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Beyond self-perception: Evaluating digital literacy across multimedia formats using the atomic digital literacy framework and ICAS benchmarks

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ABSTRACT

This study explored how university students perceive and assess their own digital literacy, focusing on how these self-evaluations align with the international competitions and assessments for schools (ICAS) computer skills levels. Drawing on responses from 1,520 students at the University of Cape Coast, the research examined patterns across gender, college affiliation, program type, and academic level. A structured questionnaire based on the atomic digital literacy framework was used to capture students' self-assessed ability to collect, compose (organizing, manipulating, and formatting), and communicate digital content in different media formats–text, numeric data, images, sound, and video. Data were analyzed with SPSS and AMOS to evaluate both the reliability of the instrument and the relationships among its components. The results showed a very dependable instrument with strong internal consistency (α = .946) and clear evidence of construct validity. The exploratory and confirmatory factor analyses revealed a coherent two-factor structure distinguishing between the "analytical work" (textual and numerical) and expressive or multimedia creation (visual, auditory, and video) dimensions of digital literacy. Males and students in STEM disciplines generally indicated higher competence than their female and non-STEM peers, although the variations across academic levels were not statistically significant. When their self-assessments were compared with the ICAS computer skills levels, most fell somewhere in the level 3–intermediate computer skills but not fluent mastery (advanced and proficient, which are level 4 and level 5, respectively). The research suggests that university curricula should incorporate multimodal production and interdisciplinary digital practices to foster a more holistic and transformative approach to digital literacy.

Keywords: digital literacy, self-assessment, university students, Ghana, atomic digital literacy framework, ICAS computer skills, multimedia competence

INTRODUCTION

Digital literacy encompasses a range of skills necessary for effective participation in the digital world, including the ability to find, evaluate, summarize, utilize, share, communicate, and create content using information technologies and the internet (Bawden, 2008; Glister, 1997). The advent of the digital revolution has revolutionized worldwide interactions and altered work scenarios, with forecasts indicating a substantial transformation in the job market owing to automation and artificial intelligence (World Economic Forum, 2020).

The rapid pace of technological change has made developing digital skills essential for survival, not just competence (Brevik et al., 2019; Wong & Kemp, 2018). Digital literacy goes beyond technical skills to encompass a wide range of abilities, such as creating and handling digital information (Chere-Masopha, 2018; Eshet-Alkalai, 2004). Despite being called "digital natives," many students still find it difficult to use digital tools effectively for academic work (Wang et al., 2014). The so-called digital native's fallacy the idea that young people naturally have advanced digital skills has been widely criticized (Omaswa et al., 2018; Prensky, 2001; van Dijk & van Deursen, 2014). A Deloitte survey in the UK highlights this skills gap, with a drop in confidence among leaders in graduates' digital abilities from 20% in 2017 to 12%

in 2018 (FutureLearn, 2020). This gap between perceived and actual skills is also relevant in developing countries, such as Ghana (FutureLearn, 2020; van Dijk & van Deursen, 2014).

Most existing research on digital literacy is concentrated in Western and Asian contexts, leaving sub-Saharan Africa (SSA) underexplored. Higher education institutions in SSA face distinct infrastructural and cultural challenges that complicate digital skill development. Global frameworks such as the European Commission's digital competence framework for citizens (DigComp), DLGF, DiSTO, the essential digital skills framework, and ISTE provide valuable categories of competence but often remain at a conceptual level, lacking concrete, measurable indicators (UNESCO, 2019; Vuorikari et al., 2022). As a result, educators in Ghanaian universities, like their counterparts elsewhere, struggle to accurately diagnose students' digital skill levels and design effective interventions. The atomic learning digital literacy framework (ADLF) offers a promising alternative through its detailed 5 × 5 matrix that assesses five processes, which are collecting, organizing, manipulating, formatting, and communicating across five media types: text, numbers, images, sound, and video (Atomic Learning, Inc., 2014). However, ADLF has not been validated in Ghana or broader SSA contexts, highlighting the need for empirical testing before it can be reliably used (Hatlevik & Christophersen, 2013).

Beyond the issue of measurement, there remains a fundamental gap in understanding what Ghanaian students can actually do with digital tools. While many students express confidence in their digital abilities, empirical studies reveal discrepancies between self-perceived competence and actual performance, particularly in multimedia-rich areas such as video editing, sound design, and image manipulation (Eshet-Alkalai, 2012; Hargittai, 2010). Understanding how digital skills across different media interrelate is equally important whether proficiency in text-based tasks predicts competence in video or sound, for instance (Eshet-Alkalai, 2004; Ilomäki et al., 2016). Moreover, the mismatch between self-assessed and tested abilities complicates efforts to design targeted training programs (Hargittai, 2010; Hatlevik & Christophersen, 2013). Combining ADLF outcomes with standardized frameworks such as the international competitions and assessments for schools (ICAS) can improve validity and provide a global benchmark for situating Ghanaian students' digital skills (Law et al., 2018; UNESCO, 2019).

Digital literacy experiences differ significantly among students, influenced by factors such as gender, academic discipline, and educational level (Ndibalema, 2025; Sayaf et al., 2022; Yang & Attan, 2024). These variations affect how students engage with digital tools and platforms, highlighting the need to recognize subgroup patterns to ensure inclusiveness in digital literacy programs. For such programs to be effective, they must reflect the diverse realities of students rather than rely on generalized assumptions (Ndibalema, 2025). From a measurement perspective, acknowledging these differences also enhances the validity of assessment instruments by ensuring they accurately capture the intended competencies across diverse student groups (Sayaf et al., 2022; Yang & Attan, 2024). Consequently, Ghanaian universities urgently need validated tools and data-driven insights to evaluate students' digital abilities, benchmark them against global standards, and develop curricula aligned with the needs of the modern digital economy (Reichert et al., 2023; World Economic Forum, 2020).

In addressing this challenge, the present study integrates two complementary frameworks: the ADLF, which emphasizes students' self-assessed skills, and the ICAS computer skills framework, which provides a standardized global benchmark. The goal is to align self-reported competence with objective proficiency levels to gain a more holistic view of student ability. This approach is particularly relevant in Ghanaian higher education, where assumptions about the digital competence of "digital natives" often mask substantial skill gaps (Hargittai, 2010; Öncül, 2021). Few studies in SSA have explored this discrepancy, and those that exist typically rely on self-assessment without anchoring results to an international standard (van Laar et al., 2017). By comparing how students collect, create, and communicate digital content across multiple media–text, numbers, images, audio, and video against ICAS benchmarks, this study seeks to uncover both the depth and accuracy of students' digital literacy within a global context.

Study Purpose

The purpose of the study is to assess university students' self-perceived digital literacy across various media using the ADLF and to validate its relevance in the Ghanaian higher education context. A secondary goal is to guide curriculum development and digital literacy policy, ensuring that students are better prepared for the demands of an increasingly digital world. Five specific objectives guide this investigation.

1. To evaluate the internal consistency, reliability, and construct validity of the ADLF scale in the Ghanaian context. Only by establishing its psychometric soundness can the instrument be applied locally.
2. To assess the proficiency of university students in using digital content across multiple formats, including text, numbers, images, sound, and video.
3. To examine correlations among the different skills that ADLF identifies, including collecting, organizing, manipulating, formatting, and communicating, both within and across media. Here, the goal is to find out whether digital skills transfer, or whether they remain separate clusters.
4. To explore the relationship between students' self-assessed digital literacy (via ADLF) and their alignment with standardized proficiency levels (via ICAS).
5. To examine whether students' digital literacy competencies differ significantly across key demographic categories: gender, faculty affiliation, and study level.

These objectives progress logically, from validating the instrument to comparing it with standardized benchmarks and analyzing sub-group patterns. This approach addresses both the methodological refinement of digital literacy measurement and the broader objective of preparing Ghanaian and SSA students for meaningful participation in the global digital society.

Rationale

Understanding the current level of digital literacy skills among university students is crucial for developing effective educational programs. By identifying and analyzing the specific components of digital literacy, educators can tailor interventions to address the gaps in students' skills. Exploring the interrelationships between these components can provide deeper insights into how digital literacy skills develop and inform targeted strategies for improvement.

LITERATURE REVIEW

This review looks at how digital literacy has changed over time, how skills are tested, the problems with self-assessment, the results of comparisons, and the reasons for using ADLF.

Definition and Evolution of Digital Literacy

The idea of digital literacy has evolved significantly over time, shifting from a focus on basic computer skills to encompassing a broad set of cognitive, ethical, and communicative abilities. Initially, it referred to simple computer know-how–using a keyboard, managing files, or operating basic software (Gilster, 1997). However, as technology and digital participation advanced, this narrow definition proved insufficient. Scholars such as Eshet-Alkalai (2004) redefined digital literacy as "survival skills" for the information age, emphasizing critical thinking, ethical navigation, and multimodal communication. Martin (2005) further expanded the idea to include awareness, attitude, and ability across different media types, framing digital literacy as a complex and integrative form of competence necessary for meaningful participation in a digital world.

Hinrichsen and Coombs (2013) advanced this discussion by distinguishing between functional and critical paradigms of digital literacy, arguing that technology is inherently shaped by ideology, culture, and power relations–a perspective consistent with Street's (2003) view of literacy as a contextual practice. Institutional frameworks also contributed to this conceptual growth. The European Commission's DigComp framework broadened digital literacy to include social, ethical, and problem-solving dimensions of digital engagement (Vuorikari et al., 2022), while UNESCO (2019) and Law et al. (2018) linked digital competence to global citizenship, inclusion, and lifelong learning. This marked a transition from viewing digital literacy as an individual skillset to seeing it as a collective resource for societal and ethical participation in a connected world.

In practice, digital literacy now involves multimodal fluency and adaptability across diverse digital environments. The National Council of Teachers of English (2019) emphasized the integration of moral and multimodal dimensions into curricula, while researchers such as Ilomäki et al. (2016) and Spante et al. (2018) noted that students are increasingly required to produce podcasts, videos, infographics, and other multimedia outputs. The rise of mobile technologies has also introduced the idea of "mobile digital literacy," defined as the ability to communicate and solve problems using mobile devices in dynamic contexts (Technology & Social Change Group, 2016). Building on this, Hinrichsen and Coombs' (2013) five-resource model, decoding, meaning making, using, analyzing, and persona captures digital literacy as a lifelong, empowering form of citizenship. By 2025, it is widely recognized as a multidimensional, evolving capability that blends technical skill with creativity, ethics, and critical reflection, serving as an essential foundation for education, employment, and social inclusion in the digital era.

As digital environments continue to change, so must our understanding of what it means to be literate in a digital society. This understanding requires both breadth and depth, as well as a dedication to equity, innovation, and lifelong learning.

Digital Skills Evaluation Frameworks

The evaluation of digital literacy has progressed considerably over the past two decades, reflecting efforts to define, measure, and enhance competencies within increasingly complex digital environments. Given the vastness and diversity of digital skillsets, frameworks have become essential for categorizing and organizing these competencies (International Telecommunication Union [ITU], 2020). Such frameworks often specify proficiency levels or learning outcomes to guide assessment and instruction (Vuorikari & Punie, 2019). Notable examples include the DigComp and the ISTE Standards, which encompass domains such as information management, communication, problem-solving, and content creation (Ala-Mutka, 2011; UNESCO, 2019; Vuorikari et al., 2022). These frameworks have significantly shaped global policy and curricular reforms, with DigComp's latest version (2.2) incorporating contemporary priorities like sustainable digital practices and ethical AI use (Vuorikari et al., 2022).

Global organizations have continued to broaden the scope of digital literacy evaluation. UNESCO's (2018) *digital literacy global framework* (updated 2023) (Reichert et al., 2023) promotes cross-cultural comparability of competencies, while the World Bank's (2024) *digital skills programs* target digital equity for marginalized youth (Kwakwa, 2024). Similarly, the *digital intelligence (DQ) framework* adopts a values-based approach to digital assessment, including competencies such as digital identity and emotional intelligence (DQ Institute, 2018, 2024). Sector-specific adaptations, such as the *JISC* (2015, 2023) *digital capabilities framework* and China's *digital health competency framework* (National Health Commission of China, 2024; Yao et al, 2025), further illustrate the importance of contextualized approaches to digital literacy. Yet, despite their broad coverage, many of these frameworks operate at a macro level, providing general categories that lack the diagnostic specificity teachers and researchers need to pinpoint particular skill gaps (Spante et al., 2018).

The ADLF addresses this limitation through its granular and diagnostic design. ADLF employs a two-dimensional 5×5 matrix that combines five skill processes–collecting, organizing, manipulating, formatting, and communicating–with five media types: text, numbers, images, sound, and video (Bawden, 2008; Herout, 2024; Miranda et al., 2018). Using a Likert scale from 0 to 4, it captures progression from basic awareness to expert mastery, offering richer insights than binary assessments (Knutsen & Presser, 2010). This structure

allows educators to identify precise strengths and weaknesses, such as a student being proficient in formatting text but struggling with manipulating video. Beyond pedagogy, ADLF also supports research through standardized comparisons and longitudinal tracking of digital skill development (Lee & Fanea-Ivanovici, 2023; Pan et al.,2025). Thus, while rooted in practical evaluation, ADLF also aligns critical perspectives on digital literacy by emphasizing contextual, measurable, and equitable learning progressions.

In short, while existing frameworks provide a strong conceptual basis for digital literacy, their broad scope limits practical use. The ADLF stands out by detailing specific skills and media, making it more effective for teaching and research.

Challenges of Self-Assessment in Digital Literacy

According to ITU (2020), digital skills assessments generally fall into three categories: self-assessment, knowledge-based, and performance-based methods. Self-assessment is widely used due to its practicality and cost-effectiveness, allowing large groups to evaluate their own skills (Ng, 2012). However, there are questions about its diagnostic reliability and research usefulness. Given the growing importance of digital literacy in education and work, understanding these strengths and weaknesses is crucial. This study addresses these issues by using the ADLF to provide a comprehensive and reliable evaluation of digital literacy.

A major challenge in digital literacy research is the discrepancy between individuals' perceived and actual skill levels known as Kruger-Dunning effect (Gaffney, 2018; Kruger & Dunning, 1999; Matjašič & Vogrinc, 2025; Mazor & Fleming, 2021). Many people either overestimate or underestimate their digital competence, leading to distorted self-assessment data (Hargittai, 2010; Rosales-Márquez et al., 2025). For example, Hargittai (2010) showed that students who believed they were adept at online searching performed poorly on objective tests, while Rosales-Márquez et al. (2025) observed only a moderate positive correlation between self-confidence and actual digital skill. Excessive confidence can thus compromise data reliability when institutions depend solely on self-reports. Multiple studies affirm that confidence and competence are distinct constructs (González-Mujico, 2024), and even in contexts like Norway, correlations between perceived and actual performance have been modest (Hatlevik & Christophersen, 2013). Furthermore, cultural values–such as collectivism, modesty norms, or face-saving behaviors– can bias self-evaluation, with learners overstating or minimizing their digital abilities to align with social norms or expectations when completing self-assessments (Aesaert & van Braak, 2015; Tandiono & Limijaya, 2025).

These discrepancies are especially evident in educational contexts, where students' digital capabilities vary widely. González-Mujico (2024) notes that learners unfamiliar with digital tools often misjudge their competence, either inflating or undervaluing their proficiency. Such inaccuracies can obscure real learning needs and perpetuate digital inequities. To mitigate these limitations, Rosales-Márquez et al. (2025) advocate for hybrid evaluation models that integrate self-assessment with performance-based measures, while González-Mujico (2024) recommends rubric-based hybrid tools that combine self-reported data with observed task performance. These blended approaches enhance both the accuracy and fairness of digital literacy evaluations, helping educators to identify skill gaps and tailor interventions more effectively across diverse student populations.

Psychometric validity further complicates self-assessment, as many instruments rely on static questionnaires that fail to simulate authentic digital tasks (Nieminen et al., 2025). Longitudinal studies also face difficulties due to evolving technologies and learner diversity (Pan et al. ,2025). Nonetheless, self-assessments provide valuable insights into learners' confidence, motivation, and self-efficacy factors crucial for engagement and exploration (Ilomäki et al., 2016). To enhance validity, self-assessments should be complemented with external benchmarks and task-based evaluations. The ADLF exemplifies this integrated approach, combining self-evaluation with a structured 5×5 skill-content matrix and a five-point Likert scale to assess competencies across text, numerical, image, audio, and video domains (Herout, 2024; Miranda et al., 2018). When aligned with the ICAS computer skills levels, ADLF enables detailed diagnostics, personalized learning plans, and standardized comparisons–balancing subjective reflection with objective assessment to promote equitable, data-driven improvements in digital literacy.

Comparative Research Findings on Digital Literacy Assessment

Research looking at how we assess digital literacy has, for a long time now, really brought to light this persistent gap between what people think they can do and what they can actually demonstrate. A clear tension exists between performance-based tools like the ICAS computer skills test, which focus on measurable outcomes, and self-assessment frameworks like ADLF, which emphasize reflection on one's digital abilities. This contrast highlights the need to explore how subjective and objective assessments align and whether either alone can fully represent digital competence.

Recent international research consistently shows that students tend to overestimate their digital skills when using self-assessment tools. Nguyen and Habók (2025), in a study of 511 English majors in Vietnam, found that students' self-assessments were consistently higher than their actual test results, despite only a modest correlation between confidence and performance. Similar patterns emerged elsewhere. Csernoch et al. (2024) reported that higher education students' self-rated spreadsheet skills were often inflated compared to their real task performance. Wu (2023) documented similar widespread overestimation among Chinese students. Most respondents overestimated their digital abilities, with self-ratings aligning closely to actual performance only on critical-thinking tasks. This suggests that while self-assessment reflects learners' confidence and attitudes, it often exaggerates their true competence.

Evidence from Africa reinforces this global pattern. In Nigeria, Chukwuemeka et al. (2019) found only a weak correlation between self-reported confidence and demonstrated digital ability, particularly when students were assessed using task-based evaluations. Kayi and van Wyk (2025) observed a similar trend in Ghana, where teacher trainees consistently overestimated their ICT integration skills

compared to their observed classroom practices. Even in-service teachers exhibited this disconnect: Amissah (2023) found that Cape Coast basic schoolteachers felt digitally competent and ready for curriculum reforms but struggled to implement ICT effectively due to poor infrastructure and limited training. These findings suggest that inflated self-perceptions are not only common among students but also among educators, complicating efforts to assess and improve digital literacy.

Together, these studies highlight that self-perception captures only part of the digital literacy picture. The gap between perceived and actual performance is a tangible reality with important implications for education policy and professional training, especially in developing regions. Frameworks like the ICAS and the ADLF demonstrate this duality: ICAS provides objective, performance-based measures that are credible but resource-intensive, while ADLF offers reflective, cost-effective self-assessment that captures perceptions but is vulnerable to bias. For institutions in contexts like Ghana, combining both approaches offers a balanced strategy that ensures credibility, scalability, and a deeper understanding of learners' true digital capabilities.

RESEARCH METHODOLOGY

This study employed a quantitative approach to explore and measure the digital literacy skills of university students based on the ADLF self-assessment instrument v2.0 (Atomic Learning, Inc., 2014). The choice of a quantitative approach was driven by the need for systematic measurement and statistical analysis of digital literacy skills across a large sample, enabling generalization of findings (Creswell, 2014).

Participants

The research was conducted at the University of Cape Coast, which offers three program types: regular (campus-based), sandwich (summer study on campus), and distance (study at various centers across Ghana). This study focused on the regular group for the 2024-2025 academic year, which had a total student population of 26,527, comprising 24,697 undergraduates and 1,830 postgraduate students. The recommended sample size for this particular group is 377, as suggested by Gujarati (2003) and Thompson (2012). For an optimal maximum sample size or an improved sampling ratio (sample size to population size), it is recommended to have a sample size of approximately 10% of the population, if this does not surpass 1,000 (Bisits, 2023).

Data Collection Instrument

The study relied on a self-administered questionnaire, delivered through Google Forms, which incorporated an adapted version of the ADLF self-assessment instrument v2.0. The Atomic Learning Self-Assessment Instrument v2.0 (Atomic Learning, Inc., 2004) contained twenty-five items arranged on a Likert scale and was designed to measure digital literacy across multiple skillsets and media types. The framework is organized into three overarching digital skillsets:

- Collecting – the ability to gather and create digital information.
- Composing – which includes Organizing, Manipulating, and Formatting digital information to create meaning and prepare it for publication.
- Communicating – the ability to publish and share digital products for consumption by others.

These skills are measured in progression from Information (Collecting), through Composing (Organizing, Manipulating, and Formatting), to Knowledge (Communicating).

These skillsets are applied across five media categories: Text, Numbers, Images, Sounds, and Video.

Each skill is rated on a scale from 0 to 4, where:

- 0 = no knowledge of the skill,
- 1 = awareness of the skill but no practice,
- 2 = ability to perform with assistance,
- 3 = ability to perform independently,
- 4 = ability to teach the skill to others.

Scores are calculated both vertically (total out of 20 for each digital skillset) and horizontally (total out of 20 for each media type). This dual scoring system provides a comprehensive profile of an individual's digital literacy, with a maximum overall score of 100.

Alongside ADLF, the study drew on the ICAS computer skills levels to provide an external frame of reference. The ICAS framework divides computer proficiency into five levels, whose summary is indicated below:

1. Level 1–Fundamental computer skills (e.g., typing and using the mouse)
2. Level 2–Basic computer skills (e.g., the Internet and email, word processing, graphics and multimedia, and spreadsheets)
3. Level 3–Intermediate computer skills (e.g., the Internet and email, word processing, graphics and multimedia, spreadsheets, and databases)
4. Level 4–Advanced computer skills (e.g., the Internet and email, word processing, graphics and multimedia, spreadsheets, and databases)
5. Level 5–Proficient computer skills (e.g., the Internet and email, word processing, graphics and multimedia, spreadsheets and databases, programming, and scripting)

The study deliberately used both ADLF and ICAS to balance local relevance with global comparability. ADLF captured students' multimedia and task-based digital experiences, while ICAS provided a recognized international benchmark for computer competence. Rather than aligning ICAS levels directly with ADLF items, ICAS served as a reference for interpreting self-assessment trends, minimizing cultural bias. Additionally, demographic data such as sex, college, program, and year of study were collected to provide context for the results.

Distribution and Data Collection

Following digital survey best practices (Bisits, 2023), the study emailed a questionnaire to a random sample of 2,000 students via the university's digital registration system, which generated randomized email lists. Only one response per student was allowed to ensure the integrity of the data.

Table 1. Biodata of respondents to the study (N = 1,520) (Field Survey Data, 2025)

Characteristic	Categories	Frequency (N)	Percentage (%)
Sex	Male	938	61.7
	Female	582	38.3
ICAS computer skills levels	Level 1-Fundamental computer skills	102	6.7
	Level 2-Basic computer skills	125	8.2
	Level 3-Intermediate computer skills	489	32.2
	Level 4-Advanced computer skills	589	38.8
	Level 5-Proficient computer skills	215	14.1
College of study	College of agriculture and natural sciences	184	12.1
	College of educational studies	393	25.9
	College of health and allied studies	53	3.5
	College of humanities and legal studies	890	58.6
Study program discipline	Non-STEM	1,283	84.4
	STEM	237	15.6
Year of study (academic levels)	Level 100 (1st-year undergraduate)	460	30.3
	Level 200 (2nd-year undergraduate)	54	3.6
	Level 300 (3rd-year undergraduate)	942	62
	Level 400 (4th-year undergraduate)	41	2.7
	Level 700 (7th-year postgraduate)	23	1.5

Data Processing and Analysis

A total of 1,729 responses were collected, with 1,520 valid entries retained after excluding incomplete data (76.3% response rate). The sample was sufficient for analysis. The instrument's reliability and validity were confirmed using Cronbach's alpha and construct validity tests. Descriptive statistics, including frequency distributions, were used to examine the distribution of student self-reported digital literacy skills. The data was processed using IBM SPSS v28.

Demographic Information

The demographic composition of the study participants provides fundamental insights into the sample distribution. It is critical for understanding the context of the research findings. The biodata of the 1520 respondents in this study (see **Table 1**) comprises several vital characteristics, each contributing to a comprehensive participant pool profile. In the demographics of the university students studied, there is a notable gender distribution with 61.7% of the respondents identifying as male and 38.3% as female. This disparity reflects broader trends observed in higher education developing nations where, globally, female enrolment rates often surpass those of males(World Bank, 2024).

The ICAS computer skills distribution shows a steady rise in proficiency, with 38.8% of students at the advanced level and 32.2% at the intermediate level. The significant representation of higher proficiency levels may suggest a trend of increasing digital literacy among university students, aligning with the broader educational objectives of fostering comprehensive digital competencies (Johnson & Maddux, 2019).

The college of humanities and legal studies accounted for the largest share of respondents (58.6%), consistent with enrollment trends favoring arts and humanities (Johnson & Turner, 2018). The presence of diverse colleges allows for examining digital literacy across different academic disciplines, which is vital for a holistic understanding of the digital divide in academic settings (Robinson, 2021).

A majority of the participants were from non-STEM programs (84.1%), which may reflect the overall student distribution within the university or indicate a variance in response rates between the two categories. This preponderance could influence the interpretation of digital literacy levels, as previous studies have suggested disparities in digital literacy between STEM and non-STEM students (Henderson & Dancy, 2017).

The majority of the respondents were third-year undergraduates (61.7%), indicating that the data may be more reflective of the experiences and skills of students amid their academic journeys. Notably, participation decreases significantly by the fourth year, which could be attributed to a smaller cohort size, higher academic demands, or lower engagement with the survey at later stages of education (Benton et al., 2013).

RESULTS AND DISCUSSION

Determining the Reliability of the Instrument

Reliability analysis was the first major step in evaluating the soundness of the digital literacy instrument. As is common in scale validation work, Cronbach's alpha (α) and composite reliability (rho_c or CR) were used to examine internal consistency–that is, the extent to which the items within each subscale measure the same underlying construct. Both α and CR can have values between 0 and 1. The general rule is that the internal cohesion of the scale gets stronger as the coefficient gets closer to 1. A high value means that the items are not separate variables but work together as one unit, indicating better reliability.

Cronbach's Alpha

The digital literacy scale demonstrated strong internal consistency, with a Cronbach's alpha of 0.946, which is well above the 0.70 threshold suggested by Nunnally and Bernstein (1994) and confirmed by Edumadze and Govender (2024). This indicates that the items collectively measure a unified construct. Subscale analysis showed alpha values ranging from

Table 2. Reliability statistics for ADLF subscales and overall scale

Scale	Cronbach's alpha	Number of items
Collecting	0.669	5
Organizing	0.785	5
Manipulating	0.783	5
Formatting	0.774	5
Communicating	0.818	5
Overall ADLF	**0.946**	**25**

0.818 for communicating to 0.669 for collecting (refer to **Table 2**). The collecting subscale is just below the ideal 0.70, but it is still in an acceptable range. Its slightly lower reliability may reflect variability in how students interpret "collecting" tasks. Overall, the high reliability across all subdomains aligns with previous findings on digital literacy measurement in developing contexts (Pan et al., 2025).

Overall, these results show that the ADLF-based instrument demonstrates excellent reliability within the Ghanaian higher education setting. Each subscale captures a distinct yet connected aspect of students' digital literacy, suggesting that the instrument is internally coherent but also rich enough to reflect multidimensional skills.

Composite Reliability

Cronbach's alpha gives a basic measure of internal consistency but assumes equal contribution of all items, which is often unrealistic. Therefore, CR was calculated using structural equation modelling for a more accurate estimate, as it accounts for factor loadings in latent constructs like digital literacy (Chin, 1998; Hair et al., 2019; Hu & Bentler, 1999). To determine the upper-limit reliability, maximum reliability (MaxR [H]) was also computed (Bagozzi & Yi, 1988). The close alignment between CR and MaxR (H) indicates that the constructs were stable and well specified, with both measures performing strongly across all five constructs as shown in **Table 3**.

All CR values exceeded 0.80, comfortably surpassing the 0.70 threshold for satisfactory reliability (Sarstedt et al., 2022). As expected, the MaxR (H) values were slightly higher, indicating that the model was already close to its optimal reliability. The close alignment of CR and MaxR (H) suggests that the scale performs near its theoretical ceiling. Despite one weak loading ("collect and create numeric data"), the numeric construct remained reliable (CR = 0.838). Overall, these results confirm that the five constructs, text, numeric, image, sound, and video, demonstrate strong internal consistency suitable for further structural analysis.

Measuring the Validity of the Instrument

Reliability measures consistency, while validity determines whether an instrument truly measures its intended construct. To establish validity, a two-stage process was used: exploratory factor analysis (EFA) in SPSS and confirmatory factor analysis (CFA) in AMOS. This combined theoretical expectations from the ADLF with empirical testing to confirm whether the data supported the proposed structure.

To begin, the dataset was tested for suitability factor analysis (see **Table 4**). The Kaiser-Meyer-Olkin (KMO) statistic produced a value of 0.964, placing it in Kaiser's "marvelous" category (Edumadze, 2023; Kaiser, 1974; Zeynivandnezhad et al., 2019). This very high score means that the relationships between items were strong enough to make factor analysis worthwhile. Meanwhile, Bartlett's test of sphericity produced a significant result (χ^2 = 23,624.778, df = 300, p < .001), confirming that correlations among items were strong enough to justify factor analysis.

EFA identified three distinct components with eigenvalues above one, accounting for 59.72% of the variance (**Table 5**).

Table 3. Construct loadings, CR, AVE, and maximum reliability for digital literacy scale (Field Survey Data, 2025)

Element	Item	Loading	CR	AVE	Maximum	MaxR(H)
Text	Collect and create digital text	0.69	0.834	0.503	0.49	0.840
	Manipulate digital text	0.69				
	Organize digital text	0.63				
	Format digital text	0.76				
	Communicate digital text	0.71				
Numeric	Collect and create numerical data	0.06	0.838	0.565	0.45	0.840
	Organize numeric data	0.77				
	Manipulate numeric data	0.78				
	Format numeric data	0.73				
	Communicate numeric data	0.73				
Image	Collect and create digital images	0.63	0.850	0.533	0.48	0.863
	Organize digital images	0.69				
	Manipulate digital images	0.73				
	Format digital images	0.84				
	Communicate digital images	0.75				
Sound	Collect and create digital sound	0.70	0.894	0.628	0.51	0.904
	Organize digital sound	0.74				
	Manipulate digital sound	0.86				
	Format digital sound	0.86				
	Communicate digital sound	0.79				
Video	Collect and create digital video	0.54	0.917	0.691	0.55	0.928
	Organize digital video	0.90				
	Manipulate digital video	0.85				
	Format digital video	0.89				
	Communicate digital video	0.78				

Table 4. KMO and Bartlett's test

Measure	Value
KMO measure of sampling adequacy	0.964
Bartlett's test of sphericity	χ^2 = 23,624.778, df = 300, p < .001

Table 5. Total variance explained (N = 1,520)

Component	Extraction sums of squared loadings	Rotation sums of squared loadings
	Total	Percentage of variance (%)
1	11.256	45.025
2	2.600	10.401
3	1.073	4.294

However, following established practices (Hair et al., 2019; Kline, 2013), only the first two factors were retained. The third was based solely on the item "collect and create numeric information", which did not meet the minimum of three items required for a stable and interpretable factor.

The rotated component matrix displayed a logical and interpretable structure. Items connected to multimedia (video, sound, and image) handling loaded strongly on the first factor, while those related to text and numeric handling loaded on the second. The final two-factor solution elegantly encapsulates the analytical and expressive dimensions commonly investigated in digital literacy research (Chang et al., 2016; Patnaik & Bhowmick, 2022), supporting the theoretical coherence of the ADLF. The communality values, which ranged from 0.428 to 0.703, were much higher than the recommended minimum levels (Analysis INN, 2020; Tavakol & Wetzel, 2020).

CFA was used to test construct validity through convergent and discriminant validity (Edumadze, 2023). Convergent validity confirms that indicators strongly relate to others measuring the same construct, while discriminant validity ensures they are not strongly related to indicators of different constructs. Together, these tests verify that each indicator accurately measures its intended concept.

To check for convergent validity, we use measures like average variance extracted (AVE) and CR. Every construct surpassed the established benchmarks for AVE ⩾ 0.50 and CR ⩾ 0.70 as shown in **Table 3** (Edumadze, 2023). The video construct showed particularly high internal consistency (AVE = 0.691, CR = 0.917). Although one numeric indicator ("collect and create numeric data") had a low loading (0.06), the broader numeric construct still demonstrated acceptable convergent validity (AVE = 0.565; CR = 0.838).

To check discriminant validity, we used the Fornell-Larcker criterion. In each case, a construct's AVE exceeded its maximum squared correlation with other constructs, confirming that the five dimensions of digital literacy were empirically distinct (Edumadze, 2023; Fornell & Larcker, 1981). For instance, the Text construct (AVE = 0.503) surpassed its highest squared correlation (0.49), and numeric followed the same pattern (AVE = 0.565 > 0.45).

The findings show that the instrument effectively captures the multifaceted nature of digital literacy, distinguishing between related but distinct skills such as text handling and multimedia creation. This allows educators to address specific learning needs instead of treating digital literacy as a single skill. Overall, the instrument is both statistically reliable and theoretically consistent with contemporary views that define digital literacy as a dynamic set of interconnected competencies.

Proficiency Levels Across Media Formats

Descriptive and frequency analyses were conducted to assess students' self-reported proficiency in using digital content across multiple formats, text, numbers, images, sound, and video. The analysis addressed the question: how proficient students were across different media types (objective 2).

As shown in **Table 6**, mean scores reveal that students' digital proficiency is not evenly distributed across media formats. The highest average performance occurred in text-based activities (mean [M] = 2.26, standard deviation [SD] = 1.13) and numeric tasks (M = 2.02, SD = 1.10), followed closely by image-related skills (M = 1.64, SD = 1.15). Sound and video competencies were comparatively weaker, with mean scores of 1.44 (SD = 1.21) and 1.19 (SD = 1.13), respectively. Across all five media types, the mean values were above 1.71, which points to generally low-to-moderate levels of self-assessed competence. Yet, when the numbers are compared across domains, the contrast becomes clear.

This outcome fits a familiar pattern seen in other studies. Ilomäki et al. (2016) and Ng (2012) also reported that many university students show solid operational and information-handling skills but tend to fall short in creative, production-oriented work. The finding probably reflects the academic culture itself. In most university settings, written reports and quantitative assignments remain the norm, while few courses require students to produce podcasts, digital stories, or short video analyses (Aesaert & van Braak, 2015). In effect, the academic environment shapes not only what students learn but also how broadly they engage with the digital ecosystem.

The results show that students' digital literacy is still centered on traditional academic uses of technology. As Hargittai (2010) noted, familiarity with technology does not equal genuine skill, particularly in creative or integrative tasks. UNESCO (2019) similarly emphasizes that true digital literacy involves creating and communicating meaning across multiple media. For Ghanaian universities, this calls for developing multimodal fluency rather than basic competence. When digital learning is limited to routine tasks such as typing essays or crunching numbers, students become efficient users but not creative producers. Integrating writing, design, and multimedia tasks, such as using videos or infographics to present data can bridge this gap. Redecker (2020) and Law et al. (2018) argue that such cross-media projects foster genuine digital fluency by uniting creativity, analysis, and communication.

Interrelationships among Digital Literacy Skills and Competencies

Correlation indicates the degree to which variables are related, supporting prediction, validity checks, and theory testing. While there is agreement that coefficients below 0.1 are negligible and above 0.9 are very strong, the interpretation of intermediate values varies. According to Schober et al.

Table 6. Descriptive statistics for digital literacy skills across media formats (N = 1,520)

Media type	Digital skill	Mean	Standard deviation
	Collect and create digital text (TextCC)	2.39	1.03
	Organize digital text (TextO)	2.25	1.22
Text	Manipulate digital text (TextM)	2.21	1.12
	Format digital text (TextF)	2.37	1.12
	Communicate digital text (TextC)	2.07	1.19
Weighted mean (text)		2.26	1.13
	Collect and create numeric information (NumericCC)	2.31	1.05
	Organize numeric information (NumericO)	1.88	1.13
Numeric	Manipulate numeric information (NumericM)	2.04	1.04
	Format numeric information (NumericF)	2.04	1.12
	Communicate numeric information (NumericC)	1.82	1.14
Weighted mean (numeric)		2.02	1.10
	Collect and create digital images (ImagesCC)	1.99	1.12
	Organize digital images (ImagesO)	1.54	1.15
Images	Manipulate digital images (ImagesM)	1.40	1.14
	Format digital images (ImagesF)	1.62	1.17
	Communicate digital images (ImagesC)	1.66	1.18
Weighted mean (images)		1.64	1.15
	Collect and create digital sound (MusicCC)	1.62	1.20
	Organize digital sound (MusicO)	1.52	1.21
Sound	Manipulate digital sound (MusicM)	1.31	1.22
	Format digital sound (MusicF)	1.31	1.22
	Communicate digital sound (MusicC)	1.43	1.20
Weighted mean (sound)		1.44	1.21
	Collect and create digital video (VideoCC)	1.44	1.16
	Organize digital video (VideoO)	1.09	1.11
Video	Manipulate digital video (VideoM)	1.09	1.11
	Format digital video (VideoF)	1.12	1.11
	Communicate digital video (VideoC)	1.20	1.14
Weighted mean (video)		1.19	1.13
Overall mean (all 25 items)		1.71	1.14

Table 7. Intercorrelations among mean scores of digital literacy across media formats (N = 1,520)

Variable	Text	Numeric	Images	Music	Video
Text	1				
Numeric	.678***	1			
Images	.599***	.668***	1		
Music	.461***	.535***	.699***	1	
Video	.421***	.502***	.680***	.803***	1

Note. All correlations are Pearson's r coefficients & p < .001

Table 8. Intercorrelations among mean scores of digital literacy competencies across skill dimensions (N = 1,520)

Variable	Collect	Organize	Manipulate	Format	Communicate
Collect	1				
Organize	.746***	1			
Manipulate	.717***	.852***	1		
Format	.745***	.801***	.835***	1	
Communicate	.752***	.797***	.810***	.847***	1

Note. All correlations are Pearson's r coefficients & p < .001

(2018), correlations can be classified as negligible (0.00-0.09), weak (0.10-0.39), moderate (0.40-0.69), strong (0.70-0.89), and very strong (0.90-1.00).

To examine the interrelationships among students' digital literacy skills, Pearson's correlation analyses were performed across both media formats and skill dimensions. **Table 7** presents the correlations among the mean scores for the five media types: text, numeric, image, sound, and video, while **Table 8** reports the intercorrelations among the five core skill dimensions: collecting, organizing, manipulating, formatting, and communicating. As shown in **Table 7**, all five media formats were strongly and positively correlated, with coefficients ranging from r = .421 to r = .803 (p < .001). The highest association emerged between sound and video literacy (r = .803), suggesting a close overlap in the skills students employ when creating or manipulating audiovisual content. Text and numeric skills were also closely related (r = .68), suggesting that students who are comfortable managing written material tend to handle quantitative data with similar ease. Altogether, these results imply that proficiency in one medium reinforces ability in another–the skills are intertwined rather than compartmentalized.

A similar picture emerges when looking at the digital skill dimensions themselves. **Table 8** shows strong intercorrelations among collecting, organizing, manipulating, formatting, and communicating skills, with coefficients between r = .72 and r = .85 (p < .001). The highest association–between formatting and communicating (r = .85)–suggests that students who know how to structure information clearly are also better at presenting it effectively. The tight coupling of collecting, organizing, and manipulating skills supports what earlier scholars such as Ng (2012) and Spante et al. (2018) have argued: that technical, cognitive, and communicative competencies do not develop in isolation but strengthen one another through repeated use.

As shown in **Table 9**, the intercorrelations among the 25 digital literacy indicators ranged from r = .42 to r = .89, with an average coefficient of .68, all significant at p < .01.

Table 9. Summary of Pearson's correlations among all 25 digital literacy indicators (N = 1,520)

Statistic	Minimum r	Maximum r	Mean r	Significance
Across 25 indicators	.42**	.89**	.68	All p < .01

Note. r = Pearson's correlation coefficient & p < .01 indicates all correlations are statistically significant at the 1% level

Table 10. Pearson's correlation between AL_composite and ICAS levels (N = 1,520)

Variables	Pearson (r)	p-value
AL_composite	1	-
ICAS level	0.516	< .001

Table 11. Chi-square analysis using full proficiency scale (0-4)

Test	Value	df	p-value
Pearson's Chi-square	507.365	16	< .001
Likelihood ratio	449.542	16	< .001
Linear-by-linear association	359.034	1	< .001

In a practical sense, these correlations offer a pedagogical message. They highlight the fact that teaching digital skills in isolation restricts learning transfer, while integrated tasks that combine data collection, manipulation, and presentation promote broader skill development (UNESCO, 2019). In short, the findings show that digital literacy among University of Cape Coast students is multidimensional yet interconnected, with improvement in one area enhancing others. This supports the ADLF framework's view of digital literacy as a continuum from collection to communication and emphasizes the need for holistic, creative, and adaptable digital education.

Comparison between ADLF and ICAS Proficiency Levels

Specific objective 4. *Explore the relationship between self-assessed digital literacy (atomic learning) and standardized proficiency (ICAS levels).*

To understand how students' self-perceptions of digital skills align with standardized benchmarks, the study compared scores from the ADLF and the ICAS. Using both correlational and categorical tests, the analysis explored how well self-ratings matched objective benchmarks, providing a broader perspective on students' understanding and demonstration of digital competence.

This analysis used the full five-point ADLF scale to explore ordinal trends yielded a slightly stronger correlation (r = .516, p < .001; **Table 10**), reinforcing the general trend observed earlier. The observed association fits well with what van Deursen and Helsper (2015) found: that self-evaluations of digital ability often correspond fairly closely with performance-based measures, provided that the self-assessment instrument is well designed. Still, the match was far from exact. Some students appeared to rate themselves a little higher or lower than their demonstrated proficiency suggested. Such discrepancies are common and may stem from confidence biases, differences in exposure to assessment formats, or simply varying interpretations of what "proficiency" means in practice.

The Chi-square result (χ^2 = 507.365, df = 16, p < .001; **Table 11**) showed that students' self-ratings on ADLF tended to rise in step with their ICAS levels. The linear-by-linear association (359.034, p < .001) reinforced this, pointing to a steady upward trend. This kind of detail helps clarify how students view their own digital skills–not just in broad strokes, but across a spectrum. This reinforces the suggestion that perceived digital skills are reflective of actual capabilities when assessed across multiple categories and with sufficient resolution (Claro et al., 2012; van Laar et al., 2017).

Table 12. Chi-square analysis between binary self-rated proficiency and ICAS levels

Test	Value	df	p-value
Pearson's Chi-square	221.609	4	< .001
Likelihood ratio	221.778	4	< .001
Linear-by-linear association	173.845	1	< .001

A Pearson's Chi-square test (**Table 12**), which looked only at those who said, "they could teach a skill", also found a significant link with ICAS levels (χ^2 = 221.609, df = 4, p < .001). Nevertheless, reducing the scale to a binary format may miss important differences. As noted by Hatlevik and Christophersen (2013), binary measures can flatten the complexity of digital skill profiles, especially when those skills span multiple domains.

The findings show a fair alignment between students' self-assessed and standardized digital literacy scores when measured with a detailed instrument. The moderate correlations and the significant Chi-square results also indicate that students are not entirely unaware of their digital abilities; they can generally judge their strengths, especially in basic and intermediate areas. This demonstrates not only their technical proficiency but also their perception and ability to apply those skills in different contexts. This reflects both technical skill and self-awareness. Institutions should combine self-assessment with standardized tools to better identify specific gaps. That student might appear confident in a general sense but likely has specific, unrecognized gaps in formal computing domains things like databases or scripting that need targeted instruction. On the other hand, a student with a high ICAS score but a low ADLF self-rating is a different case. Although they possess technical expertise, they seem hesitant to apply it to practical tasks such as digital communication or multimedia projects. To cultivate applied confidence, they may need support.

Demographic Differences in Digital Literacy

Subgroup analyses were run to see how students' digital literacy varied by gender, discipline, college, and academic level, drawing on the full sample of 1,520 respondents. The results, shown in **Table 13**, revealed several meaningful differences. When t ≈ 2 or F ≈ 3 with p < .05, the difference is generally considered statistically significant.

Gender differences were statistically significant, t (1,518) = 1.97, p = .049, with males (M = 2.03) scoring slightly higher than females (M = 1.95). Though modest, this gap reflects patterns in digital self-efficacy and exposure reported in prior studies (Hatlevik et al., 2015; Ng, 2012). Disciplinary differences were more pronounced. Students enrolled in STEM-related programs (M = 2.17) performed noticeably better than those in non-STEM fields (M = 1.93), F = 2.81, p = .005). The gap in digital confidence between STEM and non-STEM students likely stems from differing levels of hands-on

Table 13. Group differences in ADLF composite scores by gender, discipline, college, and level (N = 1,520)

Variable	Group	N	Mean	Standard deviation	t	F	p-value
Gender	Male	938	2.03	1.12	1.97		.049
	Female	582	1.95	1.13			
Discipline	STEM	237	2.17	1.09	2.81		.005
	Non-STEM	1,283	1.93	1.14			
College	Agricultural and natural sciences	184	2.14	1.07		4.21	.006
	Educational studies	393	1.89	1.15			
	Health & allied	53	1.97	1.13			
	Humanities & legal	890	1.91	1.14			
Level	100	460	1.89	1.11		0.72	.577
	200	54	1.96	1.10			
	300	942	2.01	1.13			
	400	41	2.02	1.15			
	700	23	2.05	1.14			

exposure. STEM students frequently engage in simulations, data processing, and lab software, fostering greater digital competence (Govender, 2025; Kefalis et al., 2023). This disparity reflects differences in curricular structure rather than talent, suggesting that non-STEM programs should more intentionally integrate digital skill development into coursework. The same broad tendency appeared across colleges. The overall test was statistically significant, $F(3, 1{,}516) = 2.81$, $p = .005$. A similar pattern appeared when the data were broken down by college. Students from the college of agriculture and natural sciences reported the highest average score ($M = 2.14$), followed by those in health and allied sciences ($M = 1.97$), humanities and legal studies ($M = 1.91$), and educational studies ($M = 1.89$). The order is interesting and perhaps a bit unexpected. One might assume that education students, who are frequently introduced to digital learning platforms and instructional technology, would rank higher (Ghosh, 2023; Julien, 2018). Yet their lower mean may signal something different: that much of their engagement with technology is conceptual rather than practical. In other words, they might learn about digital tools without necessarily learning through them. Such a gap between exposure and authentic use can limit the development of applied digital fluency. Across academic levels, a small upward trend was visible from level 100 ($M = 1.89$) to level 700 ($M = 2.05$), but the pattern was not statistically significant, $F(4, 1{,}515) = 0.72$, $p = .577$. The implication is that moving from one level of study to another does not automatically bring a measurable improvement in digital literacy (Song et al., 2025). Students often gain initial digital confidence but plateau once basic skills are mastered. This underscores the need for continuous, scaffolded digital literacy development throughout their studies.

These subgroup results echo earlier findings (Ilomäki et al., 2016) that contextual exposure, particularly disciplinary task structures has more influence on digital competence than demographic identity alone. The data reinforce the importance of intentional curriculum integration rather than assuming that prolonged study or generic ICT access will foster advanced skills.

CONCLUSION AND RECOMMENDATION

Concluding Reflections on Measurement and Findings

The study evaluated university students' self-reported digital literacy using the ADLF and compared it with standardized ICAS computer skills levels. Data from 1,520 University of Cape Coast students showed that ADLF functioned reliably in this context, with analyses confirming that the instrument consistently captures digital literacy performance.

Students demonstrated uneven digital proficiency. They were more confident and capable with text and numerical tasks but struggled with images, sound, and video. While most managed routine computing activities, fewer displayed the creative or production-based fluency required for complex multimedia work. Many could handle documents or data analysis, yet far fewer could integrate video, sound, and imagery with both technical skill and creative judgment (Ng, 2012; Redecker, 2020; Vuorikari et al., 2022).

Correlations among ADLF skill dimensions suggested that digital abilities are interrelated and develop together, and self-assessed skills moderately aligned with standardized benchmarks, though some overestimation was observed (Gui et al., 2020). Small demographic differences appeared, with male students and those in STEM programs showing slightly higher scores, reflecting the influence of access to technology and technical coursework on skill development (Tang & Chaw, 2016; van Laar et al., 2017). Overall, the findings depict digital literacy as layered and interdependent, with students being functional but not yet fully fluent.

Implications for Policy and Curriculum

These findings provide clear directions for how universities can strengthen digital literacy education.

Firstly, the marked gap between students' proficiency in text-based tasks and their weaker multimedia skills reveals a curricular imbalance. Most programs still emphasize "office literacy" such as word processing and data entry, neglecting creative, multimodal skills. Embedding activities that combine text, image, and sound, such as infographics or podcasts can foster digital creativity (Ferrari, 2013; Redecker, 2020).

Secondly, linking self-assessment tools like ADLF with standardized frameworks such as ICAS or DigComp would enable departments to benchmark progress and track digital skill growth over time. The study's correlations indicate that these frameworks complement each other, with ADLF capturing developmental depth and ICAS offering standardized comparison.

Thirdly, findings revealed a gender and disciplinary gap, with male and STEM students rating themselves slightly higher in digital competence. This does not imply lower potential among other groups but indicates that the learning environment may be uneven. Universities can address this by offering optional workshops and mentorship programs where non-STEM students and women can explore technology in supportive, low-pressure settings. Over time, such initiatives can foster equity and boost digital confidence. Hatlevik et al. (2015) similarly argue that inclusive, accessible digital learning environments enhance engagement and overall skill development.

Finally, digital skill development should be systematically integrated into institutional structures rather than treated as occasional training. Implementing university-wide digital literacy policies backed by faculty training, peer mentoring, and sustained ICT investment can make digital competence a core graduate attribute (Redecker, 2020; UNESCO, 2019). Moreover, connecting self-assessment tools like ADLF with standardized benchmarks such as ICAS or DigComp would enable departments to track students' progress and provide targeted support where needed.

Recommendations for Future Research

While the current study establishes a strong empirical base, it also highlights several directions for refinement.

1. **Instrument optimization**–One numeric item showed a weaker association with its construct, suggesting the need for revision. Rephrasing or replacing this item could improve the instrument without altering the instrument's overall structure.
2. **Cross-institutional validation**–Repeating the study in other Ghanaian or West African universities would help determine whether the ADLF–ICAS relationship holds across different institutional cultures.
3. **Longitudinal tracking**–The survey provides only a snapshot of students' digital skills. Longitudinal follow-ups over a couple of semesters or post-graduation would reveal whether digital learning experiences lead to genuine improvement or simply maintain existing skill levels, clarifying whether growth occurs naturally or requires intentional support.
4. **Integration of emerging literacies**–The future version of the ADLF instrument should also capture emerging forms of literacy such as AI literacy, ethical data handling, and responsible digital participation (Ng, 2023).

Concluding Statement

The findings show that tools like ADLF can be effectively adapted across cultural contexts, as seen in Ghana. However, students displayed uneven proficiency–strong in text-based tasks but weaker in multimedia creation and integration. This imbalance affects curriculum design, assessment, and staff training. Strengthening digital literacy requires fostering students' confidence and creativity across diverse media. As higher education adopts more blended and AI-driven learning, the key challenge is guiding students from being competent users to reflective digital creators, laying a foundation for more transformative digital education in Africa.

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