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Learning with Digital Media: A Systematic Review of Students' Use in African Higher Education

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Abstract: This study examined African higher education students' digital media use for learning. A total of 64 papers were selected for final synthesis from 1046 publications between 2010 and 2021. The review was dominated by campus-based undergraduate studies in the STEM subjects. The synthesis confirmed a variety of digital media usage; however, learning management systems were mainly used for course delivery and primarily accessed by students through weak internet-enabled mobile devices. Digital-media learning activities include communication, information search, instruction, knowledge management, exploration, assessment, collaboration, and simulation. Subject areas were found to have no associations with type of learning activity. These findings suggest an emphasis on transmissive learning modes in digital environments, which may not promote active learning. Although African countries have leapfrogged the development of tethered devices and internet applications, connectivity cost, reported incompatibility, technical issues, and low digital proficiency still prevent the upscaling of technology-enhanced learning via mobile devices.

Keywords: Africa, higher education, digital education.

Introduction

Due to the COVID-19 pandemic, higher education institutions (HEI) are adopting remote teaching, which is driving the global adoption of digital teaching and learning methods (Bozkurt & Sharma, 2020; Whittle et al., 2020; Hodges et al, 2020; Zawacki-Richter, 2020). Before this massive shift to online learning, Bower (2017) noted that the objectives for incorporating technology into teaching and learning varied but were generally aimed at enhancing access to learning, student learning outcomes, and learner motivation. While media and technology integration in education has been highly touted, research has demonstrated that it can only be effective if pedagogy and technology are appropriately balanced (Geist, 2011; Hattie, 2009; Kerres, 2013). Otherwise, media may be employed for social, affective, or hedonistic goals rather than academic-related ones in the classroom (Naidoo, 2016; Parry & Le Roux 2018). This emphasises the importance of instructional design in teaching and learning, which involves careful planning and a strong pedagogical approach regardless of media tool. Thus, to promote learning outcomes, media and technology must support and align with the learning task (Berry & Westfall, 2015; Evans & Matthew, 2013; Kong & Song, 2015).

Learning in a Digitally Challenged Context

Africa continuously ranks low in major global information and communication technology indices (ICT[i,ii]; Ponelis & Holmner, 2015). Van Dijk (2019) cites social and material resources as two major

reasons for digital inequality. The social context in which people live may stimulate or diminish interest in digital media use (Selwyn, 2006), whereas material resources allow individuals and institutions to invest in digital media and its upkeep costs. The effects of the COVID-19 pandemic further reinforced the trend of low technological infrastructure investments in African higher education (Asamoah, 2019; Asunka, 2008; Mtebe, 2015). During this period, some African institutions in Ghana and South Africa initiated fundraising activities[iii] to buy computers and data plans for students, a clear incidence of a first-level digital divide or access problem, which is rare in the Global North. Material access to digital media (Gonzales, 2016) continues to hinder African higher education's digitisation drive due to the continent's socio-economic issues. Therefore, Pineteh (2012) argues that traditional strategies for teaching and learning in Africa are essential because they cater for "students from economically disadvantaged backgrounds with mediocre IT skills or replace virtual activities in the event of technological failures" (p. 94).

Over the past four decades, tertiary enrolment in Africa has increased, and the demand for higher education is expected to witness a further increase (Effah & Mensah-Bonsu, 2001; Naidoo, 2007; OECD, 2016). While educational technologies provide opportunities for widening access, they may also accommodate a deep divide (Hill & Lawton, 2018). One of the ways suggested to bridge the digital divide is to explore how new media could be leveraged for digital education in Africa and related contexts (Conole, 2014; Guri-Rosenblit, 2014; Poushter, 2016). Conole (2014) remarked that "developing countries are finding a makeshift solution, for example, the use of mobile devices rather than computers, as well as making materials available on smart devices rather than online, and the use of free resources such as open educational resources" (p. 230). The establishment of many recent open universities in the Global South (Zawacki-Richter & Qayyum, 2019) represents an opportunity to expand digital education in the region. However, Africa's well documented challenges of low availability and reliability of the internet and technological devices, low levels of digital skills, inadequate institutional support for technology-enhanced learning, and slow adoption rates by students and teachers (Asamoah, 2017; Mtebe, 2015) remain obstacles for the realisation of the benefits of digital education in Africa. It is due to the often hackneyed but existential technology and infrastructural challenges in Africa, and the prominence of the continent in the digital-divide discourse (Giebel, 2013; Pénard et al., 2015), that gives credence to label the context as digitally challenged.

Education is contextual in practice, and evidence from one cultural or geographical context may not necessarily be transferable to others. Thus, adopting technologies for use without an analysis of the contextual factors for adaptation is a recipe for disaster (Wagner, 2011). Due to a myriad of structural and technological challenges encountered within the African higher education context, it would be useful to heed the call by Oliver (2011) to carefully examine our understanding of the relationship between media and learning and acknowledge that social and contextual factors should be taken into consideration (Koehler & Mishra, 2009). Therefore, it is important to examine the role of digital media for learning and teaching within the African higher education context.

Towards Evidence Mapping

Educational practice and policy should be based on evidence (Slavin, 2020), and a systematic review provides a method to summarise the evidence within a field, identify gaps in the literature, and inform evidence-based practice (Zawacki-Richter et al., 2020). Systematic review studies also provide

an important means to determine the effects in a particular sub-area of learning technology research (Lai & Bower, 2019). There have been some systematic reviews that have focused on different types of digital media used for learning in higher education. These include learning management systems (e.g., Bervell & Umar, 2017; Mwalumbwe & Mtebe, 2017), e-portfolios (e.g., Beckers et al., 2016), social media (Cheston et al., 2013), video conferencing (Chipps et al., 2015) and the application of artificial intelligence in education (Zawacki-Richter et al., 2019).

However, as Bond et al. (2020) noted, there are few educational technology systematic reviews with an explicit regional focus. Furthermore, Bartolomé et al. (2018) observed that research on digital media for student learning largely ignores the pedagogical perspectives regarding their utilisation. This gap in the literature needs to be addressed, with the goal of informing the instructional design process and media selection for improving digital education through an authentic African lens. Thus, this study uses a systematic review to explore the application of digital media for students' learning within the African higher education context.

Purpose

This review aims to provide a coherent synthesis of leaners' use contexts regarding digital media and technologies for learning activities within the African higher education context. The goal is to inform policy, and to support research and practice in digital education design by addressing the following main review question: *How do students use digital media for learning within the African higher education context?* More specifically, this systematic review responds to the following sub-questions:

1. How have publications on student digital learning in African higher education developed over time in terms of (a) geographic distribution of studies, (b) authorship, and (c) publication patterns?
2. What characteristics can be found in studies conducted on students' use of digital media for learning in African higher education regarding:

   a) theoretical frameworks and methods applied (study characteristics)?

   b) student type, field of study, mode of delivery, and type of digital media used (contextual characteristics)?
3. For what kind of learning activities were the digital tools utilised in those studies?

Methods

The study applied a systematic review method to synthesise relevant evidence that fits pre-defined eligibility criteria to answer a specific question (Moher et al., 2009). The strength of this methodological approach lies in its explicit, systematic, and replicable search strategy, which is transparent and clearly specifies the inclusion and exclusion criteria for identifying studies (Gough et al., 2017; Zawacki-Richter et al., 2020).

Search Strategy

A search string (see Table 1) was developed and applied in three databases: Web of Science, Scopus, and EBSCO Education Source (covering titles, abstracts, and keywords). The choice of these databases stems from their reputation and international acceptance for indexing high quality journals. The articles for this review were restricted to those published in peer-reviewed journals, which are

assumed to provide a certain measure of rigour (Nicholas et al., 2015). At the beginning of the 2010s, digital media applications gained significant importance by permeating all facets of economic and social life including education. This led to Mills' (2010) characterisation of the period as the 'digital turn'. Thus, the year 2010 was selected as the starting point for this review. Additionally, the corpus was limited to articles that addressed the application of digital media within a course setting in an African-based higher education context only.

A database search on April 23, 2020, yielded 947 records. These were English-language peer-reviewed journal articles from 2010–2019. The search was broadened on March 25, 2022 to encompass 2020 and 2021 papers because of the COVID-19 epidemic and the increased use of digital media in higher education. This yielded an additional 115 records. Thus, a total of 1,062 records were finally screened on titles and abstracts.

Table 1: Initial Search String

Topic and Cluster	Search Terms
Student	"Learner" OR "Student*
AND	
Digital Media	"educational technology*" OR "ICT" OR "digital media"
AND	
Educational Context	"Higher education" OR "University*"OR "College*"
AND	
Geographic Context	"Africa" OR "Sub-Saharan Africa" OR "Global South"

Screening and Selection

After Zotero reference management software deleted 138 duplicates from the 1,062 retrieved records, 924 documents remained (see Figure 1). Titles and abstracts were then screened on inclusion and exclusion criteria (see Table 2), with sensitivity above specificity, so papers were included rather than excluded at the screening stage. After screening using Rayyan software (Ouzzani et al., 2016) and removing 725 publications for not fulfilling eligibility requirements, 199 articles remained. The 197 papers were fully screened after two papers were unrecoverable. After disqualifying 135 papers, 64 were selected for synthesis[iv] (see Prisma diagram in Figure 1). To ensure coding uniformity and obtaining a decision on paper inclusion or exclusion, authors met and emailed often. Consistent with Pigott and Polanin's (2020) suggested approach, one author screened the articles while a second person validated and signed off on the eligibility decision.

Table 2: Final Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
▪ Journal article and peer-reviewed	▪ Not a peer-reviewed journal article
▪ Published between January 2010 – December 2021	▪ Published before January 2010 and after December 2021
▪ Relates to student learning with digital media	▪ Not student learning with digital media
▪ Learning activity within a course setting	▪ Learning activity outside of a course setting
▪ Study context is higher education	▪ Not higher education
▪ Identifiable digital media as focus of study	▪ Generalised ICT tools and not specific media
▪ Study's geographic context is Africa	▪ Study's geographic context outside Africa
▪ Study is primary research	▪ Not primary research
▪ English language publication	▪ Publication not in English

Coding, Data Extraction and Analysis

All 64 publications were uploaded into Rayyan, a web-based systematic review software, for coding (Ouzzani et al., 2016). Then a coding scheme was developed with codes for the review questions including, article information (year of publication, journal name, nation of study, countries of first author, authorship collaboration, student type, topic area, and delivery style), study approach, and theoretical framework. Digital media and learning activities were also coded.

Limitations

All necessary steps were taken to ensure validity and reliability of the study, however, the results should be interpreted with caution. Although one author has substantial systematic review publication experience, computed inter-rater reliability was absent. Second, this analysis only employed three highly ranked databases, where African educational technology research was underrepresented (Bond et al., 2019; Bozkurt et al., 2019). This may have excluded some relevant studies published outside these top-tier databases. Thirdly, we acknowledge and follow Gough et al.'s (2012) caution that "electronic searching is imprecise and captures many studies that employ the same terms without sharing the same focus or would lead to disregarding studies that analyse the construct but use different terms to describe it" (p. 13).

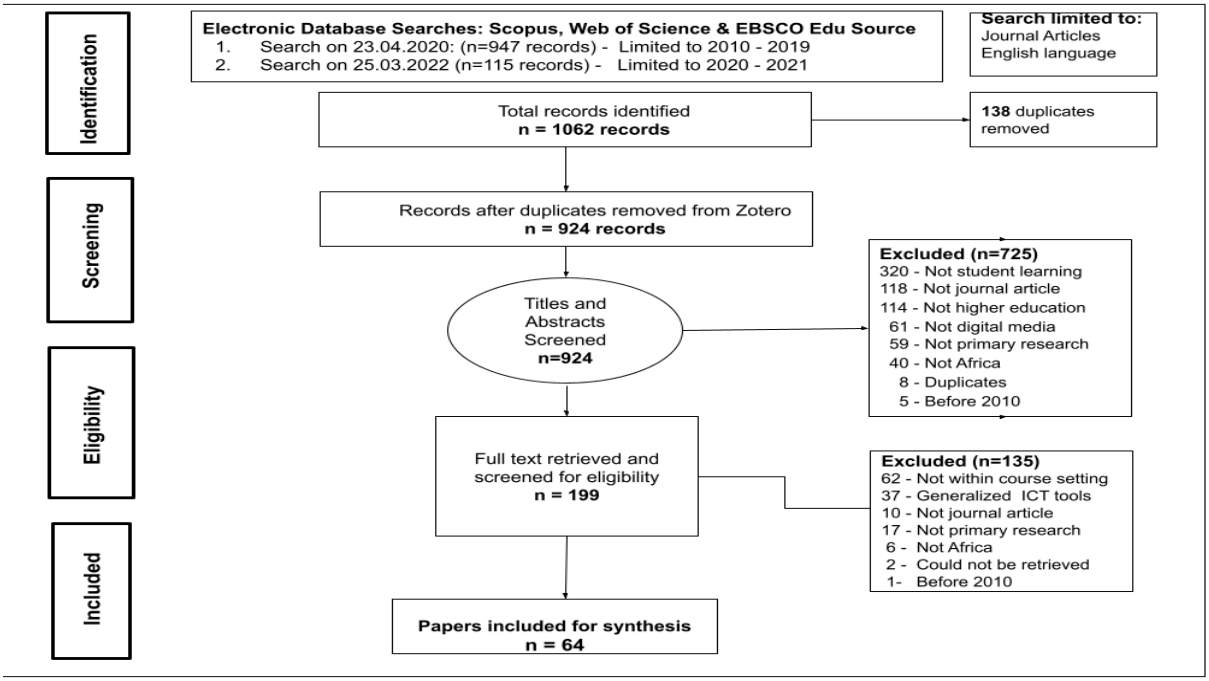

Figure 1: Systematic review PRISMA flow chart
(modified after Brunton et al., 2012, p. 86; Moher et al., 2009, p. 8)

Results

A summary of key results found in this review is presented in Table 3.

Table 3: Overview of Results

	Research Question	Dimension		Key Findings
1	Publication and authorship patterns	a.	Included articles	64 included articles; 2019 recorded the highest number (n = 11).
		b.	Key journals of included papers Papers spread among 40 Journals.	1. *South African Journal of Higher Education* 2. *British Journal of Educational Technology* 3. *Africa Education Review* 4. *International Journal of Educational Technology in Higher Education* 5. *Journal of Education and Information Technologies*
		c.	Study locations (Rankings)	A total of 8 African countries. Top three include: 1. South Africa 2. Ghana 3. Nigeria
		d.	Authorship and collaboration patterns	- South African authors (78.1%) - 57.8% of collaborations were among authors within the same country

	Research Question	Dimension		Key Findings
2	Study characteristics of included papers	a.	Research Approaches	Mixed-Methods (39.1%); Qualitative (34.4%); Quantitative (26.6%)
		b.	Theories, Frameworks, and Models (TFM) applied	- Social Constructivism; TPCK and TAM - 17 other TFMs applied. - 35 studies applied none.
3	Contextual characteristics of included papers	a.	Delivery formats/mode	Campus-based (76.6%), Distance learning (12.5%), Blended learning 1(0.9%)
		b.	Subject areas found in included studies	STEM (40.7%); Arts and Humanities (17.7%); Business and Economics (15.9%); Medical and Health Science (15.1%), Education and Social Sciences (10.6%).
		c.	Digital Media Tools and Services (Typology identified)	E-learning Tools and Services; General Web Tools and Services; Hardware and Devices; Social Networks; Text Media
4	Learning activities undertaken with digital media	a.	Classification of learning activities with digital media	Communication, Information Search, Instruction, Knowledge Management, Exploration, Assessment, Collaboration, Simulation
		b.	Subject area vs Learning activities	STEM subjects were highest or joint highest in all learning activities

Publication and Authorship Patterns

Figure 2 illustrates the incorporated article count over the review period (2010-2022). The peak was in 2019 (n = 11) was the peak, with 2020 (n = 4) witnessing a decline. The 64 included articles were published in 39 different journals. The *South African Journal of Higher Education* ranked first (n = 8), followed by the *British Journal of Educational Technology* (n = 6), and the *Africa Education Review*, the *International Journal of Educational Technology in Higher Education*, and the *Journal of Education and Information Technologies* (n = 3). A large number (n = 29) of single journal publications were also recorded. The full list of journals is provided in Appendix 1.

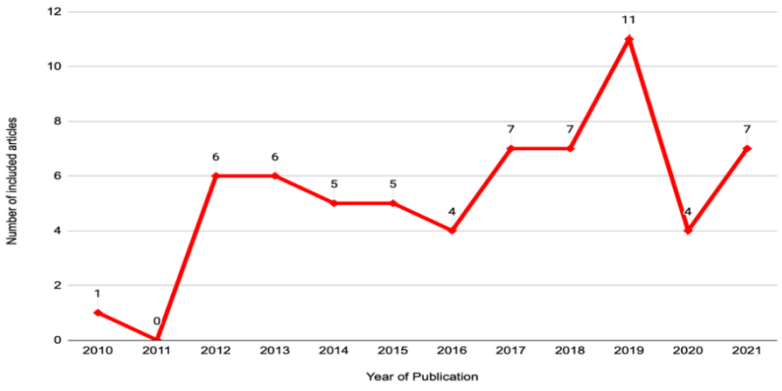

Figure 2: Number of included articles per year (n = 64)

The studies included in the review were conducted at African universities in eight different countries, with the overwhelming majority in the South African context (see Table 4).

Table 4: Geographical location of included studies (n = 64)

Rank	Country	n	%
1	South Africa	49	76.6
2	Ghana	5	7.8
3	Nigeria	3	4.7
	Botswana	2	3.1
	Malawi	2	3.1
4	Namibia	1	1.6
	Tanzania	1	1.6
	Zambia	1	1.6
	Total	**64**	**100.00**

Taking the first author's country location into consideration, most authors came from South Africa (n = 50). Overseas authors from the United States, Australia, Germany, and Ireland contributed a total of five papers. Additionally, more than half of the included papers involved collaborations within the same country (n = 37), however, collaborations between authors from different African countries were observed to be very low (n = 2). Full author country details and collaboration patterns are listed in Appendix 2 and Appendix 3, respectively.

Study Characteristics

Table 5 shows data for the included studies in terms of the research design employed. Qualitative and quantitative methods followed mixed-methods designs in popularity. These findings support the idea that qualitative and quantitative research in educational technology are balanced (e.g., Bailey, 2014; West & Borup, 2014).

Table 5: Research Approaches Employed in Included Articles (n = 64)

Approach	n	%
Mixed-Methods	25	39.1
Qualitative	22	34.4
Quantitative	17	26.6
	64	**100.00**

More than half of the included papers (n = 35) did not apply any theory, framework, or model in their research. This is consistent with previous observations and critique that theoretical underpinning of educational technology research has been often ignored (Albirini, 2007; Alper & Gulbahar 2009; Bond et al, 2020; El Gamal, 2022; Issroff & Scanlon, 2002; Oliver, 2013). In the studies that were found to have applied theoretical frameworks (n = 29), social constructivism had the highest count (n = 7), followed by the Technological Pedagogical Content Knowledge (TPACK; n = 4) and Technology

Acceptance Model (TAM; n = 4). Furthermore, 14 studies applied fourteen different types of theories, frameworks, or models. See the full list in Appendix 4.

Contextual Characteristics

In terms of student types found in the review, more than 90% (n = 58) were enrolled in undergraduate programmes. Only six of the studies were situated in a postgraduate course context. Additionally, the studies were mainly conducted in campus-based settings (n = 49) as shown in Table 6.

Table 6: Delivery Mode of Included Articles (n = 64)

Delivery Format	n	%
Campus-based	49	76.6
Distance learning	8	12.5
Blended learning	7	10.9
	64	**100.00**

STEM (n = 46) had the most digital media applications (Table 7). However, Arts and Humanities (20), Business and Economics (18), Medical and Health Sciences (17), and Education and Social Sciences (12) were well represented. Some included studies incorporated more than one subject area.

Table 7: Subject Areas Identified Across Included Articles (n = 64)

Rank	Subject Area	n	%
1	Science, Technology, Engineering, and Mathematics (STEM)	46	40.7
2	Arts and Humanities	20	17.7
3	Business and Economics	18	15.9
4	Medical and Health Sciences	17	15.1
5	Education and Social Sciences	12	10.6
		113	**100.0**

Digital Media Tools and Services Applied

The classification of media tools and services was based on a slight modification of the media typologies by Zawacki-Richter et al. (2015) and Grosch and Gidion (2011) as follows: e-learning tools and services (e.g., MOOCs, learning management system, reference management software, lecture recordings, etherpads, etc.); general web tools and services (e.g., search engines, email, blogs); social networks (e.g., Twitter, Facebook, WhatsApp, etc.); hardware and devices (e.g., laptops, smartphones, MP3 players, etc.); and text media (ebooks, PDFs, etc.). A total of 67 media tools and services were identified in the 64 included articles. E-learning Tools and Services ranked the highest (n = 29, 43.3%), with Learning Management Systems (LMS) being the focus of most studies. The possible reason for the higher numbers found for LMSs may be their capability to host other media types and tools.

The review found that single purpose media tools such as DVDs (van der Westhuizen et al., 2010), spreadsheet software (Agyei & Voogt, 2012), and videos were used more in the early years of the review (2010-2012). As the years went on, there was an increase in the use of media which were more reliant on the internet, such as social media networks (e.g., Magogwe et al., 2015), student response

systems (e.g., Basitere & Ivala, 2017), e-portfolios, and LMSs. With the proliferation of mobile devices in Africa during the same period, their focus as a device for learning gained research attention (e.g., Adedoja et al., 2013; Mayisela, 2013). These tools were not one dimensional in terms of their technological functions, compared with those in the preceding period, but were built to combine multiple media types in their utilisation and application. This may perhaps explain why very few studies focused on text media, as they may have been subsumed under other media types, particularly e-learning tools and general webtools and services. The application of games and simulations (e.g., Amevor & Bayanga, 2021; Khoza & Biyela, 2019) and messenger bots (Shmulian & Coetzee, 2019) then began to emerge, which represents a new phase for integrating technology in higher education within the African context. The full list of digital media tools and services across the review period is reported in Appendix 5.

Learning Activities Undertaken with Digital Media

The review assessed how students used digital media to support their learning using a coding framework inspired by the Ten Virtual Learning Spaces Framework by Peters (2002). Peters contended that learning with media should be conceptualised according to its technical and technological functions, and how they can be transformed into pedagogical functions. In essence, the focus should be on the pedagogical activities enabled by the digital learning environment; hence, our classifications of the learning activities focused on the relevant pedagogical activities found in the included studies and the technologies they were based on.

The review identified eight classifications of learning activities regarding how students used digital media (see Appendix 6 for full list). Digital media use for learning was mainly through communication learning spaces (n = 22). Simulation was the least common activity undertaken with digital media to support student learning (n = 9). An illustration of how the various learning activities compare across the identified subject areas is provided in Appendix 7. Overall, STEM subjects had the greatest proportion across learning activities, particularly for simulation (66.7%), exploration (58.3%), assessment (50.0%), and communication (45.5%). However, there was no significant association between the subject areas and the type of learning activities, $\chi^2 = 25.7$, $df = 28$, $p > .05$. Because the dominance of STEM subjects has been noted in previous educational technology systematic reviews (Bond et al., 2020; El Gamal, 2022; Zawacki-Richter et al., 2019), further analysis was conducted to compare the STEM subject area to non-STEM areas. Again, no significant associations were found between the dichotomised subject areas and learning activities, $\chi^2 = 7.6$, $df = 7$, $p > .05$.

Learning through Communication

Studies in this group explored how digital media facilitated communication, both between students, and between students and teachers, to promote engagement even beyond the classroom. Learning through communication included students sharing information and learning resources through the affordances of media including social networks, the LMS, and other interactive Web 2.0 tools and services, mainly through the use of mobile devices. For example, Bere and Rambe's (2013) study described how WhatsApp messenger was used by a lecturer in an undergraduate Information Technology course to boost participation and interaction through formal and informal learning. The use of the messenger also supplemented the university's LMS for both synchronous and asynchronous interactions, as the lecturer engaged students by posting topics and allowing student

interactions and feedback to each other. However, students reserved the more challenging aspects of the course for face-to-face discussions with the lecturer. In Baron et al. (2015), undergraduate students in a chemical engineering class at a South African university used a digital backchannel to provide feedback to lecturers by posting anonymous questions, comments, and voting on ongoing discussions in class. Further, discussion forums and blogs were found to facilitate learning by communication; where blogs were used for learning academic writing in a postgraduate setting in a study by Rambe (2013) A general trend identified was that mobile phone connectivity was deemed to be a very important alternative to poor connectivity via the university network. While some students struggled to download the applications, others did not have access to mobile phones to aid their course participation in the digital environment.

Learning through Information Search

Students also learned through information search by using media as a tool to retrieve course content and information for their studies, primarily through the LMS and other web-based learning platforms. In the study by Asamoah and Oheneba-Sakyi (2017), students in a postgraduate course used an LMS to download course-related materials. Students also accessed electronic learning resources for a course from online library services (e.g., in Tlakula & Fombad, 2017). In another study (Venter et al., 2012), the majority of final-year students in a strategic management course were described as occasional users of the LMS, since they only visited the platform to download course materials and read postings from other students or lecturers but did not contribute to discussions. Thus, the media's primary function was to be a repository. Mobile devices, which were the focus of some studies (e.g., Adedoja et al., 2013; Witts et al., 2016), were also used to access course information; although there were reported challenges regarding the small text sizes, which made information retrieval a tiring experience. In Witts et al. (2016), medical students were provided with tablets pre-loaded with applications and materials to support their learning. Once again, internet connectivity outside campus proved to be the major challenge, coupled with the delays in providing technical support for using the tablets. In addition, Msomi and Bansilal's (2018) study makes it evident that students, particularly those from poor backgrounds, lacked the requisite skills and technical support to retrieve course materials from the LMS at a South African university of technology. Students without mobile devices resorted to the use of the often fully occupied university computer labs.

Learning through Instruction

In this category, digital media was mostly used to transmit learning content. Thus, digital learning environments created an instructional space such as in a traditional classroom where students listen to a lecture and take notes. In a study of pre-service teachers at a Malawian university, MP3 players were used to record lectures for subsequent review and learning (see Carrier et al., 2012). Similarly, a South African medical school used videos to demonstrate the conduct of clinical examinations on children (George et al., 2019). Likewise, podcasts were used to supplement undergraduate course instruction at a South African campus-based university (Gachago et al., 2016).

Mobile devices also created instructional spaces as seen in the study by Adedoja et al. (2013) of students in a distance learning programme at a Nigerian university. The study also highlighted the potential of short message services (SMS) in providing academic support services. However, during the rainy season, some students reported problems with mobile internet connectivity. Additionally,

another form of instructional space involved using a messenger bot for virtual tutoring in an accounting course (see Shmulian & Coetzee, 2019).

Learning through Knowledge Management

Students also used digital media to curate, organise, store, and manage information by working through documents, and piecing together information from different sources to support their learning. The learning activity through knowledge management was realised using media such as e-portfolios. For example, in van Wyk's (2017) study at an open, distance learning university in South Africa, student teachers compiled artifacts for an e-portfolio that supported active and authentic learning through self-reflection. This was also the case in Nudelman (2017), where engineering students used e-portolios to reflect on their developing identities as professional engineers. In another study, van Wyk and van Ryneveld (2018) found that undergraduate veterinary science students used mobile devices to take personalised notes, a "cognitively demanding task" (p. 1640) (which included recording audio and taking pictures). Students organised and saved notes to suit their learning styles and make them easy to find later.

Learning by Exploration

If students used digital media to self-discover their learning path while exploring a sea of information, such studies were classified under the exploratory learning category. In Makhura et al. (2021), ICT students used an English Word Power Programme to improve their language skills. This was also the case in in the study by Stott and Hattingh (2014) where pre-service teachers used tutoring software to experiment with learning tasks and assessments in a natural science course. The flexibility and adaptability of the e-portfolio as a learning tool once again came to the fore. Mapundu and Musara (2019) found that South African private tertiary students used an e-portfolio to develop their entrepreneurial skills. In another exploratory learning scenario, students used mobile devices to explore Open Educational Resources and relate them to subject modules in van Wyk and van Ryneveld (2018).

Learning through Assessment

Teachers used digital media to conduct assessments, principally through an LMS and mobile devices. In Padayachee et al. (2018), undergraduate students in a mathematics course engaged in a weekly online assessment via Moodle to test their understanding of concepts taught during their week of face-to-face class. The weekly online tests formed part of the course's formative assessment and were designed to support their learning through regular weekly feedback. In Mtshali's (2021) study, students were required to submit assignments using the plagiarism detection software TurnitIn, which was embedded in the institutional LMS. TurnitIn provided students with feedback on their submitted work expeditiously to aid their learning. While the study reported that students felt exposed by the similarity index in their submissions, they acknowledged that TurnitIn aided them to be original in their assignments.

Learning through Collaboration

In some studies, students used digital media to create collaborative learning environments with their peers. In what was the most obvious collaborative space observed in the review, Mostert and Snowball (2013) described how *Moodle Workshop* enabled students in a macroeconomics course to

engage in online peer assessment and learn from peer feedback. A similar learning activity was noted with pre-service mathematics teachers in a Ghanaian university who used the concept of design teams to collaboratively design a lesson on the representation of mathematical concepts using spreadsheet software (see Agyei & Voogt, 2015). Students faced challenges, including lack of access to technological devices in the schools where they were expected to implement the lessons.

Learning through Simulation

Learning through simulation was the least common pedagogical activity enabled by digital media. Simulations were mainly used in STEM-related disciplines, primarily for the creation of mathematical representations using software such as MATLAB, MindTap, and GeoGebra (see Amevor & Bayanga, 2021; Delport, 2019). Additionally, Beukes et al. (2018) describe how students utilised an online audit simulator for engaging in virtual role playing in an accounting course. In another undergraduate research methodology course, Minecraft was used as a tool for creating a game that involved developing concepts related to the course (see Marnewick & Chetty, 2021).

Conclusions and Implications for Further Research

This study synthesised (n = 64) studies to answer the question of how higher education students in Africa use digital media for learning; by reviewing research publications and authorship trends, study and contextual characteristics of publications, and types of learning activities undertaken with digital media within their specific course contexts. The publication profile of the studies was dominated by South Africa, both in terms of study locations and authorship. This affirms the high productivity of South African authors in educational technology research within Africa (Bond et al., 2019; Bozkurt, et al., 2019); partly attributed to a deliberate home-grown policy that focuses on professional development and scholarship (N'gambi et al., 2016), and the development of communities of practice within the field of educational technology (Czerniewicz & Carr, 2005).

It is not surprising that three South African-based journals (*South African Journal of Higher Education, African Education Review,* and *South African Journal of Education*) were included in the top five ranked in terms of count for included journals for this review. Valid questions could be raised whether the seeming South Africanisation of educational technology scholarship in Africa is representative of the African continent given South Africa's advancement in digital technologies compared to other African countries. It is also the case that related publications from authors in comparatively far less developed and digitalised African countries may have been ignored as a result of the strict database selection criteria used for this study. Because of the generally low representation of African authors in mainstream databases, future studies may explore the inclusion of unorthodox or non-mainstream databases with heavy African author presence, which is likely to produce a larger corpus to better illustrate students' use of digital media in Africa. The review also observed a rather low level of collaboration between authors from different African countries. It is essential to foster strong cross-African collaborations for the benefit of educational technology scholarship in Africa.

More than half of the included articles failed to incorporate any theory, framework, or model. More intriguing was the fact that the Community of Inquiry model, which is one of the most cited in educational technology research, was conspicuously missing. This finding reinforces the critique of a general lack of theoretical underpinning for educational technology research (Bond et al., 2020; El Gamal, 2022; Zawacki-Richter et al., 2019). On the other hand, the research designs adopted by the

included studies appeared balanced and reflected the standpoint of authors who believe there is a growing recognition of a balance in research approaches used in educational technology research (Bailey, 2014; West & Borup, 2014). However, the debate regarding the most effective design for educational technology interventions is far from settled (Jou et al., 2016; Mertala et al., 2022). The debate has to be elevated by developing a critical approach to evaluate the strengths and weaknesses of various designs for effective interventions.

STEM emerged as the most applied subject area in the review; as were undergraduate studies, and campus-based delivery modes. This pattern has been observed in previous educational technology systematic reviews (Bond et al., 2020; Cheston et al., 2013; Henrie et al., 2015; Zawacki-Richter et al., 2019). In the analysis of digital media types used by students, the review revealed that LMSs, and web-based learning tools were in the majority. These tools have essentially replaced stand-alone media such as PDFs, DVDs, and media players due to their capacity to host multiple media tools. These results mirror what has been described as the blurred lines between media types, long observed in the Global North (Dolch & Zawacki-Richter, 2018; Zawacki-Richter et al., 2015). However, these LMSs remain underutilised as they largely serve as repositories for course materials, owing to an underappreciation of their potential; partly due to the low digital skills of both teachers and students, the absence of technical support, and poor technical internet infrastructure (Mtebe, 2015; Ssekakubo et al., 2011). It is thus understandable that the frustrations resulting from a combination of these factors may further contribute to disinterest and unwillingness on the part of users. The study highlighted the increasing importance and popularity of mobile devices for student learning in Africa, given their flexibility and regular use as an alternative to the poor internet connectivity of institutional networks. As African countries leapfrog the development of "tethered" devices, it creates an opportunity for deepening technology-enhanced learning practices. However, the well-documented challenges of the African context, such as connectivity cost, reported compatibility challenges, low digital skills and technical infrastructure, remain obstacles to the upscaling of technology-enhanced learning via mobile devices.

How digital media were used from a pedagogical standpoint was reviewed through the lenses of the *Ten Virtual Learning Spaces* model by Peters (2002). The study established eight pedagogical spaces through which learning with digital media was achieved by students in the African higher education context. The most common were learning by *Communication, Information Search,* and *Instruction* which suggests an emphasis on transmissive modes of learning. These pedagogical spaces point to an extensive importation of traditional teaching and learning approaches into the digital environment; a problem underscored during the so-called *emergency remote teaching* during the COVID-19 pandemic (Hodges et al., 2020; Lee et al., 2020; Sharma et al., 2021). This may emphasise the fact that the high levels of traditional learning approaches observed are symptomatic of a general technological deficiency in terms of skills and facilitating conditions within the context. Students and their teachers have had to rely on mobile devices, usually with a poor internet connection, to participate in digital learning. Therefore, low threshold applications must be given high consideration when designing digital learning environments in such contexts.

The fact that no significant associations were found between subject areas and learning activities with digital media portrays a rather uncritical use of the digital media and raises questions about the usefulness of the tools within the learning contexts. On a positive note, there are signs of incremental

progress in digital media use for more purposeful activities in pedagogical spaces such as knowledge management, exploration, collaboration, and simulation which are known to promote active learning. As such, further research is required on the use of media and how they align with student learning outcomes. Such research could inform appropriate pedagogical approaches for technology use in a digitally challenged context and ensure that the quest to use media does not impede learning and promote disengagement (Bond & Bedenlier, 2019; Howard et al., 2016; Popenici, 2013). Additionally, it would be useful to launch a scientific inquiry into finding what the most effective strategies are for incorporating digital media into higher education curricula in Africa to enhance student learning.

Finally, because the challenges of digital education in the African context go beyond access to digital media, bridging the digital divide requires a conscious effort to upgrade the technical infrastructure and radically improve the facilitating conditions for technology-enhanced learning. Leveraging the potentials of mobile devices, which are an abundant resource in Africa, must be front and centre in the discussion on design and implementation of digital learning environments. Furthermore, to achieve beneficial outcomes for technology-enhanced learning in Africa, it is essential to pursue a deliberate and sustainable policy of developing the digital skills and competencies of students and teachers, in particular, for the effective use of digital media. The teaching practices of teachers in African higher education institutions could play a significant role in shaping students' attitudes towards use of digital media for learning. Consequently, by incorporating technology into their lessons and supporting students in its use, teachers can help students to develop the digital literacy skills necessary for success in the 21st century.

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Notes

[i] https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2021.pdf
[ii] https://networkreadinessindex.org/
[iii] https://www.ug.edu.gh/vcsdi/initiatives/one-student-one-laptop
[iv] A file with all included references is available at: http://dx.doi.org/10.13140/RG.2.2.30567.93607 (CC BY 4.0)

Appendix 1: Full List of Included Journals (n = 64)

No.	Journal	n
1	*South African Journal of Higher Education*	8
2	*British Journal of Educational Technology*	6
3	*Africa Education Review*	3
4	*Journal of Education and Information Technologies*	3
5	*International Journal of Educational Technology in Higher Education*	3
6	*Accounting Education*	2
7	*Australasian Journal of Educational Technology*	2
8	*Journal of Computing in Higher Education*	2
9	*Journal of Educational Technology and Society*	2
10	*South African Journal of Education*	2
11	*The African Journal of Information Systems*	2
12	*African Journal of Health Professionals Education*	1
13	*African Journal of Research in Mathematics, Science and Technology*	1
14	*African Journal of Science, Technology, Innovation and Development*	1
15	*Assessment & Evaluation in Higher Education*	1
16	*BMJ Open*	1
17	*Computers & Education*	1
18	*Contemporary Educational Technology*	1
19	*Electronic Journal of e-Learning*	1
20	*Electronic Journal of Information Systems in Developing Countries*	1
21	*International Journal of Distance Education Technologies*	1
22	*International Journal of Education and Development using Information and Communication Technology*	1
23	*International Journal of Learning: Annual Review*	1
24	*International Journal of Medical Informatics*	1
25	*International Journal of Science Education*	1
26	*International Journal of Technology in Mathematics Education,*	1
27	*JMIR mHealth and uHealth*	1
28	*Journal of Baltic Science Education*	1
29	*Journal of Geography in Higher Education*	1
30	*Journal of Information Technology Education Research*	1
31	*Literator - Journal of Literary Criticism, Comparative Linguistics and Literary Studies*	1
32	*Social Work/Maatskaplike Werk*	1
33	*Perspectives in Education*	1
34	*Reading Research Quarterly*	1
35	*Research in Social Sciences and Technology*	1
36	*Technology, Pedagogy and Education*	1
37	*The All Ireland Journal of Teaching and Learning in Higher Education*	1
38	*The Electronic Library*	1
39	*The Turkish Online Journal of Educational Technology*	1
40	*Turkish Online Journal of Distance Education*	1

Appendix 2: First Author Affiliations of Included Articles (n = 64)

Rank	Country	n	%
1	South Africa	50	78.1
2	Ghana	4	6.3
3	Nigeria	2	3.1
	United States	2	3.1
4	Australia	1	1.6
	Botswana	1	1.6
	Germany	1	1.6
	Ireland	1	1.6
	Nigeria	1	1.6
	Tanzania	1	1.6
		64	**100.0**

Appendix 3: Authorship Collaboration Pattern of Included Articles (n = 64)

Collaboration Type	n	%
African (Within Country)	37	57.8
Single authorship	14	21.9
Africa + Overseas	10	15.6
African (Inter-country)	2	3.1
Overseas only	1	1.6
	64	**100.00**

Appendix 4: Theories, Frameworks, and Models Applied in Included Articles (n = 64)

Theories/Framework/Model Applied	n
Social Constructivism (Vygotsky, 1978; Jonassen, 1999)	7
Technological Pedagogical Content Knowledge (Mishra and Koehler, 2006)	4
Technology Acceptance Model (Davies, 1989; Venkatesh and Davis, 2000)	4
Activity Theory (Engestrom, 1987)	1
Approaches to Learning Paradigms (Biggs, 1987)	1
Diffusion of Innovation Theory (Rogers, 2003)	1
Five-Stage Model of Online Interaction (Salmon, 2004)	1
Four components model of student engagement (Appleton et al., 2006)	1
Four Parameter Model of Goal-linked practice (Saxe, 1991)	1
Framework for the Rational Analysis of Mobile Education (Koole, 2009)	1
Identity as Performance (Gee, 2014)	1
Social Cognitive Theory (Bandura, 1986)	1
The theory of register of semiotic representation (Duval, 1995)	1
The unified theory of acceptance and use of technology (Venkatesh et al., 2003)	1

Theory of Multimedia Learning (Mayer, 2009)	1
Theory of Planned Behavior (Ajzen, 1991)	1
Transformative Learning Theory (Mezirow, 2000)	1
No Theory/Framework/Model applied	35

Appendix 5: Distribution of Digital Media Types Across Review Period

	Media Typology				
Year	**E-learning Tools and Services**	**General Web Tools and Services**	**Hardware and Devices**	**Social Networks**	**Text Media**
2010	- DVD				
2011					
2012	- Simulation Software - Podcast - Spreadsheet - LMS		- Media Player	- Instant Messaging (Kommunicare)	
2013	- Online Peer Assessment	- Discussion Forum (2)	- Smart Phone (2)	- WhatsApp - Facebook	
2014	- Tutoring Software - Microsoft Office - DVD - Video - LMS				
2015	- Geometry Software - Digital Storytelling - Spreadsheet	- Student Response System		- Facebook	
2016	- Podcast - E-Assessment		- Tablet PC	-WhatsApp	
2017	- LMS - E-Portfolio	- Clickers - Padlet - Wikis	- Tablet PC	-Facebook, -Twitter	
2018	- LMS (3) - E-Portfolio - Simulation Software - Online Assessment	- Online Library Services	- Mobile Devices (2) - Tablet PC		-E-Book
2019	- Video Demonstration - E-Portfolio - Simulation Software - MindTap - LMS (2) - Video Sharing (Flipgrid) - Messenger Bots - Geogebra	- Student Response System	-Tablet PC	- Moya - Youtube - WhatsApp (2)	

2020	- LMS (3)	- Mobile Device
2021	- LMS - English Word Power Programme - Digital Story Telling (Video) - MinecraftEdu - Online Assessment - TurnItIn - MATLAB	

Appendix 6: Classification of Learning Activities Undertaken with Digital Media

No.	Activity	n	%
1	Learning through Communication	22	19.5
2	Learning through Information Search	19	16.8
3	Learning through Instruction	16	14.2
4	Learning through Knowledge Management	15	13.3
5	Learning by Exploration	12	10.6
6	Learning through Assessment	10	8.8
7	Learning through Collaboration	10	8.8
8	Learning through Simulation	9	8.0
		113	**100.00**

Appendix 7: Subject Area / Learning Activity Cross-tabulation

	Subject Area					
Learning Activity	**STEM**	**Arts & Humanities**	**Business & Economics**	**Medical & Health Sciences**	**Education & Social Sciences**	**Total**
Communication	10 (45.5%)	5 (22.7%)	1 (4.5%)	5 (22.7%)	1 (4.5%)	22
Information	6 (31.6%)	3 (15.8%)	3 (15.8%)	5 (26.3%)	2 (10.5%)	19
Instruction	5 (31.3%)	4 (25%)	3 (18.8%)	1 (6.3%)	3 (18.8%)	16
Knowledge Management	4 (26.7%)	4 (26.7%)	2 (13.3%)	2 (13.3%)	3 (20%)	15
Exploration	7 (58.3%)	2 16.7%)	1 (8.3%)	2 (16.7%)	0 (0%)	12
Assessment	5 (50%)	0 (0%)	3 (30%)	0 (0%)	2 (20%)	10
Collaboration	3 (30%)	2 (20%)	3 (30%)	1 (10%)	1 (10%)	10
Simulation	6 (66.7%)	0 (0%)	2 (22.2%)	1 (11.1%)	0 (0%)	9
Total	46	20	18	17	12	113