesizes contrasting positions discussed in the reviewed literature. GenAI = generative artificial intelligence.

The debate over teacher replacement deserves particular attention in the Global South, where teacher shortages are severe (UNESCO, 2024c). Social constructivism suggests that the teacher's role as mediator is not reducible to the provision of information: teachers diagnose learners' needs, design tasks, sustain motivation, orchestrate collaboration and make judgements about competence within a cultural context. GenAI can extend teachers' reach, but it cannot perform these functions reliably. Policies that frame GenAI as a substitute for teacher recruitment and professional development therefore risk undermining the very mediation on which CBE depends.

*5.3 Assessment, Integrity and Authentic Demonstration of Competence*

GenAI poses a direct challenge to assessment practices that rely on take-home written products. Rather than attempting to detect or prohibit AI use, which has proved unreliable (Perkins, 2023; Cotton et al., 2024), the literature increasingly recommended redesigning assessment to focus on processes, oral explanations, practical demonstrations and collaborative products (Swiecki et al., 2022). This shift aligns with the principles of CBE, which emphasize demonstration of competence in authentic tasks (Gervais, 2016), and with constructivist emphasis on authentic learning environments (Herrington & Oliver, 2000). In this sense, GenAI may accelerate overdue changes in assessment that CBE reforms have struggled to achieve.

*5.4 Equity and the Risk of a New Digital Divide*

The review highlighted a risk that GenAI could widen rather than narrow educational inequalities. Learners in urban, private and well-resourced schools are more likely to have devices, connectivity and teachers able to use GenAI effectively, while rural and low-income learners face multiple barriers (ITU, 2024; UNESCO, 2023b). Gender gaps in internet use add a further dimension, although the Nigerian trial found the largest gains among girls when access was provided in school (De Simone et al., 2025). These findings suggest that equitable integration requires public provision through schools, low-bandwidth delivery, teacher mediation and attention to language, rather than reliance on learners' private access.

*5.5 Theoretical Implications*

The study extends social constructivist theory in two ways. First, it suggests that GenAI can function as a partial more knowledgeable other, providing contingent support through language, but that its value depends on the teacher's orchestration and on design features that ensure contingency and fading. This positions GenAI within a distributed scaffolding system in which teachers, peers and AI provide complementary forms of support (Puntambekar & Hübscher, 2005). Second, it suggests that the risk of overreliance can be theorized as scaffolding without fading, a concept that links the empirical findings on cognitive offloading with established scaffolding theory. These propositions can be tested in future research on GenAI in competency-based classrooms.

*5.6 The Changing Role of the Teacher*

The findings suggest that GenAI changes rather than diminishes the role of the teacher in CBE. In the transmissive model that CBE reforms sought to replace, the teacher's principal function was to deliver content. In a GenAI-supported competency-based classroom, content is abundantly available, and the teacher's distinctive contribution shifts toward diagnosing learners' ZPDs, designing authentic tasks, structuring and monitoring AI use, orchestrating collaboration, cultivating critical evaluation and judging competence. This shift is consistent with the social constructivist view of the teacher as mediator and with the demands of TPACK in the age of GenAI (Mishra et al., 2023). It also implies that GenAI could, if appropriately supported, help realize the facilitative role that CBE reforms envisaged but that teachers found difficult to adopt under heavy content and administrative loads. Conversely, without professional development, GenAI may reinforce transmissive practices if teachers use it mainly to produce notes and tests.

*5.7 Language, Culture and Local Knowledge*

Social constructivism emphasizes that learning is embedded in culture and mediated by language. This emphasis raises important questions for GenAI in the Global South. LLMs are trained predominantly on English-language and Western content, and their performance in many African and Asian languages remains weak (Joshi et al., 2020). As a result, AI-generated explanations, examples and scenarios may not reflect learners' cultural contexts, local knowledge or the examples used in national curricula, and may reproduce biases present in training data (Bender et al., 2021). The fabricated historical content found in a Ugandan lesson planning prototype where curriculum material was thin illustrates how gaps in local data can produce errors (Kloker et al., 2024). Curriculum-grounded systems, teacher review and deliberate use of local contexts in task design are therefore essential, and the development of local-language resources is a longer-term priority for equitable integration.

*5.8 Implications for Policy and Practice*

Several implications for policy and practice follow from the discussion. For curriculum authorities, the findings imply that guidance on GenAI should be integrated into competency-based curriculum frameworks rather than issued as separate technology policies, so that GenAI use is explicitly linked to competencies, learning outcomes and assessment. For teacher education, the findings imply that AI literacy should be developed together with scaffolding-oriented pedagogy, so that teachers can design tasks that keep learners within their ZPD and decide when to withdraw AI support (Mishra et al., 2023; UNESCO, 2024b). For assessment bodies, the findings imply that examination and school-based assessment systems should increase the weight of authentic, process-based and oral evidence of competence, which is both more consistent with CBE and more resilient to GenAI. For governments and development partners, the findings imply that investment should prioritize public, teacher-mediated and low-bandwidth access in rural and disadvantaged schools, rather than relying on learners' private devices.

For school leaders and teachers, the immediate implication is to begin with teacher-facing uses that save time and improve lesson quality, to introduce learner-facing uses through structured activities with clear rules, and to emphasize verification and critical evaluation of AI outputs as part of every task. Such an incremental approach allows schools to build capacity and evidence before expanding learner use, and it is consistent with the guidance that GenAI use should be human-centered and pedagogically appropriate (UNESCO, 2023a).

### *5.9 Knowledge Gaps and Research Agenda*

The review identified five priority gaps for research. First, rigorous evidence from rural, multilingual and low-connectivity secondary schools in the Global South remains scarce, as most experimental studies were conducted in urban schools or with structured programs. Second, the long-term effects of GenAI on transferable competencies such as critical thinking, problem-solving and collaboration have not been established, because most studies measured short-term achievement. Third, little is known about how teachers in competency-based systems adapt their scaffolding practices when GenAI is introduced, and how to design professional development that supports this adaptation. Fourth, the performance of GenAI in African and Asian languages, and its effects on learners who use these languages, require investigation. Fifth, the design of assessment systems that validly capture competence when GenAI is available remains an open question. Design-based research, randomized trials and longitudinal studies that test pedagogical frameworks such as the one proposed here would help address these gaps.

## 6. The Proposed Framework

### *6.1 Rationale*

The fifth objective was to develop an integrated pedagogical framework. The Scaffolded Generative AI for Competency-Based Education (SGAI-CBE) framework was derived from the analytical themes of the review and organized around the concepts of social constructivism. It responded to the scaffolding deficit identified in CBE implementation (Section 4.1), the affordances of GenAI for mediation (Section 4.2), the conditions distinguishing scaffolding from substitution (Section 4.3) and the contextual enablers and constraints of the Global South (Section 4.4).

### *6.2 Structure of the Framework*

The framework comprises three layers (Figure 3). The foundation layer consists of enabling conditions: infrastructure and low-bandwidth access, teacher professional development and AI literacy, curriculum-aligned and multilingual tools, and policy, ethics and data protection. The core layer is a six-phase pedagogical cycle anchored in the ZPD: (1) diagnose and plan, in which the teacher identifies target competencies and learners' current levels, using GenAI to support planning; (2) activate and pose authentic tasks, in which learners encounter meaningful problems; (3) scaffold with AI and teacher, in which GenAI provides hints, questions and feedback under teacher-designed constraints; (4) collaborate and co-construct, in which learners discuss, compare and critique ideas, including AI outputs, in groups; (5) apply and demonstrate, in which learners complete authentic performance tasks with reduced AI support; and (6) assess, reflect and fade, in which teachers assess competence through authentic evidence, learners reflect on their learning, and AI support is reduced for subsequent tasks. The guardrail layer specifies principles that apply throughout: hints before answers, verification of AI outputs, teacher oversight, transparency about AI use, privacy protection and inclusion.

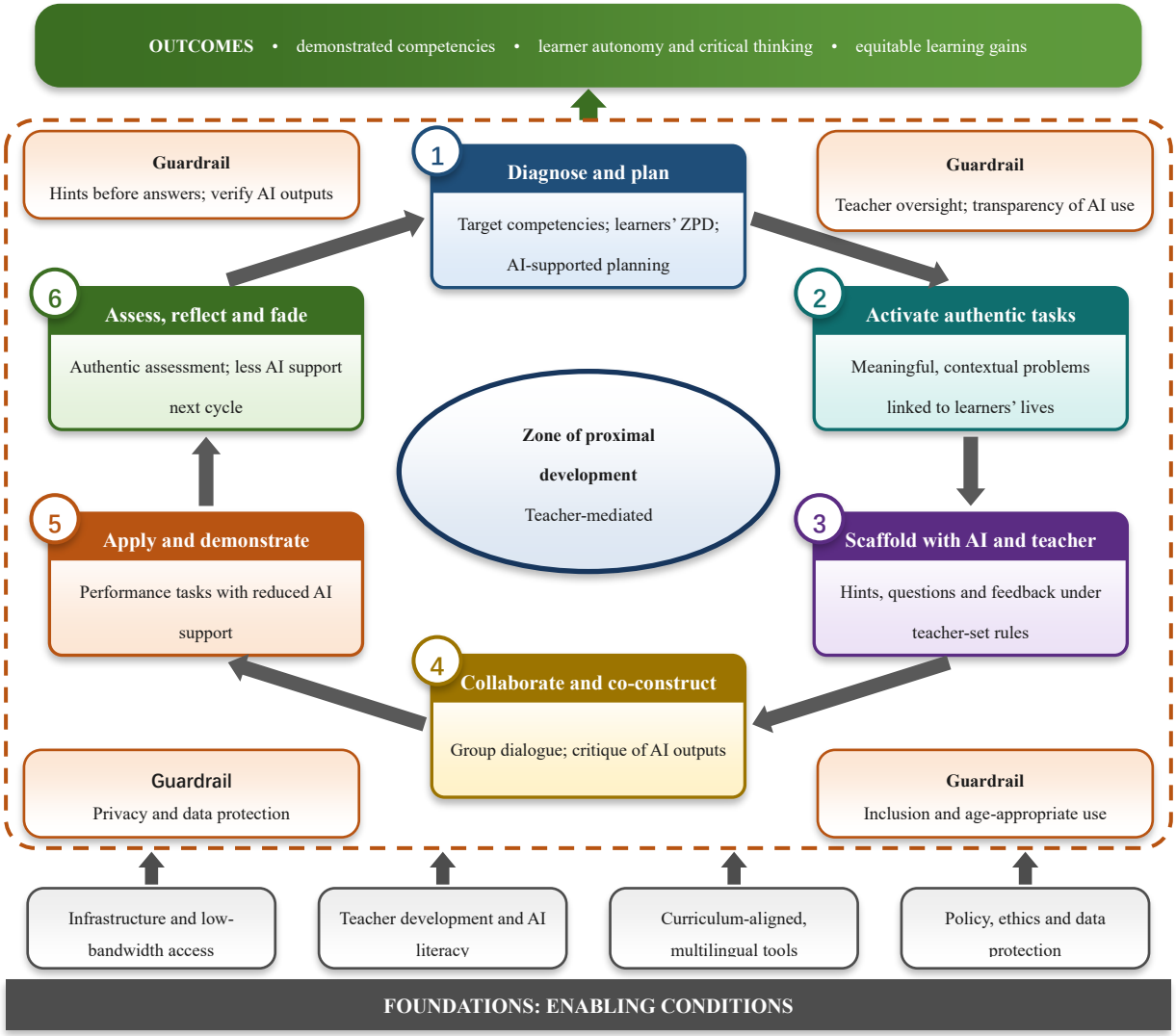



Figure 3. The Scaffolded Generative AI for Competency-Based Education (SGAI-CBE) framework

*Note.* The framework was developed from the thematic synthesis of the reviewed literature and social constructivist theory. Numbered cards and arrows show the sequence of the pedagogical cycle around the zone of proximal development; Phase 6 returns to Phase 1. The dashed frame indicates guardrails that apply throughout the cycle, and the foundations represent enabling conditions. AI = artificial intelligence; CBE = competency-based education; GenAI = generative artificial intelligence; ZPD = zone of proximal development.

Table 8 specifies, for each phase, the roles of the teacher, the learner and GenAI, and the evidence of competence that the phase generates. The distribution of roles reflects the principle that the teacher remains the principal mediator, the learner progressively assumes responsibility, and GenAI provides contingent support that fades.

Table 8 Phases of the SGAI-CBE pedagogical cycle and the roles of teacher, learner and generative AI

| Phase | Teacher role | Learner role | Generative AI role | Evidence of competence |
|---|---|---|---|---|
| **1. Diagnose and plan** | Identifies target competencies<br>Diagnoses prior knowledge | Completes diagnostic tasks | Supports lesson planning and diagnostic item generation | Baseline performance |
| **2. Activate and pose authentic tasks** | Presents a meaningful problem linked to learners' context | Connects the task to prior experience | Generates contextual scenarios and examples | Problem framing |
| **3. Scaffold with AI and teacher** | Sets AI rules and prompts<br>Monitors and intervenes | Attempts the task<br>Asks for hints and explanations | Gives hints, questions and feedback, not complete answers | Draft solutions and reasoning |
| **4. Collaborate and co-construct** | Organizes groups<br>Facilitates discussion | Explains, compares and critiques ideas and AI outputs | Offers alternative perspectives for critique | Group products and dialogue |
| **5. Apply and demonstrate** | Designs performance tasks<br>Reduces AI support | Completes tasks independently or in teams | Limited or no support | Projects, demonstrations and oral explanations |
| **6. Assess, reflect and fade** | Assesses with rubrics<br>Gives feedback<br>Adjusts the next cycle | Reflects and sets goals | Supports feedback drafting under teacher review | Rubric-based judgements and reflective records |

*Note.* The phases form a cycle; evidence from Phase 6 informs Phase 1 of the next cycle. SGAI-CBE = Scaffolded Generative AI for Competency-Based Education.

The guardrail layer translates the evidence on risks into operational principles. The principle of hints before answers requires that GenAI tools used by learners be configured or prompted to provide questions, hints and partial support rather than complete solutions, reflecting the evidence that pedagogically constrained tutors avoided the harms of unrestricted access (Bastani et al., 2025). The principle of verification requires learners to check AI outputs against textbooks, data or peer discussion and to explain why they accept or reject them, which develops critical thinking and mitigates hallucination. The principle of teacher oversight requires that teachers set the purposes and limits of AI use in each activity. The principle of transparency requires learners to disclose how they used AI in their work, which supports both integrity and reflection. The principles of privacy and inclusion require that tools protect learners' data, respect age limits and be accessible to learners with different languages, abilities and levels of access (UNESCO, 2023a).

### *6.3 Adapting the Framework to Different Resource Contexts*

Because resource conditions vary widely within and between countries of the Global South, the framework is designed to be implemented at different levels of technological access (Table 9). In schools without learner devices or connectivity, GenAI can still support teachers in planning and in generating tasks, examples and feedback, which teachers then use in conventional classroom activities. In schools with intermittent connectivity and shared devices, teacher-led demonstrations and small-group use of GenAI through low-bandwidth channels can provide scaffolding and stimulate collaborative critique. In schools with reliable access, learners can use pedagogically constrained AI tutors individually and in groups, with assessment and fading designed explicitly into the cycle.

Table 9. Implementation of the SGAI-CBE framework across resource contexts

| Element | Low-resource schools (no learner access) | Intermediate schools (shared or intermittent access) | Higher-resource schools (reliable access) |
|---|---|---|---|
| **Mode of AI use** | Teacher-only use for planning and materials | Teacher demonstrations<br>Small-group use via low-bandwidth channels | Individual and group use of constrained AI tutors |
| **Scaffolding** | Teacher provides scaffolds prepared with AI support | Combined teacher and AI scaffolds in groups | Contingent AI hints with teacher monitoring |
| **Collaboration** | Group work using AI-generated tasks and cases | Groups critique AI outputs together | Peer review of AI-assisted work |
| **Assessment** | Oral and practical demonstrations | Process records and group presentations | Portfolios, projects and oral defences |
| **Priority enablers** | Teacher training and offline resources | Low-bandwidth tools and shared devices | Guardrails, data protection and fading routines |

*Note.* The table illustrates how the framework can be adapted; schools may combine elements across columns. AI = artificial intelligence; SGAI-CBE = Scaffolded Generative AI for Competency-Based Education.

### *6.4 Roles of Stakeholders in Implementation*

Implementing the framework requires coordinated action by several stakeholders. Ministries of education and curriculum agencies are responsible for aligning GenAI guidance with competency frameworks, approving curriculum-aligned tools and setting data protection standards. Teacher education institutions are responsible for developing teachers' AI literacy and scaffolding-oriented pedagogy. School leaders are responsible for establishing school-level rules, organizing shared access and supporting teachers' professional learning. Teachers are responsible for designing and orchestrating the pedagogical cycle, monitoring AI use and assessing competence. Learners are responsible for using GenAI to support rather than replace their thinking, verifying outputs and reflecting on their learning. Parents and communities can support responsible use at home and contribute local knowledge to authentic tasks. Developers and development partners can contribute by building low-bandwidth, multilingual and pedagogically constrained tools that provide hints before answers.

### *6.5 Novelty of the Framework*

The novelty of the SGAI-CBE framework lies in three respects. First, it is grounded in an explicit learning theory, which provides a rationale for each phase and role rather than a list of tools or uses. Second, it addresses the empirical evidence on both benefits and harms by building fading, verification and authentic assessment into the pedagogical cycle. Third, it is designed for the Global South by distinguishing implementation levels according to resource conditions and by placing teacher capacity, language and equity among its foundations. The framework is conceptual and should be validated through design-based research and controlled trials in diverse secondary school settings.

## 7. Conclusion and Recommendations

This study set out to develop a theoretically grounded pedagogical framework for integrating GenAI into competency-based secondary education in the Global South. The review found that CBE reforms were constrained by a scaffolding deficit arising from limited teacher preparation, large classes, demanding planning and assessment, and scarce resources. GenAI offered affordances that could expand mediation capacity, including contingent explanations, dialogue, feedback, authentic task design and teacher support. Empirical evidence showed that GenAI improved learning when it was structured as a scaffold within teacher-designed activities, as demonstrated in trials in Nigeria and Ghana, but harmed independent learning when it substituted for learners' thinking. Infrastructure, language, cost, teacher capacity and policy gaps conditioned equitable integration.

Guided by Vygotsky's social constructivist theory, the study proposed the SGAI-CBE framework, which organizes GenAI use into a six-phase pedagogical cycle anchored in the ZPD and supported by enabling conditions and guardrails. The framework positions the teacher as principal mediator, GenAI as a contingent and fading scaffold, and the learner as an increasingly autonomous constructor and demonstrator of competence.

Several recommendations follow. Ministries of education and curriculum agencies should issue guidance on GenAI that is aligned with competency-based curricula and that emphasizes pedagogy and assessment, not only access and ethics. Teacher education institutions should integrate AI literacy and scaffolding-oriented pedagogy

into pre-service and in-service programs. Developers and education authorities should prioritize curriculum-aligned, multilingual and low-bandwidth tools that provide hints before answers. Schools should redesign assessment towards authentic, process-based and oral demonstrations of competence. Governments should invest in connectivity and shared devices in public and rural schools to prevent a new digital divide. Finally, researchers should conduct rigorous, long-term studies of GenAI in Global South secondary schools, including in rural and multilingual settings, and should test and refine the SGAI-CBE framework through design-based research.

**References**

African Union. (2024). *Continental artificial intelligence strategy: Harnessing AI for Africa's development and prosperity*. African Union Commission.

Akala, B. M. (2021). Revisiting education reform in Kenya: A case of competency based curriculum (CBC). *Social Sciences & Humanities Open*, *3*(1), 100107. https://doi.org/10.1016/j.ssaho.2021.100107

Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence*, *3*, 100099. https://doi.org/10.1016/j.caeai.2022.100099

Bastani, H., Bastani, O., Sungu, A., Ge, H., Kabakcı, Ö., & Mariman, R. (2025). Generative AI without guardrails can harm learning: Evidence from high school mathematics. *Proceedings of the National Academy of Sciences*, *122*(26), e2422633122. https://doi.org/10.1073/pnas.2422633122

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. (2021). On the dangers of stochastic parrots: Can language models be too big?. In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency* (pp. 610–623). Association for Computing Machinery. https://doi.org/10.1145/3442188.3445922

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

Choi, J. H., Garrod, O., Atherton, P., Joyce-Gibbons, A., Mason-Sesay, M., & Björkegren, D. (2023). *Are LLMs useful in the poorest schools? TheTeacher.AI in Sierra Leone* (arXiv:2310.02982). arXiv. https://doi.org/10.48550/arXiv.2310.02982

Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2024). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, *61*(2), 228–239. https://doi.org/10.1080/14703297.2023.2190148

Darvishi, A., Khosravi, H., Sadiq, S., Gašević, D., & Siemens, G. (2024). Impact of AI assistance on student agency. *Computers & Education*, *210*, 104967. https://doi.org/10.1016/j.compedu.2023.104967

De Simone, M., Tiberti, F., Barron Rodriguez, M., Manolio, F., Mosuro, W., & Dikoru, E. J. (2025). *From chalkboards to chatbots: Evaluating the impact of generative AI on learning outcomes in Nigeria* (Policy Research Working Paper No. 11125). World Bank. https://doi.org/10.1596/1813-9450-11125

Deng, R., Jiang, M., Yu, X., Lu, Y., & Liu, S. (2025). Does ChatGPT enhance student learning? A systematic review and meta-analysis of experimental studies. *Computers & Education*, *227*, 105224. https://doi.org/10.1016/j.compedu.2024.105224

Education Endowment Foundation. (2024). *ChatGPT in lesson preparation: A teacher choices trial*. Education Endowment Foundation.

Gerlich, M. (2025). AI tools in society: Impacts on cognitive offloading and the future of critical thinking. *Societies*, *15*(1), 6. https://doi.org/10.3390/soc15010006

Gervais, J. (2016). The operational definition of competency-based education. *The Journal of Competency-Based Education*, *1*(2), 98–106. https://doi.org/10.1002/cbe2.1011

Henkel, O., Horne-Robinson, H., Kozhakhmetova, N., & Lee, A. (2024). *Effective and scalable math support: Evidence on the impact of an AI-tutor on math achievement in Ghana* (arXiv:2402.09809). arXiv. https://doi.org/10.48550/arXiv.2402.09809

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, *48*(3), 23–48. https://doi.org/10.1007/BF02319856

Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., … Pluye, P. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for*

*Information*, *34*(4), 285–291. https://doi.org/10.3233/EFI-180221

International Telecommunication Union. (2024). *Measuring digital development: Facts and figures 2024*. ITU.

Ji, Z., Lee, N., Frieske, R., Yu, T., Su, D., Xu, Y., … Fung, P. (2023). Survey of hallucination in natural language generation. *ACM Computing Surveys*, *55*(12), 248. https://doi.org/10.1145/3571730

Joshi, P., Santy, S., Budhiraja, A., Bali, K., & Choudhury, M. (2020). The state and fate of linguistic diversity and inclusion in the NLP world. In *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics* (pp. 6282–6293). Association for Computational Linguistics. https://doi.org/10.18653/v1/2020.acl-main.560

Kamaghe, J. (2026). Generative AI as a partner for teachers in building personalised learning paths for students with ease in Tanzania. *Research in Learning Technology*, *34*. https://doi.org/10.25304/rlt.v34.3594

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., . . . Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*, 102274. https://doi.org/10.1016/j.lindif.2023.102274

Kenya Institute of Curriculum Development. (2017). *Basic education curriculum framework*. KICD.

Kestin, G., Miller, K., Klales, A., Milbourne, T., & Ponti, G. (2025). AI tutoring outperforms in-class active learning: An RCT introducing a novel research-based design in an authentic educational setting. *Scientific Reports*, *15*, 17458. https://doi.org/10.1038/s41598-025-97652-6

Kloker, S., Bukoli, H., & Kateete, T. (2024). *New curriculum, new chance: Retrieval augmented generation for lesson planning in Ugandan secondary schools. Prototype quality evaluation* (arXiv:2408.07542). arXiv. https://doi.org/10.48550/arXiv.2408.07542

Lo, C. K. (2023). What is the impact of ChatGPT on education? A rapid review of the literature. *Education Sciences*, *13*(4), 410. https://doi.org/10.3390/educsci13040410

Ministry of ICT and Innovation. (2023). *The national artificial intelligence policy*. Republic of Rwanda.

Ministry of Information, Communications and the Digital Economy. (2025). *Kenya artificial intelligence strategy 2025–2030*. Republic of Kenya.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Mishra, P., Warr, M., & Islam, R. (2023). TPACK in the age of ChatGPT and generative AI. *Journal of Digital Learning in Teacher Education*, *39*(4), 235–251. https://doi.org/10.1080/21532974.2023.2247480

Muralidharan, K., Singh, A., & Ganimian, A. J. (2019). Disrupting education? Experimental evidence on technology-aided instruction in India. *American Economic Review*, *109*(4), 1426–1460. https://doi.org/10.1257/aer.20171112

National Curriculum Development Centre. (2019). *Lower secondary curriculum framework*. NCDC.

Ndihokubwayo, K., & Habiyaremye, H. T. (2018). Why did Rwanda shift from knowledge to competence based curriculum? Syllabuses and textbooks point of view. *African Research Review*, *12*(3), 38–48. https://doi.org/10.4314/afrrev.v12i3.4

Nemorin, S., Vlachidis, A., Ayerakwa, H. M., & Andriotis, P. (2023). AI hyped? A horizon scan of discourse on artificial intelligence in education (AIED) and development. *Learning, Media and Technology*, *48*(1), 38–51. https://doi.org/10.1080/17439884.2022.2095568

Ng, D. T. K., Leung, J. K. L., Chu, S. K. W., & Qiao, M. S. (2021). Conceptualizing AI literacy: An exploratory review. *Computers and Education: Artificial Intelligence*, *2*, 100041. https://doi.org/10.1016/j.caeai.2021.100041

Organisation for Economic Co-operation and Development. (2019). *OECD future of education and skills 2030: OECD learning compass 2030*. OECD.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., . . . Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*(71). https://doi.org/10.1136/bmj.n71

Perkins, M. (2023). Academic integrity considerations of AI large language models in the post-pandemic era: ChatGPT and beyond. *Journal of University Teaching and Learning Practice*, *20*(2), 7. https://doi.org/10.53761/1.20.02.07

Puntambekar, S., & Hübscher, R. (2005). Tools for scaffolding students in a complex learning environment: What have we gained and what have we missed?. *Educational Psychologist*, *40*(1), 1–12.

https://doi.org/10.1207/s15326985ep4001_1

Rwanda Education Board. (2015). *Competence-based curriculum: Curriculum framework pre-primary to upper secondary*. REB.

Selwyn, N. (2022). The future of AI and education: Some cautionary notes. *European Journal of Education*, *57*(4), 620–631. https://doi.org/10.1111/ejed.12532

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J. M., Milligan, S., … Gašević, D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence*, *3*, 100075. https://doi.org/10.1016/j.caeai.2022.100075

Thomas, J., & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, *8*, 45. https://doi.org/10.1186/1471-2288-8-45

UNESCO. (2023a). *Guidance for generative AI in education and research*. UNESCO. https://doi.org/10.54675/EWZM9535

UNESCO. (2023b). *Global education monitoring report 2023: Technology in education—A tool on whose terms?*. UNESCO. https://doi.org/10.54676/UZQV8501

UNESCO. (2023c, June 1). *UNESCO survey: Less than 10% of schools and universities have formal guidance on AI* [Press release]. UNESCO.

UNESCO. (2024a). *AI competency framework for students*. UNESCO. https://doi.org/10.54675/JKJB9835

UNESCO. (2024b). *AI competency framework for teachers*. UNESCO. https://doi.org/10.54675/ZJTE2084

UNESCO. (2024c). *Global report on teachers: Addressing teacher shortages and transforming the profession*. UNESCO.

United Nations Children's Fund & International Telecommunication Union. (2020). *How many children and young people have internet access at home? Estimating digital connectivity during the COVID-19 pandemic*. UNICEF.

van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher–student interaction: A decade of research. *Educational Psychology Review*, *22*(3), 271–296. https://doi.org/10.1007/s10648-010-9127-6

van den Berg, G., & du Plessis, E. (2023). ChatGPT and generative AI: Possibilities for its contribution to lesson planning, critical thinking and openness in teacher education. *Education Sciences*, *13*(10), 998. https://doi.org/10.3390/educsci13100998

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Whittemore, R., & Knafl, K. (2005). The integrative review: Updated methodology. *Journal of Advanced Nursing*, *52*(5), 546–553. https://doi.org/10.1111/j.1365-2648.2005.03621.x

Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. *Learning, Media and Technology*, *45*(3), 223–235. https://doi.org/10.1080/17439884.2020.1798995

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, *17*(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

World Bank, UNESCO, UNICEF, FCDO, USAID, & Bill & Melinda Gates Foundation. (2022). *The state of global learning poverty: 2022 update*. World Bank.

Wu, R., & Yu, Z. (2024). Do AI chatbots improve students learning outcomes? Evidence from a meta-analysis. *British Journal of Educational Technology*, *55*(1), 10–33. https://doi.org/10.1111/bjet.13334

Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., … Gašević, D. (2024). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology*, *55*(1), 90–112. https://doi.org/10.1111/bjet.13370

Zhang, P., & Tur, G. (2024). A systematic review of ChatGPT use in K-12 education. *European Journal of Education*, *59*(2), e12599. https://doi.org/10.1111/ejed.12599

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

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