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Rethinking Roles of Open-Source Platforms in Equipping Ghanaian Graduates for the Future of Work

Jessica Amarteifio¹

 0000-0001-7869-2666

University of Ghana

jamarteifio002@st.ug.edu.gh

Goldman Dodzi Awuku²

 0009-0007-4488-0643

University of Ghana

awukugoldman@gmail.com

Abigail A. Aryeh-Adjei^{3*}

 0000-0003-0767-9100

University of Ghana

aaryeh-adjei@ug.edu.gh

ABSTRACT

Open-source platforms (OSPs) hold untapped potential to equip Ghanaian graduates with the skills demanded by the future of work. Yet in Ghana's higher education system, the impact of open-source platforms such as Sakai learning management software (LMS), Moodle LMS, GitHub, and Sentence-BERT models remains limited by fragmented strategies and poor institutional coordination. In fact, existing studies have failed to assess how these platforms contribute to employability. Guided by Connectivism, the review draws on evidence from eighteen relevant studies that demonstrate how open-source platforms have strong potential to support collaboration, digital problem-solving, and continuous learning. The value of OSPs remains untapped because most universities rely on them for content delivery rather than skill development. The analysis reveals limited curricular integration, weak faculty capacity, unreliable infrastructure, and fragmented digital policy structures, which restrict graduates' opportunities to engage with these platforms as learning networks. The review establishes that current practices provide only partial support for the acquisition of future-oriented competencies. It also shows that institutional systems must shift from access provision to intentional, skill-focused design. The synthesis provides a clearer understanding of the structural and instructional reforms

required to embed open-source platforms in higher education and offers practical insights for strengthening graduate readiness in Ghana and similar contexts.

Keywords: *Open-source platforms, skill development, Connectivism, future of work, higher education*

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**Corresponding author: Abigail A. Aryeh-Adjei, aaryeh-adjei@ug.edu.gh*

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Introduction

Open-source platforms (OSPs) have gained renewed attention as universities seek practical ways to prepare graduates for fast-shifting forms of work driven by automation, data intelligence and distributed innovation. Open-source platforms refer to digital systems whose underlying code is publicly available for use, modification, and redistribution (Beattie et al. 2020), which sets them apart from closed-source or proprietary platforms that restrict access to source code and limit user control through paid licences. OSPs span operating systems, learning management systems, database tools, design software and emerging artificial intelligence applications such as Llama 2-Chat and Sentence Bert (Boateng et al. 2022), and they draw contributors from both technical and non-technical fields. Their openness supports collaboration, knowledge sharing and self-directed skill development, yet higher education institutions often do not realise the full value of these platforms because of limited investment in training, insufficient technical support and uneven institutional adoption (Beattie et al., 2020; Longe et al., 2021).

There is growing interest in open-source platforms solutions as enablers of workforce readiness, especially where universities seek practice-oriented digital skills through experiential learning and close industry engagement (Chakraborty et al. 2024). Many institutions in North America, Europe and Asia integrate open-source platforms into project-based modules that strengthen problem-solving and applied technological competencies (Beattie et al. 2020). In Africa, researchers report that open-source adoption helps institutions reduce costs and widen access to learning materials, although progress remains uneven due to infrastructure gaps, limited faculty preparedness and weak policy alignment (Sarpong 2023; Loglo 2024). Countries such as Kenya and South Africa show promising use of open-source learning management systems (Sims 2024; Maluleke and Maake 2025), yet large-scale integration remains constrained.

Ghana reflects this wider continental pattern. Policy frameworks such as the ICT4AD Policy and the ICT in Education Policy encourage technology use across tertiary institutions (Adarkwah & Huang 2023), and universities have introduced platforms such as Moodle and Sakai to support blended and distance learning (Sarpong, 2023). Local innovations such as the iBox system further demonstrate potential for context-responsive open-source solutions that address bandwidth and device limitations (Mallet et al., 2022). Although these initiatives point to steady progress, research indicates that adoption remains inconsistent

because of connectivity challenges, limited staff capacity and the absence of targeted measures that promote future-oriented digital skill development (Loglo, 2024). Understanding how open-source platforms equip Ghanaian graduates for emerging forms of work therefore remains essential for strengthening institutional strategies and informing policy decisions.

OSPs promise strong contributions to future-oriented skills, yet existing research does not provide a clear assessment of how these platforms shape graduate readiness in Ghana. Studies in Ghanaian higher education focus on ICT access and emergency remote teaching rather than systematic engagement with open-source platforms for employability. Aryeh-Adjei *et al.* (2023) investigated online learning experiences of students with special needs through qualitative interviews and centred their analysis on accessibility challenges within an uncustomised learning management system, but they do not assess skill development for future work. While Mallet *et al.* (2022) examined the iBox offline system as a response to infrastructure barriers and document its strengths for content delivery, their conference paper has a descriptive design that limits evaluation of long-term skills acquisition. Longe *et al.* (2021) further described AI education reforms through an institutional case of an emerging AI degree and presented programme-level intentions without empirical evidence on outcomes. Beattie *et al.* (2020) advance a global argument for open-source STEM tools through a conceptual exposition rather than field-based analysis, while Zhang *et al.* (2025) evaluate GeoGebra supported professional development through a qualitative dominant mixed design centred on one preservice teacher, which restricts its transferability. These studies diverge in scope, methods and theoretical frames, yet they converge on the absence of rigorous examination of open-source platforms as mechanisms for structured skills training.

Research outside Ghana indicates that open-source adoption supports readiness for emerging work when platforms integrate with industry informed curricula and when institutions provide sustained technical support (Sarpong, 2023). However, reviews show scattered implementation across African universities and limited evidence on how students engage open-source platforms for self-directed learning or applied problem solving (Loglo, 2024). Current scholarship (Loglo 2024; Longe *et al.* 2021; Zhang *et al.* 2025; Beattie *et al.* 2020) therefore lacks a consolidated analysis that compares educational intentions with actual graduate preparation and that aligns open-source practices with national workforce priorities. This review offers a needed contribution through a Meta synthesis of academic and policy literature that clarifies how open-source platforms contribute to skill development that leads to employment, identifies structural constraints that restrict their uptake and establishes an evidence base that supports coherent institutional planning in Ghanaian higher institutions. More specifically, this study seeks to:

- (1) assess how open-source platforms contribute to the preparedness of Ghanaian graduates for the future of work,
- (2) explore how these platforms are being used among Ghanaian graduates,
- (3) examine some institutional implementation gaps that hinder full integration of these platforms.

Reviewing relevant studies in this area, holds practical value because a meta synthesis can consolidate dispersed evidence across institutional reports, policy documents and empirical studies in ways a single case study cannot achieve, thereby offering a broader

foundation for decision making. The urgency stems from rapid shifts in work driven by automation and AI that require universities to align digital learning systems with industry expectations. A synthesis of this scope will support higher education leaders seeking credible guidance on scalable adoption models, inform policymakers who design national skills frameworks and assist curriculum planners and faculty who integrate open-source platforms into teaching and assessment.

Related Works

Research across higher education shows strong interest in open-source platforms as cost-effective tools that expand access to digital resources and support skill formation for fast-changing work environments, yet evidence remains scattered and methodologically uneven. International contributions view open-source platforms as enablers of digital literacy and collaborative problem solving, although many rely on conceptual reasoning rather than empirical analysis (Beattie et al., 2020; Chakraborty et al., 2024). African studies document their potential for widening access to learning materials but often employ descriptive designs that limit explanations of long-term employability outcomes (Sarpong, 2023).

Most studies from Ghana focus more on online learning experiences, distance education outcomes and assistive technologies rather than systematic assessment of open-source ecosystems for graduate readiness (Aryeh-Adjei et al. 2023; Ofosuhen 2023; Odame et al. 2021). These differences reveal a fragmented body of work that does not fully examine how open-source platforms shape graduate preparation. This review therefore consolidates diverse strands of evidence to establish a clearer basis for understanding their role in future-oriented skills development.

Open-Source Platforms and Graduate Preparedness

Evidence from international and African research indicates that open-source platforms can strengthen graduate preparedness through experiential learning, industry collaboration and cost-efficient access to digital training, although studies vary in scope and methodological rigour. Forshaw et al. (2016) present one of the few practice-based cases where structured engagement with open-source technologies and industry partners improved employment outcomes, yet their design focuses on a single programme in a developed context. Ebom-Jebose (2025) argues that open-source platforms expand digital skills in low-income settings, but the analysis remains descriptive and does not examine institutional or behavioural factors that shape adoption. Platforms such as GitHub, Moodle and Sakai embody several connectivist learning affordances, including collaborative content creation, peer interaction and iterative knowledge updating, which can facilitate networked learning communities that extend beyond traditional classroom boundaries.

In the context of the fourth industrial revolution, some studies of employability among Nigerian graduates offer quantitative evidence on student readiness but does not investigate the role of specific open-source platforms (Opesemowo et al. 2025). While Ghanaian studies on distance education and disability inclusion confirm that university programmes develop some employability attributes, they do not evaluate how open-source platforms influence these capabilities (Ofosuhen, 2023; Odame et al., 2021). This review

extends current literature through an integrative assessment that links platform use, skill development and changing work requirements.

Application of Open-Source Platforms

Research on actual use of open-source platforms among graduates remains thin and fragmented across sector-specific case studies. For instance, Mallet et al. (2022) document how the iBox offline system supports flexible learning in low-connectivity areas, although their analysis emphasises content delivery rather than applied skill development. While Boateng et al. (2022) demonstrate how KwameAI draws on open-source S-BERT models and supports data-driven problem solving in STEM competitions, this example remains limited to high-achieving student groups. Studies on health worker development show how open-source mobile platforms support continuous professional learning among rural nurses, although they do not address graduate transition into broader labour markets (Mwaikambo and Dolphyne 2025).

Moreover, Peterson and Finn (2025) reveal strong faculty-led adoption of free and open-source platforms but limited institutional support, which affects student engagement and continuity of use. These findings show that adoption exists across various domains but lacks systematic integration into graduate preparation pathways, an issue this review addresses through cross-sector analysis.

Institutional Implementation Gaps

Institutional constraints remain a central barrier to the full integration of open-source platforms in Ghanaian higher education, as studies repeatedly identify gaps in infrastructure, governance, and staff capacity. Loglo (2024) reports inconsistent implementation across universities due to connectivity challenges, inadequate technical support, and weak policy alignment. Khelifi et al. (2009) argue that open-source adoption reduces costs and increases customization, yet their case study from a Gulf context emphasises initial development rather than long-term sustainability. Midha and Bhattacharjee (2012) examine governance structures in open-source projects and show how participation and responsibility management influence maintenance outcomes, a dimension absent in Ghanaian institutional practices. Peterson and Finn (2025) identify faculty willingness but limited institutional frameworks for integrating free and open-source applications with existing learning management systems.

Across Ghana, resistance to change, limited pedagogical training and isolated innovation constrain progress even where promising initiatives exist such as AI-focused programmes at Academic City (Longe et al., 2021). This review advances the literature through a focused synthesis that links institutional conditions with platform functionality and assesses how these constraints shape graduate readiness.

Theoretical Framework

Learning within digital environments increasingly reflects the principles of George Siemens's Connectivism (Siemens, 2004), which conceptualises knowledge as distributed across networks of people, digital tools and information sources. Rather than being

confined to individual cognition, learning occurs through the ability to form connections, access diverse knowledge nodes and continuously update information within dynamic digital environments (Siemens, 2004). Open-source platforms (OSPs) provide practical infrastructures that align with these principles. For instance, collaborative repositories such as GitHub enable distributed knowledge construction through version control systems that track contributions, revisions and collective problem-solving among networked users. Similarly, learning management systems such as Moodle incorporate discussion forums, peer review modules and collaborative workspaces that allow learners to engage in shared knowledge production and iterative feedback. These features support connectivist processes of network creation, knowledge exchange and continuous learning, where learners actively participate in digital communities rather than passively receiving content (Hendricks, 2019). In the context of higher education, such environments have the potential to help students develop competencies associated with the future of work, including collaborative problem-solving, digital literacy and adaptive learning practices. However, as this review later demonstrates, the integration of these platforms in many Ghanaian universities has not yet fully leveraged their connectivist potential for graduate employability development.

Empirical studies affirm its utility in technology-integrated education. For example, Longe et al. (2021) demonstrate how AI-driven education in Ghana fosters future-ready skills through networked learning principles, aligning with connectivism's emphasis on adaptability and connectivity. Likewise, Bekele et al. (2023) advocate for culturally grounded strategies to integrate technology effectively, echoing connectivism's call for contextualized networks that respect local realities. These insights strengthen the argument that OSPs, when intentionally designed, can move beyond content delivery toward skill-focused learning ecosystems.

Connectivism has also been applied in studies exploring personal learning environments and digital pedagogy. Conradie (2013) shows that connectivist approaches support self-directed learning and critical thinking, while Plueger (2024) highlights their role in expanding theoretical bases for educational technology in higher education. Reviews by Utecht and Keller (2019) further emphasize its transformative potential for designing learner-centred, technology-integrated curricula.

Despite its promise, connectivism faces notable limitations. Scholars such as Clarà and Barberà (2014) question its theoretical rigor, citing conceptual ambiguities and insufficient explanation of deep learning processes like concept formation. Others argue that its reliance on technology risks exacerbating digital divides, particularly in resource-constrained contexts (Şahin & Abu Safieh, 2012). Furthermore, Dennis (2024) critiques its under-theorization of interaction and overemphasis on connectivity without adequately addressing pedagogical structure. These limitations underscore the need for complementary frameworks and robust institutional support when applying connectivism in higher education.

By framing OSPs as nodes within a learning network, connectivism provides a powerful lens for analyzing structural and instructional reforms needed to embed digital platforms in Ghanaian universities. It offers a theoretical foundation for shifting from mere access provision to intentional, skill-focused design, ensuring graduates acquire future-oriented competencies. This perspective is critical for strengthening graduate readiness in Ghana and similar contexts where technology integration remains fragmented.

Research Design

This qualitative inquiry adopted an interpretivist orientation and an inductive approach because these positions support exploratory work that seeks to understand patterns in published evidence rather than test predetermined hypotheses. A systematic review design guided the process since it enables transparent and rigorous synthesis across diverse sources and reduces bias through structured screening procedures. The review followed PRISMA guidelines to ensure methodological clarity and reproducibility (Moher et al. 2009). Database searches covered ProQuest, Scopus, ERIC, Google Scholar and Springer Nature Link, focusing on publications from 2010 to 2025 to capture contemporary discussions on digital transformation and workforce readiness. Boolean search strings from Table 1 targeted the following research question that addressed open-source platforms graduate preparation and skills development.

- (1) To what extent do open-source platforms contribute to preparing Ghanaian graduates for the future of work?

Table 1: Search equation keyed into academic databases

Connector	Keywords
	('open-source' OR 'open-source platforms' OR 'non-proprietary platforms' OR 'open educational technologies' OR Moodle OR Sakai OR GitHub OR 'OpenAI' OR 'Sentence-BERT')
AND	('higher education' OR university* OR 'graduate education')
AND	('skills development' OR 'future of work' OR employability OR 'work readiness')
AND	Ghana* AND (2010:2025).

After thorough academic database searches, 11,254 records were produced, which were screened through eligibility criteria that emphasised peer-reviewed studies, policy analyses and project evaluations relevant to higher education in Africa. Eighteen studies were retained for full-text synthesis after assessing relevance, methodological coherence and thematic alignment. The review applied a two-stage screening and appraisal process to ensure the credibility of retained evidence. Initial filtering removed duplicates and excluded studies outside the defined period or unrelated to higher education in Africa. The critical appraisal skills programme provided a structured framework for assessing validity, rigour and methodological transparency across qualitative, quantitative and mixed methods designs (Critical Appraisal Skills Programme [CASP] 2025). This appraisal helped identify strengths and limitations in research designs, including reliance on descriptive case studies, absence of theoretical framing in some contributions and limited generalisability of single-institution investigations. Applying a uniform appraisal tool strengthened the

reliability of the synthesis and enabled consistent comparison across studies that varied widely in scope and methodological orientation.

Table 2: Summary of Selected Studies

Ref. ID	Author Details	Paper Source
1	Amos et al. (2025)	ERIC
2	Annan-Brew et al. (2024)	ERIC
3	Asamoah (2021)	ERIC
4	Asiedu et al. (2024)	ERIC
5	Solís et al. (2022)	ERIC
6	Sarpong-Nyantakyi et al. (2021)	ERIC
7	Nkansah and Oldac (2024)	ERIC & Springer Nature Link
8	Oppong and Maluleka (2022)	Scopus
9	Dampson et al. (2020)	Scopus
10	Dei (2024)	Scopus
11	Alhassan et al. (2021)	ProQuest
12	Segbenya et al. (2023)	Google Scholar, ERIC & Scopus
13	Shaban et al. (2024)	Google Scholar
14	Atadika et al. (2024)	Google Scholar
15	Ofosu-Ampomg et al. (2020)	Springer Nature Link
16	Asamoah and Amarteifio (2025)	Springer Nature Link
17	Pittri et al. (2025)	ProQuest
18	Asravor et al. (2024)	ProQuest

Thematic synthesis, using Creswell and Poth's Data Analysis Spiral, supported interpretive work through iterative engagement with the eighteen selected studies from Table 2 (Creswell and Poth 2018; Omega Graduate School, 2023). The process began with preparing and organising extracts from the retained studies, followed by repeated reading and analytic note taking that captured early conceptual patterns. Inductive coding enabled themes to emerge from the reviewed literature, while deductive coding combined theoretical considerations relevant to digital learning and workforce development.

Further, three reviewers cross-checked coding decisions to strengthen trustworthiness, and disagreements were resolved through discussion and reference to the review protocol. The final phase involved deriving interpretive themes that captured the contribution of open-source platforms, patterns of use among Ghanaian graduates, and institutional barriers that affect integration. This structured process provided a clear analytic foundation for drawing conclusions on the role of open-source platforms in preparing Ghanaian graduates for the future of work.

Results

Higher education hosts a growing portfolio of digital and open-source platforms, yet these tools rarely translate into stronger graduate readiness for the future of work. Although the studies address e-learning, digital literacy, analytics readiness, virtual learning environments, gamification, ITS, LMS deployment and employability strategies, they seldom investigate how open-source platforms such as Moodle, Sakai, GitHub or Sentence-BERT strengthen work-relevant skills. This omission leaves a clear gap because universities invest heavily in digital systems but seldom connect these systems to employability outcomes.

Connectivism provides a sharper interpretive lens because it positions open-source platforms as distributed networks where learners build knowledge through connections with digital resources. Only a few studies, such as Mukhlis et al. (2024), recognise this potential and none explore how graduates in resource-constrained contexts use open-source platforms to develop adaptable skills. The present review therefore foregrounds how institutional fragmentation, inconsistent digital policies and limited pedagogical integration weaken the transformative potential of open-source platforms.

Developing Skills and Collaboration with OSPs

Several studies document pockets of skill development and collaborative learning enabled by digital platforms, yet they stop short of proving that open-source platforms deliver sustained employability gains. Youth Mappers and mapping initiatives show that student-led, faculty-mentored projects build practical geospatial skills, teamwork, and external networking, but the case study centres on movement dynamics rather than on formal adoption of open-source repositories or version control systems that employers value. Solís et al.'s (2022) work indicates capacity for project-based, open collaboration but does not measure whether participants translate those experiences into measurable job outcomes. Studies on AI-driven virtual learning environments and intelligent tutoring systems identify personalised learning and improved engagement as potential benefits. However, authors report infrastructure, equity and digital literacy barriers that prevent broad uptake and assessment of labour market relevance (Shaban et al. 2024; Asamoah and Amarteifio 2025). These observations point to pilot successes without longitudinal evidence that open-source platforms such as GitHub or open NLP models form part of graduates' professional portfolios.

Empirical comparisons reveal methodological and theoretical gaps that weaken claims about platform effectiveness. Quantitative studies on analytics readiness and AI

antecedents use Unified Theory of Acceptance and Use of Technology (UTAUT) and related models to predict adoption, but they typically focus on attitudes and intentions rather than on observable skill transfer to workplaces (Amos et al. 2025). Qualitative accounts of curriculum misalignment in commercial art and teacher training identify curriculum rigidity and insufficient industry engagement. They rarely test interventions that embed open-source workflows into assessment or internship tasks (Sarpong-Nyantakyi et al. 2021). Mixed-methods evaluations of e-learning pilots show high usage for assessments and low usage for interactive features, but they omit measures of students' capacity to use open-source toolchains for collaboration, code management or data-driven problem solving (Alhassan et al. 2021). Across these approaches, the same pattern emerges. Researchers measure readiness, perceptions, or pilot usage without tracing causal pathways from platform features to employability metrics.

Underutilization of OSPs for Graduate Preparedness

Digital tools appear across many of the reviewed studies, yet they are primarily implemented as instructional delivery systems rather than mechanisms for skill development. For example, Alhassan et al. (2021) examine an e-learning system for health trainees and report high use for assessments but limited engagement with interactive functions. Their mixed-methods design identifies infrastructural constraints and low faculty capacity but does not examine how LMS features translate into digital competencies required in technology-mediated workplaces. A similar pattern appears in Dampson et al. (2020), who analyse LMS usage at the University of Education, Winneba using strengths, weaknesses, opportunities, and threats (SWOT) analytical framework. While the study highlights system reliability and user competence issues, it does not evaluate whether LMS tools cultivate transferable digital skills. Dei (2024) similarly reports that institutions adopted several open and proprietary platforms during the COVID-19 transition, though these systems were used mainly for content access and assessment rather than collaborative digital practice. Taken together, these studies illustrate that platform adoption frequently prioritises instructional continuity instead of structured skill formation.

Other studies indirectly highlight the consequences of this limited pedagogical integration by documenting broader digital readiness challenges. Amos et al. (2025) show that students possess only foundational capacities for analytics adoption, suggesting that existing digital ecosystems do not sufficiently cultivate advanced digital competencies. Nkansah and Oldac (2024) similarly attribute digital literacy gaps to personal, institutional, and governmental factors that shape students' exposure to digital learning environments. Although these studies do not explicitly examine open-source platforms, their findings imply that students rarely encounter open and collaborative digital practices that mirror contemporary workplace environments.

Oppong and Maluleka (2022) further demonstrate that institutional digital resources can remain underused despite significant investment, as students seldom engage online research support platforms beyond basic functions. When these findings are compared with Asamoah's (2021) interviews with ICT officials, a clearer pattern emerges: universities report substantial investments in systems such as Moodle and Sakai, yet persistent user-training gaps and uneven deployment across faculties limit their educational impact.

Collectively, these observations suggest that many Ghanaian universities possess open-source platforms but have yet to embed them into learning activities that foster collaboration, problem-solving and portfolio-ready digital practice.

What this review contributes is a reframing of digital adoption in Ghanaian higher education as a missed opportunity for future-of-work preparation. The eighteen studies collectively show that institutions often treat open-source platforms as administrative or instructional tools rather than as environments where students can develop collaboration, problem-solving, data literacy and adaptive learning skills. The review adds theoretical grounding through Connectivism, positioning open-source platforms as networked learning spaces capable of linking learners to global knowledge communities in ways that proprietary systems may not afford. This perspective exposes the gap between adoption and meaningful use. It also clarifies that Ghana's challenge is not the absence of open-source technologies but the absence of strategies that link these platforms to skill development, industry expectations and continuous digital adaptation.

Institutional Barriers and Policy Gaps on OSP Use

A consistent finding across the reviewed studies concerns institutional and governance constraints that limit the systematic integration of open-source platforms in Ghanaian universities. ICT officials report investments in systems such as Sakai and Moodle but highlight uneven deployment, inadequate training structures and limited support for pedagogical redesign (Asamoah 2021). Studies on analytics readiness similarly point to institutional, personal, and governmental factors that shape students' ability to participate in digital learning environments (Amos et al. 2025). Research beyond the education sector, such as Pittri et al. (2025), identifies comparable structural barriers including financial limitations, regulatory constraints, and insufficient knowledge systems. These findings suggest that challenges in OSP integration extend beyond classroom practice and reflect broader institutional capacity issues.

Taken together, the evidence indicates the need for coordinated institutional strategies rather than isolated technology initiatives. Universities must strengthen faculty training structures, align digital investment with curriculum reform and establish partnerships with industry to clarify the digital competencies required in entry-level roles. Reliable connectivity infrastructure and monitoring systems that track graduates' digital skill outcomes would further support sustainable integration of open-source platforms across academic programmes.

Mismatches between Academia and Industry

Across the studies, a clear misalignment emerges between pedagogical practices and the digital competencies that graduates need. Segbenya et al. (2023) show that learner centred teaching and summative assessment predict employability skills. However, there was no evidence that open-source platforms support these methods despite their capacity for collaborative tasks and authentic assessment. Annan-Brew et al. (2024) report that pre-service teachers integrate technology more often than critical thinking or creativity, which

signals an environment where platform exposure does not equate to deeper skill formation. Their cross-sectional design confirms uneven skill application but offers no mechanisms for integrating open-source platforms into teacher preparation programmes. Sarpong-Nyantakyi et al. (2021) identify weak practical instruction in commercial art education and note that graduates lack industry-standard competencies. The authors do not examine whether open-source creative tools could expand access and skill acquisition in resource-limited settings or not. Atadika et al. (2024) demonstrate that demographic characteristics shape AI usage, benefits, and challenges among graduate students. For them also, their explanatory design does not address whether institutional structures can support equitable adoption of open-source platforms that reduce proprietary dependency. Together these findings show an education system that values employability outcomes but relies on methods and tools that do not foster the networked, collaborative and adaptive skills demanded in technology-driven work environments.

Institutional responses in the reviewed works further demonstrate a recurring gap where universities focus on delivery systems rather than on sustained skill building. Dei (2024) documents widespread adoption of blended systems during COVID-19. This study shows that these tools serve content transmission rather than project-based or industry-linked digital practice. Oppong and Maluleka (2022) find underuse of online research support platforms, suggesting that students encounter digital resources without structured pathways that connect them to inquiry, collaboration or problem solving. Gamification research presented by Ofosu-Ampong et al. (2020) demonstrates interest in engaging students through enriched LMS environments. However, the authors do not assess whether gamified features, when hosted on open-source platforms, can support skill transfer to workplace tasks. The barriers identified across AI-driven VLE research, ITS implementation and circular economy digital systems point to a shared constraint in infrastructure, training and policy coordination that affects both platform adoption and skill development. These converging findings indicate that institutions enable access to digital systems but rarely scaffold digital practice in ways that prepare graduates for the future of work.

It should be noted that across the eighteen studies, authors use diverse methods ranging from systematic reviews, phenomenological interviews, descriptive surveys, mixed methods designs and structural equation modelling. They rely on theories such as UTAUT, diffusion of innovations, ecological theory, and planned behaviour, though few apply learning theories that capture how students build digital skills through distributed networks. Their findings converge on infrastructural deficits, limited user competence, curriculum rigidity and weak institutional support. None investigates how open-source platforms foster scalable employability outcomes. Studies that examine LMS deployment, analytics readiness, AI adoption, digital literacy or blended learning provide partial insights but do not connect these systems to graduates' ability to carry out tasks that modern workplaces assign through open collaboration, version control, digital data handling or computational reasoning. This review contributes a needed shift by positioning connectivism as a suitable frame for understanding how open-source platforms can help Ghanaian graduates form adaptive knowledge networks. It identifies a persistent gap where universities invest in tools without leveraging their open and participatory affordances to develop job relevant competencies. The review therefore offers a policy and research agenda that calls for structured integration of open-source platforms into teaching, assessment, internships, and industry partnerships so that graduates acquire evidence of practical digital capability rather than mere exposure to institutional technologies.

Discussion

The synthesis indicates that although digital platforms are increasingly available in Ghanaian universities, their pedagogical use often remains limited to basic instructional functions rather than networked learning practices. For example, studies examining learning management systems report that platforms such as Moodle are primarily used to upload lecture slides, distribute assignments, and administer quizzes. In Dampson et al.'s (2020) examination of LMS adoption at the University of Education, Winneba, lecturers reported relying mainly on the system for course announcements and assessment submissions, with limited use of discussion forums or collaborative tools. Similarly, Alhassan et al. (2021) found that e-learning platforms supporting health training programmes were frequently used to host learning materials and conduct assessments, while interactive features such as peer discussion boards or collaborative problem-solving activities remained underutilized. During the COVID-19 transition, Dei (2024) also observed that several universities adopted platforms such as Moodle and Sakai to maintain instructional continuity, yet their use largely centred on content delivery rather than collaborative knowledge creation.

From a connectivist perspective, these practices represent only a partial realization of the affordances offered by open-source platforms. According to the principles articulated by George Siemens, learning emerges through the formation of networks that enable individuals to share, update and collectively construct knowledge. Many of the platforms identified in the reviewed studies contain features that could support such processes. For instance, discussion forums can enable peer-to-peer dialogue around real-world problems, collaborative wikis can support joint project development, and open repositories can allow students to document and refine digital work over time. When used in this manner, open-source platforms can function as digital knowledge networks where students interact with peers, instructors and external knowledge communities, thereby cultivating the collaborative and adaptive competencies associated with the future of work. However, the reviewed studies suggest that such practices remain relatively uncommon within current institutional implementations.

The results of the eighteen studies show a higher education environment where digital tools exist but rarely foster the strong learning networks that Connectivism requires. Studies on LMS use, analytics readiness, blended systems, registrars' experiences, and AI supported environments confirm that Ghanaian universities invest in open and proprietary platforms. However, students seldom form the sustained connections that drive knowledge development and employability. These findings support SDG 4.3 and SDG 4.4, which aim to ensure equal access to affordable, quality technical, vocational, and tertiary education, and significantly increase the number of youth and adults with relevant skills for employment, decent work, and entrepreneurship by 2030 (Saini et al. 2023).

Research on LMS deployment revealed high access but minimal collaborative engagement, which contradicts Connectivism's emphasis on maintaining information pathways and building distributed knowledge. This underuse of platform affordances aligns with concerns raised in the literature on higher education in Africa, which stresses infrastructural constraints and weak digital pedagogies (Bekele et al., 2023). The results also echo SDG

Target 4.5 since the studies identify gaps across learner groups that reflect unequal access to meaningful digital learning opportunities. These combined patterns show that institutions create access to digital tools but fail to extend that access into effective skill formation.

The results further confirm that most digital practices in the reviewed studies support transmission of information rather than the formation of adaptive learning networks. Studies on e-learning in health training, LMS use in Winneba and blended systems in Ghanaian universities describe environments where students consume content but rarely connect to external peers, global repositories or open project spaces that expand their learning networks. Mukhlis et al. (2024) present Connectivism as a viable digital pedagogy. However, the review of Ghanaian studies shows limited attempts to cultivate distributed knowledge spaces that reflect this theory. This gap aligns with concerns raised in SDG 4.1 and 4.6 (ensure all children complete free, equitable, quality primary and secondary education with effective learning outcomes, and guarantee that all youth and a substantial proportion of adults achieve literacy and numeracy). This calls for relevant learning outcomes and strong literacy foundations, because weak digital engagement limits students' capacity to acquire digital reading, analysis, and knowledge-seeking skills that modern work requires. Studies on digital literacy and analytics readiness reveal low competence in sourcing and connecting to digital information. This matches the concerns in SDG literature that emphasize strong foundational cognitive skills for future learning (Hanemann, 2019). These results collectively show that Ghanaian universities secure access to systems but not to the deeper skill sets that support continuous learning in fast-changing knowledge environments.

Several studies in the dataset confirm a serious misalignment between curricula, assessment practices, and the digital skills that SDG 4.4 prioritizes for decent employment and entrepreneurship. Studies on commercial art education, teacher education preparedness and AI usage patterns show that programmes often stress theoretical knowledge while workplace skills remain weak. This gap reflects the disconnect between institutional teaching methods and the practical digital competencies identified in SDG 4.4, which calls for technical, vocational and transferable skills such as collaboration, innovation, and logical analysis (Hamburg, 2020). The absence of structured engagement with open-source platforms such as Moodle, Sakai, Git-based environments or Sentence-BERT pipelines prevent students from forming the connections that Connectivism treats as central to learning. The reviewed studies show that students perform isolated tasks within institutional systems rather than engage in open, networked problem solving. This pattern aligns with research on African higher education digitalisation, which stresses that weak institutional coordination disrupts students' ability to develop sustained digital habits (Longe et al., 2021). The results therefore show that Ghanaian universities have not aligned teaching and assessment with the practices that Connectivism identifies as essential for continuous digital competence.

The overall synthesis reveals a higher education system that meets some conditions of SDG 4.3 through increased access to tertiary systems, yet falls short of SDG 4.4, which requires strong technical and transferable skills for employment. The review of the eighteen studies shows that open-source platforms possess substantial potential to support these SDG expectations because they offer the environments needed for collaboration, inquiry, creation and network building. However, the studies also show that institutions seldom treat these platforms as learning networks. Instead, they treat them as delivery tools that

support administrative efficiency rather than skill development. This review advances the field by demonstrating that the missing link is not the existence of technology but the absence of connectivist learning conditions. Students do not consistently connect to diverse information sources, maintain digital relationships, update their knowledge, or participate in distributed knowledge building. By applying Connectivism to Ghanaian higher education, the review explains why current practices do not yield employability outcomes despite digital investment and why the absence of strong learning networks contradicts the aims of SDG 4.1, 4.3, 4.4 and 4.5. The discussion, therefore, positions open-source platforms as essential networking spaces and calls for deliberate pedagogical redesign so that Ghanaian graduates gain the adaptive, connected and future-ready skills that both SDG 4 and connectivist theory require.

Policy Implications

The findings point to a need for national and institutional policies that treat open-source platforms as strategic learning infrastructures rather than optional support systems. Government agencies and university councils should align digital investment plans with curriculum reform and staff development so that open-source platforms strengthen the acquisition of technical and transferable skills required under SDG 4.4. Policies that support stable connectivity, faculty incentives for digital pedagogy, cross departmental coordination and systematic monitoring of digital skill outcomes would correct the fragmented adoption patterns reported in the reviewed studies. Stronger alignment between higher education policy, industry skill needs, and institutional accountability frameworks would ensure that open-source platforms contribute directly to graduate preparedness for emerging forms of work.

Conclusion

This review demonstrates that open-source platforms possess significant potential to support the development of digital competencies required for the future of work. However, the synthesis shows that this potential remains only partially realised within Ghanaian higher education. The reviewed studies indicate that institutions have introduced a range of digital systems, yet these tools are rarely embedded in learning designs that cultivate collaborative problem-solving, open knowledge creation or sustained digital practice. Addressing this gap requires coordinated institutional reforms that align digital infrastructure, faculty capacity and curriculum design with the networked learning environments envisioned in connectivist theory.

The reviewed studies reveal that students encounter these platforms mainly as delivery systems rather than as environments that build competencies required in modern workplaces. The review establishes that open-source platforms can contribute meaningfully to graduate preparedness when institutions embed them in project-based learning, practical assessment and industry aligned instruction. OSPs contribute only to a limited extent under current practices, not because the tools lack capacity but because institutional systems do not activate their affordances.

Furthermore, usage of OSPs remains narrow, often restricted to accessing content, submitting assignments, or engaging in basic virtual communication, which does not support the formation of the broader digital networks that Connectivism emphasises. Institutional gaps such as weak digital policy coordination, limited faculty capacity, unreliable infrastructure and absence of structured digital skill pathways restrict the expansion of open-source practices across programmes. The review provides a practical pathway forward by showing that stronger curriculum alignment, targeted faculty development, coordinated policy support and structured integration of open-source platforms can convert access into skill development. Through this synthesis, the review delivers clear answers to the research objectives and clarifies that Ghanaian graduates can benefit from open-source platforms only when universities treat these tools as learning networks that support continuous skill growth rather than as peripheral technologies.

Recommendations

Universities should embed open-source platforms in teaching, assessment, and internship structures so that students form the continuous learning networks described in Connectivism. Faculty should receive training that supports the design of project-based instruction where students use Moodle, Sakai, GitHub, open AI models and other open systems to solve authentic problems. Institutions should establish partnerships with employers to define the specific digital competencies required for entry level roles and integrate those expectations into course outcomes. Monitoring systems should track how students use open-source platforms across programmes to identify gaps and refine instructional strategies. Researchers should conduct intervention-based studies that measure how sustained engagement with open-source platforms strengthens the higher order skills required for decent work, entrepreneurship, and lifelong learning under SDG 4. Policymakers should establish measurable benchmarks for AI integration within tertiary curricula. Universities should institutionalise the use of open-source AI platforms through faculty training, student workshops, and credit-bearing coursework. Further, national ICT policies must include explicit targets for AI-supported pedagogy and allocate budget lines for implementation. Collaborative platforms between Ghanaian universities and global AI communities should be formalised to foster peer learning and innovation.

Limitations

This review draws evidence from eighteen studies that vary in methods, focus and quality, which restricts the consistency of comparisons across institutional settings. Most of the included studies examine digital adoption, user readiness or instructional practices without measuring long-term outcomes, which limits the assessment of how open-source platforms influence sustained digital competence. Several studies rely on self-reported data, which introduces reporting bias and weakens conclusions about students' actual skill performance. The review also depends on published work that gives uneven attention to graduate employability, which narrows the scope for drawing strong inferences about how open-source platforms shape job relevant skills. These limitations narrow the scope of conclusions and highlight the need for focused empirical studies that track how students acquire, apply, and sustain digital skills within open-source environments over time.

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Authors jointly wrote and edited the final manuscript.

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An AI tool was used in the development of this paper. Specifically, Microsoft Copilot was employed to assist with tasks such as language refinement, summarising literature, generating initial outlines, and formatting references. All outputs from the AI tool were critically reviewed, edited, and validated by the authors to ensure accuracy, originality, and compliance with academic standards. The authors take full responsibility for the content of this manuscript.

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About the Authors

Jessica Amarteifio is a Ph.D. student at the University of Ghana, Department of Adult Education and Human Resource Studies, with a strong interest in research, academic inquiry and community-focused development. Jessica engages actively with learning opportunities that support growth in critical thinking, communication, and innovation. Academic work reflects commitment to excellence, attention to detail, and a genuine drive to expand knowledge through disciplined study. Jessica values collaboration, open-minded engagement with new ideas, and participation in projects that advance understanding of social and developmental challenges. Through continuous effort and enthusiasm for learning, Jessica aims to contribute meaningfully to scholarly work and to future professional endeavours.

Goldman Dodzi Awuku is a doctoral student at the University of Ghana, Department of Adult Education and Human Resource Studies. He brings over a decade of experience in community development, local governance, and youth advocacy, an experience that now shapes his research into community development and education, civil society organisations, digital technology, and entrepreneurship.

Dr. Abigail A. Aryeh-Adjei is a Senior Lecturer in the Department of Adult Education and Human Resource Studies at the University of Ghana. She holds a PhD in Community Development and Management from China Agricultural University, as well as MPhil and BSc degrees from the University of Ghana. Her research focuses on adult education, community development, technology-enabled learning, and sustainable education, with growing interest in digital platforms and the future of work. Dr. Aryeh-Adjei has published widely in peer-reviewed journals and actively contributes to academic leadership, mentorship, and policy-oriented research. Her work seeks to strengthen the role of education in addressing development challenges and advancing innovative, inclusive learning systems in Africa.