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Students' experiences with the utilisation of the 4IR technologies in online learning: a case study of institutions of higher learning in Botswana and Zambia

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Abstract

Rationale of Study – This study delved into students' experiences with using 4IR technologies in institutions of higher learning.

Methodology – Adopting a cross-sectional descriptive survey design, this study targeted students in higher learning institutions in Botswana and Zambia. Data was collected through an online questionnaire (Google Forms). Quantitative data was analysed using IBM SPSS version 26 for descriptive statistics, while qualitative data was analysed manually using a thematic technique.

Findings – The findings suggest that higher institutions of learning in Botswana and Zambia have taken steps to integrate 4IR technologies by utilising learning management systems, virtual classrooms, video conferencing tools, and social media platforms. However, there is still a need to further incorporate advanced technologies such as blockchain, AI virtual teaching assistants, augmented reality (AR), and virtual reality (VR) to exploit the potential of Education 4.0 fully.

Implications – The insights derived from this study offer valuable guidance for policymakers, educational administrators, and instructors seeking to contribute to advancing Sustainable Development Goal 4 in the Southern African region.

Originality – This study is one of the few exploring the perspectives of 4IR among students in the Southern African education sector.

Keywords

4IR, higher learning institutions, Education 4.0, Botswana, Zambia, university students

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1 Introduction

Institutions of higher learning (IHL) operate in a fast-changing new environment characterised by unprecedented rapid technological advancement, information explosion, and competition. An era driven and transformed by information and communication technologies designated as the fourth industrial revolution (4IR). The 4IR has brought significant technological advancements, revolutionising various industries, including education (Ndung'u & Signé, 2020). A range of technologies, such as artificial intelligence (AI), cloud computing, robotics, virtual and augmented reality, 3D printing, blockchain, the Internet of Things (IoT), and big data, epitomise the 4IR landscape (Elayyan, 2021). These technological advancements are creating semi-autonomous and innovative workplaces, which raises the demand for an intelligent workforce with digital knowledge and skills (Oosthuizen, 2022). Thus, since education in the 4IR is propelled by digital innovation (Alakrash & Razak, 2022), IHL is expected to prepare students to be creative and innovative. IHL is expected to produce graduates with skills such as critical thinking, people management, emotional intelligence, judgment and decision-making, negotiation, cognitive flexibility, knowledge production and management, problem-solving, communication, and collaboration (Alakrash & Razak, 2022; Suvin, 2020) for them to be relevant and competitive in the 4IR era. In response to this expectation, IHL is embracing 4IR technologies for teaching and learning.

A digital leap was also observed during the Covid-19 pandemic lockdown (Alakrash & Razak, 2022; Mhlanga & Moloi, 2020). Many higher learning institutions worldwide have adopted digital innovations to support remote learning. Integrating 4IR technologies in online learning brought numerous benefits, such as personalised learning, increased student engagement, and improved access to educational resources (Suvin, 2020). However, despite the proliferation of 4IR technologies in innovative education, the extent to which these technologies have been utilised and their impact on students' experiences in higher education institutions in developing economies is yet to be ascertained. While these technologies have the potential to enhance the quality of online learning, there is a need to investigate the extent of utilisation and identify the challenges encountered in their implementation and usage. Furthermore, 4IR technologies and their applications in developing countries are still in their early stages. Hence, further research is highly encouraged (Al-Emran et al., 2020). Knowledge of students' experiences with using 4IR technologies helps educators gauge the extent to which IHL produces

competent, knowledgeable, and skilled graduates who can work in the 4IR era. Therefore, the findings of this study will benefit the IHL policymakers, administration, faculties, departments, industries, and society at large.

The main objective of this study was to explore students' experiences with utilising 4IR technologies in IHL in Botswana and Zambia. The specific objectives of the study were to identify the 4IR technologies utilised in IHL in Botswana and Zambia, explore the skills students possessed to enable them to use 4IR technologies effectively in online learning, determine the benefits 4IR technologies bring to learners, and establish the challenges students face with the use of 4IR technologies.

2 Literature review

This section presents a brief literature review of 4IR technologies structured under subheadings relating to the study's specific objectives.

2.1 Application of 4IR technologies in education

The application of 4IR technologies in education has transformed the traditional classroom setting and opened up new possibilities for teaching and learning. This has led to introducing the concept of Education 4.0 (Elayyan, 2021). Education 4.0 is a term used to describe the latest phase of the evolution of education in the context of the 4IR. It is characterised by integrating digital technologies and advanced pedagogical approaches into teaching and learning and aims to prepare students for the demands of the 21st-century workforce (Fourtané, 2021). For instance, Massive open online courses (MOOCs) now utilise gamification and 3D technologies such as virtual (VR) and augmented reality (AR) to keep learners engaged and make them feel like they are in a traditional classroom. Kayembe and Nel (2019) averred that AR, VR, and 3D printing enhance personalised learning by providing new ways of visualisation, memorisation, and observation.

Another application of digital innovations in Education 4.0 relates to educational Chatbots. These are AI-powered virtual teaching assistants (Audras, 2022). One of the best-known Chatbots employed in universities is IBM Watson, which expedites student responses, downloads and provides documents, and answers subject-specific questions. An AI Chabot can respond quickly to library requests, sign up students for new classes, and get them to the admissions department in the blink of an eye (Kumar, 2021). For instance, according to Newton (2021), the following universities implemented chatbots

to play different roles: (1) Georgia State University uses a Chabot named Pounce, which is always ready to answer student questions about course material; (2) Staffordshire University uses a Chabot named Beacon, which can recommend reading resources and connect students with tutors, and (3) Australia's Deakin University also implemented Genie who can know whether a student asking a question has engaged with specific online course materials and can check students' locations and activities to determine if they have visited the library or tell them when they have spent too long in the dining hall and prompt them to move along. A study conducted in Ghana by Essel et al. (2022) established that the students who interacted with the KNUSTbot outperformed those who interacted with the course instructor.

Another example of 4IR technology applications in education is using humanoid robots in the classroom, which has become common in developed countries. An example is the bilingual humanoid robot called NAO. Much of the research to date has concentrated on the technological capabilities of robots to serve as educational tools, such as language acquisition, Science, Technology, Engineering, and Mathematics (STEM), and fundamental programming principles (Mishra et al., 2021). Similarly, blockchain revolutionises online learning by authenticating and securing student records (Capetillo et al., 2022). For instance, the MIT Media Lab developed a digital learning certificate system incorporating blockchain technology and Mozilla's open badge (Zhao et al., 2023). Blockchain applications relate to digital grading, credentialing, certification, real-time contracting and time stamping of learning (Chaka, 2023). Maryville University (n.d.) asserted that blockchain gives students ownership of their records, allowing them to control their academic identity. IoT is another example of Education 4.0 technology changing how we learn and teach. Thanks to IoT technologies, students can have consistent access to everything from learning materials to communication channels (Al-Emran et al., 2020). In education, IoT applications are used in augmented reality-equipped systems, distance learning, enhanced interaction in smartphone-based virtual classes, and automated attendance recording (Sultana & Tamanna, 2022).

Other changes we see in Education 4.0 are the wide use of mobile technologies such as handheld and tablet computers, digital pens, MP3 players, and smartphones. Many higher education institutions use mobile technologies and create mobile-optimised websites that can be downloaded from mobile application stores (Chen & Denoyelles, 2013). The proliferation of mobile technologies has led to game-based learning (Krouska et al., 2022). Game elements in courses increase student engagement, foster collaboration,

activate a competitive spirit, and enhance digital competencies (Grinshkun & Osipovskaya, 2020). A study conducted at New Zealand University established that mobile apps were used by academics and students for both teaching and research, primarily in the form of document and data storage and exchange and communication (Hinze et al., 2022). Now a days, social media applications have become common knowledge-sharing platforms utilised in Education 4.0 (Xie et al., 2023).

2.2 Skills needed by students to effectively utilise 4IR technologies

Students need a new set of skills to utilise the 4IR technologies successfully. PwC (2017) observes that 4IR technologies and their applications often require specialised skills beyond basic digital literacy. These skills are considered necessary to survive and thrive in the 4IR era. The skills include complex problem-solving, critical thinking, creativity/design mindset, people management, coordinating with others, judgement and decision-making, service orientation, negotiation, cognitive flexibility, initiative, collaboration, creative problem-solving, intercultural fluency/cross-cultural competence, empathy, oral communication, resilience, sense-making, social intelligence, novel and adaptive thinking, computational thinking, new-media literacy, transdisciplinarity, and cognitive load management (Gray, 2016; Institute for the Future, 2011; Education Design Lab, 2018).

According to Scepanović (2019), one of the challenges faced by universities is imparting skills and knowledge to learners that will enable them to function in the 4IR and sustain them for long-term jobs. However, it has emerged that Higher Education Institutions (HEI) neither effectively communicate the urgency of soft skills development to students nor adequately prepare them to enter the job market (Succi & Canovi, 2020). Hill (2016) maintains that if skills are enforced, there will be an inevitable move towards participatory and self-regulatory teaching, learning and assessment. These attributes must be communicated across all levels, meaningfully relevant to all students, and taught within the formal curriculum (Jones & Pate, 2019).

2.3 Benefits of 4IR technologies to students

Students are the main stakeholders and beneficiaries of the educational ecosystem. Using technology, students can connect better with many other stakeholders in the system and better communicate with teachers, parents, and management. 4IR technologies have the potential to address social and economic challenges successfully, and they have successfully transformed numerous industries (Ndung'u & Signé, 2020), including the

education sector. The following is a brief overview of how the 4IR technologies have impacted education:

- **Collaborative learning** - Students collaborate online on projects and assignments utilising technological resources like video conferencing (e.g., Microsoft Teams, Google Meet, Zoom, and Tencent Meeting) and online collaboration and storage tools (e.g. Google Drive and OneDrive) (Haleem et al., 2022). These tools facilitate smooth and adequate work progress amongst teams.

- **Personalised learning** - Where students can learn at their own pace and receive customised feedback. For instance, AI-based learning platforms can analyse student data and provide tailored recommendations to improve learning outcomes. In addition, in the 4IR era, students are more independent, and technology has enabled them to mould the learning process according to their styles and techniques (Joshi, 2022). For instance, at the University of British Columbia, students use an AI-enabled avatar called Language Chatsim to practice speaking German in virtual reality (University of British Columbia, 2020). They do this at their own pace.

- **STEM education** - The 4IR has emphasised the importance of STEM (Science, Technology, Engineering, and Mathematics) education, and we see an increase in the budget towards the 4IR STEM curriculum (Penprase, 2018). Students receiving STEM education are better prepared for professions like robotics, coding, and data analysis.

- **Blended learning** - which integrates traditional classroom instruction with online learning, has been made possible by the 4IR (Bizami et al., 2022). With blended learning, students can access course materials anytime and from any location with flexibility and convenience (Oke & Fernandes, 2020). Mhlanga (2021) asserted that the introduction of blended learning post-COVID-19 could help to expand access to education in South Africa, where access was limited by space, especially at the tertiary level.

- **Lifelong learning** - people continue to acquire and advance their talents. The 4IR has highlighted its value. Lifelong learning is crucial in a world where technology continuously changes and new skills are needed to flourish (Reaves, 2019). For instance, AI can assist individuals in identifying skill gaps and planning

their educational paths by leveraging data from student CVs, course catalogues, and job adverts (Ho, 2022). This will enable practitioners to plan for continuous professional development (CPD). On the other hand, students can benefit from this data analysis by using it to plan their career path.

- **Digital literacy** - This is the ability to use digital technologies effectively (Bolden, 2021). Digital literacy is essential for students to succeed in the modern workforce, where digital skills are in high demand. Hence, the exponential proliferation of 4IR technologies in education presents an opportunity for students to practice and improve their digital skills.

- **Digital institutions of higher learning** - Massive open online courses (MOOCs), virtual classrooms and laboratories, virtual libraries, and virtual teachers are just a few examples of the emerging type of higher education institution that carries out teaching, research, and service in a different way. This augments the traditional educational experience (Lupanda, 2020).

- **Expanding access to education** - Access to education is constrained because of resource limitations. With the adoption of Education 4.0 technologies, access to education can be expanded in technical, vocational, community and training colleges through online/blended learning (Mhlanga, 2021). For instance, Tamayo, Herrero and Martin (2020) demonstrated and emphasised the importance of a virtual teaching assistant in giving 24/7 attention to distance learning students.

2.4 Challenges faced by students in utilising 4IR technologies

Despite unparalleled flexibility in learning and teaching, there is empirical evidence of the challenges that inhibit the effective utilisation of 4IR technologies in online/remote teaching and learning. For instance, in South Africa, some of the challenges established were: inequality because of skewed income distribution, poor ICT infrastructure, unreliable and expensive infrastructure, unequal access to opportunities, insufficient funding, digital divide, ubiquity of data connectivity and digital skills shortages (Kayembe & Nel, 2019; Mhlanga, 2021; Oke & Fernandes, 2020). In Zimbabwe, challenges hindering remote learning were established as a lack of regulated policy on technology use, lack of digital resources, access to household computers, cost of connectivity, lack of administrative support, lack of adequate parental involvement, and poor Internet access (Chinengundu, et al., 2022; Chingara et al., 2021; Nhengu, 2023). Another study by Ramola (2021) recognised resistance to redesigning online courses, inadequate online

educational infrastructure, and conducting online examinations as significant challenges in India. Studies conducted in Malaysia claimed that students lacked the skills to use 4IR technologies, teachers lacked virtual teaching experience, and a lack of technological facilities (Chua & Bong, 2022; Halili & Sulaiman, 2021).

2.5 Gaps in the literature

Few studies have been conducted to examine the adoption of 4IR and its impact on the education sector (Rüßmann et al., 2015; Collins & Halverson, 2018; Kreijns et al., 2013). Oke and Fernandes (2020) and Mbandlwa (2021) have observed that using 4IR and associated technologies in manufacturing has been extensively studied. However, fewer studies are exploring the perspectives of 4IR among staff and students in the African education sector. This gap limits the use of 4IR technologies in education and their impact on stakeholders (Maj-Waśniowska et al., 2023). Furthermore, many scholars observe that, despite the extensive literature on the possible contributions of technology to learners' development, there is a lack of knowledge regarding the motivations, barriers, and implications of the acceptance and diffusion of 4IR in the education sector (Rashid & Asghar, 2016; Penprase, 2018; Lubinga et al., 2023). It is also worth noting that most of the studies conducted on the 4IR technologies in the education sector focus on students' awareness, perceptions and preparedness to use the 4IR technologies (Ujakpa et al., 2020; Tinmaz & Lee, 2019; Sikhakhane et al., 2021; Al-Maskari et al., 2022). Lastly, most studies on 4IR in Africa are concentrated in South Africa and Nigeria. Therefore, this study hopes to contribute by filling some of these identified gaps. Our knowledge regarding students' experiences and usage of 4IR technologies in African online learning is still limited and fragmented (Ng'ambi et al., 2016). There is a need, therefore, to conduct more research regarding key stakeholders' adoption and usage of 4IR in the education sector with more emphasis on the students and teachers.

3 Methodology

The study adopted a cross-sectional descriptive survey design. The study's target population were students in the institutions of higher learning in Botswana and Zambia, mainly comprising universities. This study used a sample size of 354 based on the formula of an infinite population SS = [Z2p (1 − p)]/ C2; where SS = Sample size, Z = Given Z value, p = Percentage of population, C = Confidence level. Respondents were selected using the convenience and snowball sampling technique. A structured online questionnaire (on Google Forms) consisting of close-ended and open-ended questions

was used to collect quantitative and qualitative data. The survey link was distributed via email and WhatsApp contacts. Data was collected over five months, from October 2022 to February 2023, and each respondent was allowed only one attempt to answer the questionnaire. Quantitative data was analysed using IBM SPSS version 26 to run descriptive statistics, while qualitative data was analysed manually using thematic techniques and categorised into emerging themes.

Two hundred and eighty-six respondents participated in this study, giving a response rate of 74.3%. Of the 286 respondents, 141 (49.3%) were from ten universities and colleges in Botswana, and 145 (51.7%) were from seven universities in Zambia. A hundred and seventy-eight respondents (62.2%) were females, and 105 (36.7%) were males; three (1.0%) respondents did not disclose their gender. Most respondents (n=229; 80.1%) were pursuing undergraduate programmes, while 19.2% (n=55) were pursuing postgraduate programmes. Most of the respondents were in 2nd year (n=107; 37.4%), followed by third years (n=68; 21.3%), fourth years (n=61; 21.3%) or above, and first years (n=48; 16.8%); two (0.7%) respondents did not disclose their year of study.

Table 1: Demographics of respondents

Variable	Values	Frequency *(n=286)*	Per cent
Country	Botswana	141	49.3
	Zambia	145	50.7
Gender	Female	178	62.2
	Male	105	36.7
Educational level	Undergraduate	229	80.1
	Postgraduate	55	19.2
Year of study	1st year	48	16.8
	2nd year	107	37.4
	3rd year	68	23.8
	4th year or above	61	21.3

4 Research findings

This section presents the study's findings organised according to the study's objectives. The section is structured according to the specific objectives of the study.

4.1 4IR Technologies used by students in online learning

The first objective of this study was to investigate the fourth industrial revolution technologies students use in online learning. The results are presented in Table 2 and Table 3. The most commonly used technologies were virtual classrooms (82.4%) and social media platforms (n=73, 37.7%). The virtual classrooms were categorised into learning management systems (LMS) and video conferencing platforms (VCP). Google

Classroom (n=271, 94.8%) and Moodle (n=106, 37.1%) were commonly used learning management systems. Others were Blackboard (n=29, 10.1%), Astria (n=15, 5.2%) and Webskewl (n=8, 2.8%). Commonly used virtual conferencing technologies were Zoom (n=284, 99.3%), BigBlueButton (n=274, 95.8%), Google Meet (n=236, 82.5%), Webex (n=234, 81.9%), Microsoft Teams (n=73, 25.7%) and Skype (n=9, 0.9%).

Table 2: Virtual Classroom Technologies

Virtual classrooms	Application	Frequency *(n=286)*	Percentage %
Learning Management Systems (n=194, 68.3%)	Google classroom	271	94.8
	Moodle	106	37.1
	Blackboard	29	10.1
	Astria	15	5.2
	Webskewl	8	2.8
Video Conferencing Platforms	Zoom	284	99.3
	BigBlueButton	274	95.8
	Google meet	236	82.5
	Webex	234	81.9
	Microsoft Teams	73	25.7
	Skype	9	0.9

Other technologies used in online learning included social media (n=107, 37.7%) such as WhatsApp, Twitter and Facebook; mobile technologies (n=57, 19.9%) such as smartphones, laptops, pen tablets, digital pens and bright notebooks; cloud computing technologies (n=49, 17.3%) such as Google Drive, Dropbox, and OneDrive; virtual libraries (n=32, 11.3%); virtual whiteboards (3.9%); massive open online courses (MOOCS) (2.1%); virtual laboratories (1.1%); 3D technologies (1.1%); and artificial intelligence (0.7%) (Table 3).

Table 3: Other 4IR technologies used in online learning

	Frequency (n=286)	Percentage %
Social media platforms	107	37.7
Collaborative tools	73	25.7
Mobile technologies	57	19.9
Cloud computing	49	17.3
Virtual libraries	32	11.3
Massive open online courses	6	2.1
3D technologies	3	1.1
Artificial intelligence	2	0.7

The participants were further asked to briefly explain how they used the 4IR technologies for online learning, and responses varied from downloading lecture notes, textbooks,

syllabi and video clips, uploading assignments, group work, communicating with lecturers and fellow students, and attending classes and discussions. For example, respondent P3 said, "We use Google Docs for group work; it allows every student to work remotely, and we all can see instantly when other group members edit the document". Further, respondent P19 said, "Webskewl is used to download assignments, notes and slides. It is also used to submit assignments from home". In contrast, respondent P39 reported that "we use ISBS e-library to access e-books and Webskewl to access online study material like notes, slides, assignments and podcasts, and Microsoft Teams to attend tutorials and lectures and for discussion purposes with classmates. Lastly, as a revision platform since lectures and tutorials are recorded".

4.2 Skills students possessed to use 4IR technologies

The second objective sought to explore the skills students already possessed to enable them to use 4IR technologies in online learning. Table 4 presents the findings. The findings revealed that 46.8% possessed interpersonal skills, 44.3% possessed technological skills, 26.6% possessed personalised and self-paced learning skills, 25.5% possessed innovation and creativity skills, 22.3% possessed lifelong and student-driven skills, and 20.9% possessed problem-based and collaborative learning skills. The results revealed that very few students possessed accessible and inclusive learning skills (13.5%), global citizenship skills (6.4%), peer education and family planning education (0.7%), environmental and public awareness skills (0.4%), and library and information skills (0.4%).

Table 4: Skills possessed by the respondents

	Frequency (n=286)	Percentage %
Interpersonal skills	132	46.8
Technology skills	125	44.3
Personalised and self-paced learning	75	26.6
Innovation and creativity skills	72	25.5
Lifelong and student-driven	63	22.3
Problem-based and collaborative learning	59	20.9
Accessible and inclusive learning	38	13.5
Global citizenship skills	18	6.4
Peer education and family planning education	2	0.7
Environmental and public awareness skills	1	0.4
Library and information sciences skills	1	0.4

4.3 Benefits of 4IR technologies to learners

The third objective sought to determine the opportunities offered to learners by the 4IR technologies. The responses are presented in Table 5. The main opportunities acknowledged were: improved use and adaptability of e-learning platforms (n=256, 91.1%), flexibility in learning (n=228, 81.1%), taking control of own learning (n=213, 75.8%), more dynamic learning (n=209, 74.4%), building an education system for lifelong learning (n=202, 71.9%), time-effective learning (n=192, 68.3%), connecting and communicating better with teachers and other stakeholders (n=175, 62.3%), professional development through free webinars (n=165, 58.7%), cost-effective learning (n=151, 53.7%), and offered a solution to social exclusion (n=135, 40.0%).

Table 5: Opportunities/benefits offered by 4IR technologies

Opportunities	Frequency (n=286)	Percentage %
Improved use adaptability of e-learning platforms	256	91.1
Flexibility in learning	228	81.1
Take control of your learning	213	75.8
Learning is more dynamic	209	74.4
Build an education system for lifelong learning	202	71.9
Time-effective learning	192	68.3
Improved communication with teachers and other stakeholders	175	62.3
Professional development through free webinars	165	58.7
Cost-effective learning	151	53.7
Resolve the issue of social exclusion	135	48.0

4.4 Challenges faced by learners

The fourth objective of this study sought to establish the challenges students face in online learning. Table 6 presents challenges faced by students with online learning. The challenges included unconducive home environment (n=164, 57.3%), financial constraints (n=142, 49.7%), poor Internet connectivity (n=138, 48.3%), difficulty in writing online assessments/examination (n=125, 43.7%), inadequate interactions with lecturers and fellow students (n=110, 38.5%), inadequate technological infrastructure (n=38, 42%), inadequate technological skills (n=25, 28%), and resistance to change (n=21, 23%). Other challenges identified were difficulties in accessing digital tools (n=70, 24.5%), noncompliance with virtual classroom etiquette (n=59, 20.6%), resistance to change (n=56, 19.6%), technological trauma (n=55, 19.2%), inadequate support from academic and administration (n=44, 15.4%), inadequate education resources (n=36,

12.6%), inadequate online education facilities (n=33, 11.5%), and online learning management systems not use friendly (n=23, 8.0%).

Table 6: Challenges faced by learners

Challenges	Frequency *(n=286)*	Percentage
Home environment not conducive to online learning	164	57.3
Financial constraints	142	49.7
Poor Internet connectivity	138	48.3
Challenging to write online assignments and examinations	125	43.7
Inadequate interactions with lecturers and fellow students	110	38.5
Inadequate technological skills	80	28.0
Difficulties accessing digital tools	70	24.5
Noncompliance with virtual classroom etiquette	59	20.6
Resistance to change	56	19.6
Technological trauma	55	19.2
Inadequate support from academic faculty and administration	44	15.4
Inadequate online education resources	36	12.6
Inadequate online education facilities	33	11.5
Available online learning platforms are not user-friendly	23	8.0

5 Discussion

Investigating students' experiences using the 4IR technologies in online learning is very important as institutions of higher learning can use the findings to improve their curricula, pedagogy, policies and learning facilities. Students' experiences with using 4IR technologies significantly impact their academic performance and ability to acquire requisite skills, which determines their employability in the 4IR era.

The study has established that the most utilised 4IR technologies for online learning by students are virtual classrooms and social media platforms. Specifically, virtual classrooms were categorised into learning management systems (LMS) and video conferencing platforms (VCP). The most used LMS was Google Classroom, while the most used VCPs were Zoom, BigBlueButton, Google Meet, Webex, and Microsoft Teams. However, the study also found that mobile technologies, cloud computing technologies, virtual whiteboards, massive open online courses (MOOCs), 3D technologies, and artificial intelligence were less commonly used. However, they still represent essential tools for enhancing the online learning experience. Similarly, none of

the open-ended questions revealed the use of virtual teaching assistants or general Chatbots.

The study findings have important implications for online learning, as they suggest that students widely use virtual classrooms and social media platforms. Therefore, educational institutions should focus on providing these technologies to enhance the learning experience. Additionally, the popularity of specific platforms such as Google Classroom, Zoom BigBlueButton, Google Meet, and Webex suggest that these technologies effectively support online learning and may be preferred by students due to their ease of use and familiarity. Nevertheless, the study also highlights the need for further research into the use of other 4IR technologies, such as artificial intelligence (AI), blockchain, and augmented reality (AR), which may have the potential to enhance the online learning experience even further.

The findings revealed that many students possessed interpersonal and technological skills, indicating they were comfortable using digital tools and platforms for communication and collaboration. Additionally, a quarter of the students possessed personalised and self-paced learning skills, innovation and creativity skills, and lifelong and student-driven skills essential for self-directed and autonomous learning. These skills are considered vital for the Education 4.0 environment, as alluded to by Advani (2023) and Suvin (2020). Education 4.0 reimagines education as a diverse, lifelong experience where learners are responsible for developing their skills (Advani, 2023). Thus, one of the critical features of Education 4.0 is its focus on developing skills and competencies relevant to the digital age.

The findings revealed that students perceive a wide range of benefits offered by 4IR technologies in online learning. The most acknowledged opportunities include improved use and adaptability of e-learning platforms, flexibility in learning, taking control of one's learning, more dynamic learning, and building an education system for lifelong learning. Students also recognise the time-effective nature of online learning, which allows them to balance their studies with other commitments. The study also found that online learning provides opportunities for better communication and connection with teachers and other stakeholders and professional development through free webinars. Furthermore, cost-effective learning was also identified as a significant opportunity for students who may not have access to traditional educational opportunities due to financial constraints.

Interestingly, the study also found that online learning offers a solution to social exclusion, indicating that students perceive online learning to overcome geographical and physical disability and other social barriers. These findings resonate with the findings of various studies (Haleem et al., 2022; Joshi, 2022; Oke & Fernandes, 2020), which observed that online learning offered a wide range of opportunities to expand education across a larger population. More importantly, recognising various opportunities offered by 4IR technologies in online learning demonstrates students' acceptance and readiness to adopt and utilise these technologies in their learning. The extent to which these opportunities can be realised depends on many factors, including affordability, improved ICT infrastructure (including the Internet, LMS, and virtual conferencing technologies), skilled academic staff, and robust student support systems.

This study has identified the most common challenges: an unconducive home environment, financial constraints, and poor internet connectivity, which can all negatively impact students' ability to engage effectively with online learning. It was also established that students face challenges related to difficulty writing online assessments and examinations and inadequate interactions with lecturers and fellow students. These challenges affect students' ability to receive feedback and collaborate effectively with others online. Furthermore, other challenges identified were difficulties in accessing digital tools, non-compliance with virtual classroom etiquette, technological trauma, inadequate support from academics and administration, and insufficient education resources. These findings confirm previous studies (Kayembe & Nel, 2019; Mhlanga, 2021; Oke & Fernandes, 2020; Chinengundu et al., 2022; Chingara et al., 2021; Ramola, 2021), which included, among others, poor ICT infrastructure, poor Internet connectivity, inadequate or lack of skills among both students and lecturers, resistance to change, high cost of Internet services, and lack of administrative support. The persistent presence of these challenges hinders the effective implementation and utilisation of 4IR technologies. Nhengu (2023) stated that, due to numerous challenges, online learning has only succeeded in presenting promises yet to be realised. Thus, the policymakers and managers in IHL need to address these challenges as they affect the extent of students' readiness for 4IR, their competencies and employability in the various social and economic sectors.

6 Conclusion

This study investigated students' experiences with utilising 4IR technologies in institutions of higher learning (IHL) in Botswana and Zambia. The findings suggest that while higher institutions of learning in Botswana and Zambia have made some progress towards 4IR technologies by using tools such as learning management systems, video conferencing tools, and social media platforms, there is still a need for further integration of advanced technologies such as blockchain, virtual teaching assistants, AR, and VR to realise the potential of 4IR technologies fully. Though the findings revealed that students perceive a wide range of opportunities offered by 4IR technologies, they still face many challenges in online learning. These challenges highlight the need for educational institutions to provide adequate support and resources to students to ensure that they can fully engage with online learning.

4IR has brought both opportunities and challenges to higher learning institutions. However, not all education stakeholders have the capacity to exploit these 4IR technologies, particularly considering that this is an era characterised by rapid disruptive change. Therefore, it is crucial for developing nations to form partnerships and collaborate in resource sharing to innovate the education sector. Southern African IHL administrators are challenged to adjust their visions, plans, organisational structures, policies, and curricula regarding the demands, challenges and opportunities of the 4IR era. Therefore, administrators in IHL must be conversant with the opportunities and challenges associated with the 4IR, revise curricula, adjust the learning and teaching environment, provide requisite skills to students and faculty, and mobilise required critical resources.

7 Recommendations

Based on the findings of the study, the following recommendations are made:

1. To embrace Education 4.0 and maximise its benefits, the government should put more effort into creating a conducive environment for quality online teaching and learning. This includes ensuring country-wide network connectivity, providing hotspot centres in rural areas and upgrading public libraries with digital tools that promote quality online experience.
2. IHL should lobby for reduced internet access costs with Internet service providers (ISP) to overcome the high costs of internet access.

3. IHL should develop targeted training programs and other initiatives to develop students' skills to address challenges related to inadequate technological skills, technological trauma, resistance to change, inclusivity, global citizenship, noncompliance with virtual classroom etiquette, and information literacy.
4. IHL should adopt open and free software to minimise the cost of 4IR technologies. These would help to enhance their virtual labs and libraries.
5. Lobby governments to provide adequate funding to improve ICT infrastructure both in urban and rural areas.
6. Further research should be conducted, including the academic and administrative staff in the sample. This will enable a comprehensive understanding of the challenges and opportunities associated with integrating 4IR technologies in education.

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Availability of data and material

The data used to support the findings of this study is available on the researchers' personal drive and, available from the authors upon reasonable request.

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