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The Fourth Industrial Revolution: Overcoming Digital Divides in Zimbabwean Rural Learning Ecologies

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Abstract: The Covid-19 pandemic has accelerated the adoption of Fourth Industrial Revolution (4IR) practices and the growth of distance education, leading to fast technological advancements in educational institutions worldwide. The implications of this evolution on students in rural areas and their surrounding environments are ambiguous, presenting various obstacles within the educational sphere, particularly concerning rural learning environments. This study investigated the 4IR's potential to bridge digital divides and ensure equitable access to education in rural Zimbabwe, identifying prospects, challenges, and best practices. The research examined the impact of 4IR techniques on the academic performance of rural students using desktop exploration. It also highlighted educational opportunities for rural learning environments and emphasises the importance of localised

collaboration. The link between e-learning and rural contexts in education, using secondary data from previous research was also examined. The study identified patterns and trends in implementing 4IR methodologies in education by using the content analysis to systematically scrutinise and interpret a large amount of textual data. The results indicated that student performance was impacted by technical, practical, and psychological impediments, additionally, academic and emotional decline due to remote learning was evident. Moreover, the study revealed that, despite challenges, 4IR methods offer multiple advantages, including enhanced information accessibility, distance learning opportunities, collaborative initiatives, personalised learning experiences, and teacher empowerment. To maximise these opportunities, the research recommended strategies such as infrastructure enhancement, resource accessibility, teacher professional development, curriculum adjustments, and collaborative efforts between public and private entities. Ultimately, the study proposed that rural environments can harness 4IR techniques in order to facilitate the quality of education and provide students with necessary digital skills by overcoming obstacles and taking advantage of opportunities.

Keywords: Fourth Industrial Revolution (4IR), distance education, digital infrastructure, information and communication technology (ICT), COVID-19, rural learning ecologies.

Introduction

The COVID-19 pandemic significantly impacted Zimbabwe's education system, leading the government to support e-learning and provide students with ICT devices and internet access. The ICT has now become an indispensable element in academic curricula (Nhongo & Siziba, 2022; Nhongo & Tshotsho, 2021; Nyagadza et al., 2022; Zimbabwe Ministry, 2015), with its importance growing as society progresses towards a knowledge-based structure (Moyo, 2020; Nziramasanga, 1999). This technology is revolutionizing educational delivery methods by offering a wide range of opportunities to different educational systems and institutions. ICT encompasses wireless networks, mobile phones, and online resources (Alghamdi et al., 2020; Ali & Hanna, 2021; Dube, 2020; Dunga, 2020), facilitating teaching and learning, as well as collaborative and communication tasks (Abe, 2020; Afzal et al., 2023). Consequently, according to Andrade et al. (2021), Bozkurt and Sharma (2020) and Kayembe and Nel (2019), digital educational tools and materials such as computers, projectors, cameras, and customised digital content are all encompassed within the ICT framework in education. It is essential to underline that ICT plays a pivotal role in education (Lopres et al., 2023; Wang, 2022; Wang et al., 2021; Zhong et al., 2022), offering opportunities, supporting critical information processes, and encompassing all digital technologies utilised in educational settings (Gereluk et al., 2020; Viner et al., 2020; Yu, 2021).

The integration of ICT in classrooms allows students to effectively and autonomously study. This digital revolution enables students engaging in learning activities at their convenience and from any location, be it at home, in the community, or at school (Moorhouse & Wong, 2022; Tang et al., 2021; Van Wyk & Waghid, 2022; Zhang et al., 2020). Thus, the emergence and increased accessibility of digital technologies provide teachers with a broader array of professional resources. Mangundu (2022), Mavengano and Marevesa (2022) and Moyo (2022) argue that the Fourth Industrial Revolution (4IR), characterised by enhanced computational power and technological diversity, has fundamentally transformed the application of ICT in teaching and learning. The internet connects devices, facilitate local and global learning interactions in classrooms, thereby enhance the motivation and participation. As posited by Dube (2020), Manda and Dhaou (2019) and Mathende and Beach (2021), ICT creates numerous opportunities for learning, fosters increased student engagement in the digital realm and reshapes the educational landscape by fostering student connectivity and collaboration.

The 4IR is characterised by the ubiquitous presence of digital technologies in society, revolutionising work, leisure, and communication practices. Nonetheless, a notable challenge in this digital evolution is the digital divide, where specific communities, particularly those in rural areas, may lack access to or proficiency in digital technologies (Dhawan, 2020; Nhemachena, 2021; Nhongo, 2022; Rocconi et al., 2020; Schleicher, 2020). In the context of Zimbabwean rural educational settings, bridging the digital gap is imperative to ensure equitable access to 4IR advancements for all students. It is the goal of every government to equip students with ICT access and skills to support learning not only within traditional classrooms but also virtually (Liao et al., 2023; Maphosa, 2021; Pedler et al., 2020), from any location and at any time. Consequently, the ICT facilities serve as a conduit for all rural communities to global resources, setting an example as nations aim to achieve upper-middle-income status by 2030.

The integration of ICT in educational settings presents a range of advantages and challenges. Although ICT shows potential in improving teaching and learning methods (Andrade et al., 2021; Anthonysamy et al., 2020; Elharake et al., 2023; Mwila et al., 2021), certain limitations may hinder its effective implementation in classrooms. This research delved into the obstacles faced by Zimbabwean rural educational environments when utilising ICT to educate rural students. The outcomes of this study aimed to equip teachers with insights to surmount these challenges and facilitate the seamless integration of ICT into pedagogical practices (Baranova et al., 2022; Huang & Wang, 2023; Martin et al., 2020). Specifically, the research sought to pinpoint the unique challenges in adopting ICT encountered by teachers working in Zimbabwean rural educational contexts, offering strategies to address these hurdles. Currently, 36% of Zimbabwe's 10,522 schools lack access to electricity, with 76% experiencing a deficit in internet connectivity (Moyo, 2022; Moyo et al., 2022; Moyo-Nyede & Ndoma, 2020; Mupfumira, 2023; Netsianda, 2020). This raises the crucial question of the feasibility of deploying ICT under such circumstances. The study acknowledged the efforts made by Zimbabwean education stakeholders in the past decade to introduce ICT-focused curricula in rural educational settings. Nevertheless, Mwiinde and Muzingili (2020), Phiri et al. (2020), Shava (2022) and Zinyemba et al. (2021) found out that the progress in Zimbabwean education system has been impeded by obstacles like inadequate infrastructure, a scarcity of proficient ICT instructors, and underutilisation of computers donated by the government. This study scrutinises how education stakeholders can contribute to fostering ICT advancement in Zimbabwe's rural educational environments to enhance educational access, quality, and equity, thereby supporting the country's enduring rural development goals.

Research Problem

The 4IR, characterised by emerging technologies such as artificial intelligence, big data, and the Internet of Things (IoT), is globally reshaping societies and economies (Besser et al., 2022; Dalagan, 2020; Daniel, 2020; Elfaki et al., 2019). Nonetheless, notable digital disparities persist between urban and rural ecologies in Zimbabwe, posing a risk of marginalising rural students from benefiting from these technological advancements and the ensuing social and economic prospects. Consequently, rural ecologies often lack the requisite digital infrastructure, devices, consistent electricity supply, digital skills training, and other essentials to effectively utilise new technologies for educational and developmental purposes. This situation accentuates the prevailing educational, economic, and social gaps between rural and urban students. This research endeavoured to identify the main impediments that contribute to these digital divides between rural and urban ecologies in Zimbabwe, encompassing infrastructural, economic, social, and educational aspects. It also explored the repercussions of digital exclusion on rural ecologies and opportunities within the context of the 4IR. Ultimately, it aimed to devise context-specific, evidence-supported policy recommendations and practical strategies to address barriers to digital inclusion, empowering rural Zimbabwean communities to meaningfully access and

harness emerging technologies for learning, social advancement, and economic progress. This study established a roadmap focused on diagnosing the principal challenges to digital inclusion in these under-served communities and suggesting remedies to assist rural learning environments in embracing, rather than being excluded from, technological advancements.

Research Focus

This study aimed to investigate the disparities between rural and urban ecologies concerning access to digital technologies and internet connectivity in Zimbabwe. The research focused on identifying gaps in digital infrastructure, digital literacy, and skills and their implications for education and development in rural ecologies. Furthermore, the study examined different policy measures, government regulations, and initiatives from both the public and private sectors that are targeted at closing the digital divide in Zimbabwe. It also delved into sociocultural aspects that influence barriers to the adoption of technology, including the norms, attitudes, perceptions, and beliefs. Moreover, the research examined indigenous solutions developed by rural communities, rural ecosystems, and non-governmental organisations to enhance digital inclusion, highlighting grassroots innovations that have the potential for scalability. The research endeavoured to enhance comprehension of leveraging the opportunities presented by the 4IR to facilitate comprehensive and fair access to digital resources and opportunities in rural ecologies in Zimbabwe.

Research Aim and Research Questions

The objective of this research was to investigate the potential applications of Fourth Industrial Revolution (4IR) technologies in addressing digital inequalities and promoting equal opportunities for educational access in rural regions of Zimbabwe. The study was guided by the following question in order to investigate and understand the digital divides present in rural learning environments compared to urban environments:

- i. What is the impact of 4IR inclusion in rural Zimbabwean rural learning ecologies?
- ii. What are the main challenges and barriers to achieving digital inclusion in Zimbabwean rural learning ecologies?
- iii. What are the best practices and recommendations for addressing digital divides and enhancing digital inclusion in rural Zimbabwean rural ecologies?

Literature Review

Zimbabwe's Path to ICT Integration in Education

The progressive implementation of ICT into Zimbabwe's curriculum was intended to enhance technological proficiency, foster digital skills, and align education with the demands of the 21st-century labour market (Chigama & Goronga, 2022; Dhliwayo & Jita, 2023; Dzinoreva & Mavunga, 2022; Netsianda, 2020). Before the 1990s, ICT received little attention in Zimbabwe's rural ecologies due to the limited computer and Internet access, particularly in rural educational settings. Recognising the global importance of ICTs, the government launched initiatives to provide access to ICT tools and deliver essential computer skills training. In the early 2000s, an official ICT policy was established to promote computer education in rural communities (Kangara et al., 2022; Mangeya & Makoni, 2021; Maphosa et al., 2021; Moyo, 2022; Ministry of Primary and Secondary Education, 2020). Nhongo and Tshotsho (2021) noted the establishment of partnerships between the private sector and NGOs to equip additional rural ecologies with computer labs and to train teachers. Despite these efforts, the adoption rate has been slow, particularly in under-served communities, as emphasised by Mhlanga and Ndhlovu

(2020). An e-learning initiative was launched in 2007 to promote ICT utilisation in education as well as provide training for teachers and administrators on integrating ICTs across various disciplines. Additionally, a new governmental policy introduced ICT and computer science as independent subjects in secondary rural ecologies starting in 2013 (Magocha, 2021; Mandikiana, 2020; Tsimba et al., 2020; Yingi et al., 2022). Currently, ICT is an examinable subject from grade four onwards. This illustrates the curriculum's expansion to encompass more advanced skills early on, such as programming, networking, multimedia, and digital literacy. Basic computer skills, familiarity with common software and apps, and internet research abilities are regarded as integral components of the current ICT curriculum. The government also launched the Science, Technology, Engineering, and Mathematics (STEM) programme in 2016 to promote technological advancement and skill development (Netsianda, 2020; The Herald, 2018). The distribution of e-learning kits by the President bolstered endeavours to supply computers, internet access, and ICT training for teachers to enhance the teaching and learning of STEM subjects (Ministry of Primary and Secondary education, 2020; Nyika & Modise, 2022; Macheka et al., 2022). Nonetheless, obstacles continue to arise in regards to the development of infrastructure, connectivity in rural areas, and ensuring that students are adequately prepared for the technology-centered global economy. This study sought to address the specific ICT adoption challenges encountered by Zimbabwean rural ecologies and provide assistance in surmounting these barriers.

Zimbabwe's Piecemeal Curriculum Reforms and Rural Digital Divide

According to Moyo (2022) and Nziramasanga (1999), Zimbabwe's education system has faced challenges in maintaining an equitable and organised curriculum since gaining independence in 1980. This has resulted in a curriculum that lacks consistency and has generated discontent among parents, teachers, and students. One notable issue highlighted by Nhongo & Siziba (2022) and Yingi et al. (2022) is the incongruity and financial burden of curriculum reforms, such as the introduction of computer science in all secondary ecologies in rural areas, which often lack the necessary resources. Scholars argue that the current curriculum is overly theoretical and fails to adequately prepare individuals for the demands of the 4IR (Mabika & Maireva, 2022; Madimabe & Omodan, 2021; Moyo et al., 2022; Muzira & Bondai, 2021). A successful integration of technology in education necessitates political commitment, yet government efforts in ICT implementation have been inconsistent, particularly in rural ecologies. Furthermore, challenges such as high data costs and restricted internet access, as noted by Dube (2020) and Nhongo (2022), have widened the digital gap between rural and urban ecologies. The fragmented nature of Zimbabwe's curriculum reform, coupled with insufficient resources and strategic planning, has resulted in an academic curriculum that does not align with economic needs and has limited equitable access to computer science and ICT education, disproportionately affecting rural students.

Dube (2020) and Dube et al. (2022) emphasise that excessive reliance on donations for e-learning materials can further exacerbate disparities among rural ecologies, perpetuating the digital divide and hindering self-sufficiency in the education sector. Unethical practices can arise from adopting e-learning strategies from foreign contexts without considering Zimbabwe's cultural heritage and traditions. Rather than importing e-learning materials, as suggested by UNICEF (2020) and Yingi et al. (2022), Moyo (2022) puts forward the idea that the government should focus on the advancement of e-learning technologies that are suitable for local needs and budget-friendly. It is imperative to establish measures that safeguard rural areas and marginalized groups from being excluded from the incorporation of technology in education. Consequently, a thorough and all-encompassing technology strategy is necessary, with a particular emphasis on enhancing local skills, adapting to specific contexts, and guaranteeing fair access. This research aims to identify the precise ICT obstacles encountered by rural communities in Zimbabwe and offer assistance in surmounting these challenges.

The Digital Transformation of Education in Rural Zimbabwe During COVID-19

Millions of children globally, with 4.6 million in Zimbabwe alone, have faced educational disruptions due to the COVID-19 pandemic (Chimbunde, 2021; Chirisa et al., 2021; Dube, 2020). The uncertainty surrounding the duration and impact of the COVID-19 outbreak on education became evident when it began spreading in Zimbabwe in March 2020, leading to a nationwide lockdown (Netsianda, 2020; United Nations Zimbabwe, 2020).

The advent of Education 4.0 has been facilitated across various sectors, including education, by the repercussions of COVID-19. In response to the imperative of social distancing, traditional face-to-face teaching methods became unfeasible, prompting Zimbabwe to transition to online learning (Nhongo & Siziba, 2022; Rudhumbu et al., 2021; Shava, 2022). Since the onset of the pandemic, Zimbabwe has adopted a phased strategy for the closure and reopening of schools. Rural ecologies transitioned from a period of complete closure for in-person learning between March and mid-September 2020, to a partial reopening until October 2020, and eventually resumed full operations from November to December 2020. Following this, they operated with limited capacity from January to March 2021, and are now fully functional as of April 2021. Throughout 2020, Zimbabwe has been exploring alternative methods to ensure continuous learning (Dube, 2020; Mhlanga & Ndhlovu, 2020; Moyo, 2022; Nhongo & Tshotsho, 2021). Initially, radio lessons were provided during the early stages of the pandemic, which proved effective. However, a lack of a digital repository to access these radio lessons hindered their continued utilisation by students. While online learning holds promise for expanding educational opportunities, it remains inaccessible to the majority of rural students in Zimbabwe due to infrastructure limitations, high costs of internet services, the absence of rural-specific platforms, and a broader digital divide. Dube (2020) and Tsimba et al. (2020) noted that governmental efforts to support online education seemed to be mainly directed towards urban ecologies, neglecting the accessibility issues in rural ecologies, thereby exacerbating a significant digital discrepancy for rural students.

Moreover, the Ministry of Primary and Secondary Education (MOPSE) and UNICEF took advantage of the situation to expedite digital-assisted learning initiatives (Ministry of Primary and Secondary Education, 2020; Moyo, 2022; Yingi et al., 2022). Through collaborative efforts between MOPSE, Microsoft, and UNICEF, the Learning Passport Zimbabwe was developed and officially launched in March 2021. This educational technology platform aimed to reach 300,000 students by the year's end (Higherlife Foundation, 2017; Nhongo & Siziba, 2022). The platform provides free online access to educational resources, including audio lessons, syllabi, teaching guides, and interactive materials for both students and teachers. The aim was to mitigate the educational disruptions caused by COVID-19 while focusing on aspects such as access, educational quality, health and safety, continuity, and community involvement. However, the closure of learning ecologies highlighted the discrepancies in access to tools and technology for rural students during lockdowns, intensifying the learning crisis and digital gap (Mseleku, 2020). Many rural students in Zimbabwe lack internet access, with only 10% having such connectivity (Yingi et al., 2022). Inadequate electricity infrastructure, power outages, and high poverty rates further diminish the prospects for online learning. Families in rural communities struggle to afford electronic devices and data/airtime expenses, making online education more difficult to access. This disparity negatively impacts their learning outcomes and increases their social vulnerabilities, including prolonged dropouts, mental health issues, risks of gender-based violence and abuse, and deepening poverty (Moyo, 2022).

Materials and Methods

A desk research methodology was employed to objectively assess the issues and potentialities in rural learning ecologies (Mark et al., 2023). By analysing the peer-reviewed literature and authoritative sources (Crossman, 2020; Stoianoff, 2021), the study aimed to gain insights into the digital transformation of Zimbabwe's education system. The research primarily focused on secondary data analysis in order to understand the barriers and possibilities of implementing online education, particularly in rural areas, during the COVID-19 pandemic. This study explored the potential of the 4IR to bridge the digital divide and ensure an equal access to education in rural Zimbabwe, identifying challenges, impacts, and best practices. The study identified and screened study abstracts, titles, research overviews, publication years, sources, and approaches used in the studies, as well as the sources and content of the studies. Studies with titles and objectives that did not align with the topic were excluded. The analysis included studies published between 2019 and 2023, with a significant proportion from 2021 to 2023. Most of these studies were conducted in the Zimbabwean context and focused on ICT and COVID-19, adopting qualitative approaches that met the inclusion criteria. Studies that did not address the digital divide, challenges, or impacts were excluded from the study.

Various databases, such as AJOL, PubMed, Google Scholar, and Scopus, as well as university and government libraries and catalogues, were systematically searched during this literature review. Electronic databases were examined using the keywords related to themes such as the "Fourth Industrial Revolution" (4IR), "e-learning in rural Zimbabwe," "technology utilisation during COVID-19," "educational transformation in rural Zimbabwe during COVID-19," "integration of ICT in Zimbabwean education," "curricular reforms and rural-urban digital disparities," and "rural-urban digital divide." A comprehensive definition of "e-learning" was applied across both urban and rural contexts in the study. The reliability and accuracy of sources were assessed, resulting in the removal of articles with insufficient credibility. The concept mapping was employed as a technique to collect and synthesise data.

Results

Three possible reasons for conducting research in Zimbabwe focus on strategic goals of optimising the "*prospects*" of utilising online educational resources, addressing "*challenges*" such as technological assimilation and academic programme harmonisation, and bridging the "*roadmap*" for mitigating the digital divide between rural and urban regions. These arguments highlight the need to improve fair access, remove obstacles in the system, empower teachers, and utilise teamwork and innovative initiatives to maximise the advantages of online education. The ultimate objective is to promote equality in society and drive economic progress. Moreover, the study advocate for the implementation of teacher training programmes, distributed renewable energy infrastructures, and public-private partnerships as mechanisms to link disadvantaged educational institutions in Zimbabwe with global knowledge networks. This is summarised in the Tables 1 and 2 below:

Table 1

Summary of Themes and Key Findings from Literature on Digital Divides in Zimbabwean Rural Learning Ecologies

Prospects of 4IR in the rural ecologies	Challenges in the implementation of 4IR in rural ecologies	Roadmap for the implementation of 4IR
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• Improvement of learning outcomes and future life prospects for disadvantaged students. • Supporting social justice and economic progress. • Digital equity proactively closing gaps between rural and urban students • Improved internet connectivity, supply of electronic gadgets and development of e-learning applications (Higherlife Foundation, 2017) to be used in rural ecologies. • Built solar-powered internet hubs to electrify off-grid rural communities.	• Vandalised renewable energy systems in rural areas. • Shortage of ICT electronic devices to use in rural ecologies. • Challenges in integrating advanced technologies into traditional teaching methods. • Limited awareness, monitoring and acceptance by rural communities. • Remoteness, difficult terrain, and lack of accessibility, hindering the monitoring of 4IR education • Limited curriculum alignment to into existing lesson plans and educational objectives due to lack of practical lessons.	• Comprehensive government policies and activities to provide rural Zimbabweans with greater access to educational technology. • Provides contextualised access to online courses, platforms, and information, linking students internationally. • Enrich teachers first by providing individualised training, providing access to online courses, platforms, and information, connecting teachers to global peers. • Large-scale pilot initiatives in rural learning ecologies that demonstrate the educational advantages of internet access. • Seeking CSR funding from IT companies and Zimbabwean businesses. • Implementing decentralised renewable energy systems to promote sustainability
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Source: Created by authors.

Overall, the literature review indicates that online learning has the potential to bring about a significant transformation in Zimbabwe's rural education sector. It can effectively widen access to education, enhance educational standards, stimulate innovation, and contribute to economic growth. However, realising this potential, several challenges were also identified within the rural communities at the micro- and macro-levels, as well as other systematic challenges. It is necessary to address a number of these challenges currently faced, which are discussed further in the subsequent section. Presently, Zimbabwe faces various obstacles in its rural regions that hinder participation in and access to the benefits of the 4IR. Nevertheless, the government has a crucial role in realising quality education in these areas. In order to achieve this, Zimbabwe must focus on “developing infrastructure”, including the expansion of internet accessibility to rural and under-served areas, “providing devices to students who are unable to afford them”, and “creating digital learning materials that cater to diverse learning styles and abilities”. Some summary findings from the above show that teachers in Zimbabwe should “receive professional development” and “technical support” to ensure they have the “necessary tools and skills for online learning”. Findings show that the “affordability and accessibility” can be achieved by “subsidising internet costs” and “advocating for zero-rated educational websites” by the government of Zimbabwe in collaboration with different stakeholders. Furthermore, the “engagement” was identified as “fostering parent and community involvement”, and also the “collaboration with local organisations” (Chigama & Goronga, 2022; Chimbunde, 2021; Dhliwayo & Jita, 2023; Dube, 2020; Dube et al., 2022; Kangara et al., 2022; Mabika & Marevesa, 2022; Magocha, 2021; Mandikiana, 2020; Maphosa, 2021; Mavengano & Marevesa, 2022; Ministry of Primary and Secondary Education, 2020; Moyo, 2022; Moyo et al., 2020; Nhongo, 2022; Nhongo & Siziba, 2022; Nhongo & Tshotsho, 2021; Nyagadza et al., 2022; Phiri, et al., 2020; Tsimba et al., 2020; Zinyemba et al., 2021). It was clear that policy and governance should focus on developing regulatory frameworks to govern online education, ensuring quality standards, and security measures as a roadmap to the challenges faced. The study concluded that by addressing these areas comprehensively and collaboratively, Zimbabwe can harness the full potential of online learning to promote educational equity and empower learners across the

country. The opportunities, challenges and solutions of 4IR were summarised in themes in the Table 2 below:

Table 2

Summary on Strategies and Impact of Digital Divides in Zimbabwean Rural Ecologies

Main theme on Rural students access to 4IR during Covid-19	Sub-Themes on Rural students access to 4IR during Covid-19	Strategies/impact for bridging digital divides
Theme 1: ICT Integration in Zimbabwean Rural Schools: Improving Learning Outcomes and Future Life Prospects	❖ The access to information - ICT provided rural students with a wealth of information, enhancing their understanding of various topics. ❖ Interactive learning - ICT enabled dynamic and engaging learning experiences, catering to a variety of learning styles. ❖ Digital literacy skills - ICT enabled rural students to gain digital literacy skills, preparing them for further education and future career prospects. ❖ Access to educational resources - ICT provided access to a wide range of educational resources, which enriched the curriculum and supplemented traditional teaching methodologies. ❖ Improved communication and collaboration - ICT enabled students, teachers, and rural communities to communicate and collaborate more effectively, hence extending their social networks and learning opportunities. ❖ Promotion of STEM education - ICT inspired rural students to pursue careers in STEM fields. ❖ Empowerment and motivation - ICT empowered disadvantaged rural students by increasing their self-esteem, motivation, and future goals.	• Specific ICT interventions in rural Zimbabwean schools (computer labs, tablet programs, internet connectivity projects, etc.). • Evidence of improved test scores, grades, and skill levels after ICT introduced. • Importance of technology literacy and access to digital content for rural students' future education and employment.
Theme 2: Rural Learning Challenges in the 4IR	❖ Limited infrastructure - in rural areas, a lack of basic infrastructure such as power, internet access, and ICT integration facilities hampered the successful implementation of technology-driven learning programmes. ❖ Access to technology - limited access to electronic devices in rural ecologies exacerbates educational gaps. ❖ Digital literacy gaps - rural students and teachers did not have the requisite digital literacy abilities to properly use technology.	• Limited electricity and internet connectivity ✓ Many rural areas lack reliable electricity and broadband internet. ✓ A hindered use of technology and access to online learning tools and content. • Shortage of computers, tablets, and other devices ✓ Low student-to-computer ratios. ✓ Schools relied on outdated hardware and software. • Teacher technology skills and training

	❖ Curriculum relevance - the curriculum failed to fully represent the skills required in the 4IR. ❖ Limited access to remote schools - limited stakeholders' access to install digital resources and educational content in those locations hinders learning results for students in rural ecologies. ❖ Resource constraints - limited funds made it difficult to invest in technological infrastructure, equipment, and maintenance. ❖ Power and connectivity issues - disruption of online learning activities and restricted access to digital materials hampered the effectiveness of online classes.	✓ Teachers lacked exposure and training on new technologies. ✓ Impeded ability to incorporate technology into lessons. • Relevance of curriculum ✓ Concerns that curriculum is not teaching relevant digital skills. ✓ Gaps between what students are learning and workforce needs. • Funding and resources ✓ Rural schools chronically underfunded. ✓ Cannot afford modernization of technology infrastructure
Theme 3: Bridging the digital divides in Zimbabwean rural learning ecologies	❖ Infrastructure development - investing in improving rural access to energy, internet, and telecommunications services. ❖ Technology access - equipping rural schools with suitable technology resources. ❖ Teacher capacity building – offering training and professional development opportunities for teachers. ❖ Mobile learning solutions - exploring mobile learning platforms that make use of the ubiquitous use of mobile phones. ❖ Community engagement - engaging parents, community leaders, and local stakeholders in supporting digital literacy initiatives. ❖ Digital inclusion policies - advocating for policies and regulations promoting digital inclusion and equitable access to technology. ❖ Monitoring and evaluation - creating methods for monitoring and assessing the effectiveness of digital inclusion initiatives.	• Infrastructure expansion ✓ Government and NGO initiatives to expand rural electrification. ✓ Public-private partnerships to build mobile broadband networks. • Provision of low-cost devices ✓ Shared computing labs in schools. ✓ Subsidised sales of solar-powered devices. • Policy and funding priorities to enact multifaceted bridging strategies. • Thinking long-term and starting early for new generations • Teacher training programs ✓ Pre-service and in-service training on ICT integration. ✓ Training teachers as facilitators to enable self-directed learning.

Source: Created by authors.

Findings from the literature reviewed show that bridging the digital divide in rural students' access to 4IR during the COVID-19 pandemic must prioritise the integration of information and communication technology (ICT) in rural schools in Zimbabwe. Additionally, it is crucial to address various challenges faced by rural students, including limited infrastructure, lack of technology access, curriculum relevance, and difficulties in accessing remote schooling. To narrow this gap, a range of strategies should be implemented, such as adopting specialised ICT interventions, providing enhanced learning outcomes, and promoting digital literacy for future opportunities. Furthermore, it has been identified that infrastructure development, technological access, teacher capacity building, mobile learning solutions, community participation, and digital inclusion policies all contribute to closing this digital gap. It is recommended that strategies such as improving rural infrastructure, offering affordable devices, establishing policy and financing priorities, implementing teacher training programmes, and

adopting a long-term perspective should be employed to reduce the disparity between rural and urban students. These programmes should be carefully monitored and evaluated, with a strong emphasis on their sustainability.

Discussion

Theme 1: ICT Integration in Zimbabwean Rural Schools: Improving Learning Outcomes and Future Life Prospects

The study has identified many potential advantages concerning education digital transformation in addressing issues of educational inequity in Zimbabwe, particularly focusing on disparities in the access to high-quality education between urban and rural ecologies. The research provided evidence that online learning played a significant role in equalising educational opportunities for rural students by providing them with high-quality instruction and academic support (Mhlanga & Ndhlovu, 2020). It also offers a vast amount of information (Mangeya & Makoni, 2021) and enhances their understanding of various subjects (Kangara et al., 2022). Furthermore, it enables rural students developing digital literacy skills (Dhliwayo & Jita, 2023), preparing them for further education and future career prospects (Keche, 2021), and improving communication and collaboration (Mabika & Maireva, 2022). Online learning also facilitates more effective communication and collaboration between students, teachers, and rural communities (Magocha, 2021), while empowering disadvantaged rural students by boosting their self-esteem, motivation, and aspirations for the future (Moyo, 2022). These studies underscore the importance of prioritising online learning programs for Zimbabwe's rural ecologies in order to surmount challenges related to affordability, availability, and accessibility that currently hinder equal access to education. While Dube (2020) and Nhongo and Siziba (2022) emphasise the potential of online learning to 'enhance learning outcomes and prospects for marginalized students', they also acknowledge existing obstacles and suggest context-specific interventions, such as government investments, public-private partnerships, and community involvement. It is argued that by proactively addressing digital equity disparities through the integration of these stakeholders, online learning has the potential to be transformative for rural students in Zimbabwe, promoting social justice and economic advancement in both rural and urban ecologies. Furthermore, Dube (2020) and Nhongo (2022) have identified that within rural ecologies of Zimbabwe, the lack of pervasive internet connectivity and limited access to internet-enabled devices present significant challenges to the feasibility of online learning. Research conducted by Moyo (2022) and Yingi et al. (2022) demonstrates how the recent expansions of 3G and 4G networks by NetOne, along with the collaboration between TelOne and Potraz Zimbabwe to provide internet services in rural areas, have successfully increased coverage in areas that were previously lacking access. Moreover, initiatives by the Rwandan organization Devtech to distribute affordable smartphones and tablets demonstrate the potential for circumventing conventional infrastructure constraints. This demonstrates that the 4IR has presented numerous opportunities in Zimbabwe, particularly within rural communities, as evidenced by the literature examined. This engenders a sense of optimism for the advancement of quality and inclusive education.

Furthermore, Econet Zimbabwe's noteworthy e-learning program for students, known as Ruzivo, operated by offering discounted bulk purchases of reading materials and charitable backing (Higherlife Foundation, 2017; Maphosa et al., 2021). Therefore, utilising mobile networks, complimentary internet services, and electronic devices was essential in expanding the reach of online education to rural areas beyond major centers. Despite the government's and donors' efforts to prioritise providing subsidised internet-capable devices and connectivity packages to low-income families, Dube (2020) and Nhongo and Tshotsho (2021) emphasise that disparities in the distribution of ICT resources in schools persist due to a variety of challenges faced by the government and others. Consequently, it is inconclusive

whether the government's intensive endeavours have effectively ensured that all students in rural ecologies receive the intended quality education. Given the shortage of ICT devices, individuals from economically disadvantaged backgrounds are hindered from accessing quality online educational resources (Baranova et al., 2022; Heo et al., 2022; Liao et al., 2023; Martin et al., 2020; Schleicher et al., 2020). Although collaborations between mobile service providers and technology firms have facilitated the pilot programs targeting limited rural ecologies thereby preparing them for enhanced digital skills (Moyo, 2022; Yingi et al., 2022), not all rural students have been recipients of the anticipated quality education. In conclusion, Zimbabwe must adopt comprehensive strategies to close the gap between urban and rural areas in preparation for online learning.

Furthermore, the implementation of collaborative initiatives involving partnerships between state mobile operators, such as NetOne and TelOne, alongside Liquid Telecom, developmental agencies like USAID, non-governmental organisations such as the Africa Foundation and Oxfam, and prominent technology entities like Facebook, Microsoft, and Huawei played a crucial role in ensuring access to previously inaccessible communities. The subsequent COVID-19 outbreak underscored the imperative for pioneering educational strategies grounded in sustainable energy sources and widespread internet access (Chazovachii & Mawere, 2021; Chimbunde, 2021; Chirisa et al., 2021; Dhliwayo & Jita, 2023; Higherlife Foundation, 2017; Macheke et al., 2022). The urgent need for such advancements was particularly pronounced in rural ecologies, where the absence of reliable electricity and internet infrastructure resulted in a substantial portion of students being deprived of educational opportunities. Moyo (2022) remarked that establishing consistent connectivity in remote ecologies necessitated ingenuity in devising decentralized solutions for the limited e-learning facilities available in regions lacking access to electricity. As a response, the Zimbabwean government initiated the construction of solar-powered internet hubs to electrify under-served communities, thereby enabling access to educational resources in rural ecologies and community centres without the need for expensive grid expansion (Nhongo & Tshotsho, 2021; Nhongo & Siziba, 2022). This initiative facilitated the internet access for students in rural ecologies with electronic devices, even during power outages. Regrettably, the government faced setbacks as residents in rural communities vandalised the solar-powered hubs, disrupting the much-needed internet connectivity essential for educational access in these communities. These instances highlight the significant impact of cultural attitudes among rural populations on the adoption of technological advancements. Thus, it is recommended that the public extend support to innovative approaches aimed at safeguarding the internet connectivity, consequently enabling rural students to access high-quality education.

Theme 2: Rural Learning Challenges in the 4IR

While the innovations of the 4IR offer numerous opportunities, the realisation of benefits, particularly in rural ecologies faces a considerable obstacle in guaranteeing the durability of digital education endeavors (Daniel, 2020; Huang & Wang, 2023; Nhongo & Siziba, 2022; Rocconi et al., 2020). This challenge manifests as the vandalism of 4IR equipment in various rural ecologies, putting its future sustainability at risk. Scholars such as Dube (2020) and Nhongo and Tshotsho (2021) have identified reasons for the vandalism of 4IR equipment, including limited digital literacy and skills among rural populations, inadequate electricity and connectivity infrastructure in rural ecologies, and difficulties in effectively integrating advanced technologies into conventional teaching practices. Research indicates that the irregular or discontinued utilisation of 4IR technologies in rural ecologies can be attributed to deficient government supervision and evaluation of digital services in these settings (Moyo, 2022; Nhongo & Siziba, 2022). Consequently, the lack of awareness, monitoring, and acceptance within rural ecologies resulted in the short-term implementation of 4IR initiatives in rural areas in Zimbabwe.

Scholars, such as Dube (2020), Moyo (2022), and Nhemachena (2021), have come up with a range of constructive and practical strategies to overcome the challenges associated with education. Strategies for community engagement include communication campaigns, partnerships, public demonstrations, inclusive materials, workshops, media collaboration, surveys, and community participation, involving parents, local authorities, and media (Baranova et al., 2022; Bouilheres et al., 2020; Lubinga et al., 2023). It is contended that the implementation of these recommended strategies can facilitate the progression of digital education initiatives within Zimbabwean rural educational environments, transitioning from temporary solutions to implementing a solid foundation for enduring outcomes and thereby promoting the enduring development of education within these rural communities.

The study revealed that numerous rural learning ecologies encounter geographical challenges, such as remoteness, arduous terrain, and limited accessibility, which impede the integration of 4IR education (Dube, 2020; Moyo, 2022; Nhongo, 2022). Nhongo and Tshotsho (2021) noted that many rural ecologies are situated in remote and geographically distant locations, leading to difficulties in resource sharing, collaborative teacher training programmes, and accessing centralised infrastructure even within the same district. Despite the government's intentions to establish every school as an e-learning hub, the significant distances involved escalate costs and inconveniences in setting up ICT facilities. It is crucial for governments to address these geographical disparities by investing in local infrastructure (Afzal et al., 2023; Baranova et al., 2022; Daniel, 2020; Keche, 2021; Yingi et al., 2022), including roads and transportation networks essential for improving accessibility and facilitating mobile education delivery models in rural learning environments. Viable solutions include mobile computer laboratories, networking rural kiosks for distance learning, enabling the access to advanced technologies at village panchayat resource centres, and forming local partnerships for community engagement (Moyo, 2022). The failure to address these geographical barriers will perpetuate substantial discrepancies in rural access to 4IR technologies.

Moreover, Dube (2020) and Kangara et al. (2022) found that there was a limited alignment of the curriculum with existing lesson plans and educational objectives due to the absence of practical applications. Moyo (2022) and Nhongo (2022) observed that since the integration of ICT into the new curriculum in 2015, there has been a disparity between the intended outcomes for rural students and the curriculum content. This gap is primarily driven by the inadequate availability of ICT resources in rural learning ecologies for practical learning experiences. As a result, most students possess theoretical knowledge without practical ICT exposure, resulting in a tendency to forget important concepts. Kerkhoff and Makubuya (2021), Moyo and Tshotsho (2020) and Nhongo and Siziba (2022) recommend that curriculum developers and government entities ensure the incorporation of practical digital literacy within the national curriculum to expose students to vital digital skills early in their education. Therefore, ICT curriculum content must be implemented alongside the provisioning of digital equipment to ecologies to alleviate the challenges faced by rural students arising from inadequate ICT resources in their learning environments (Bouilheres et al., 2020; Daniel, 2020; Elfaki et al., 2019; Heo et al., 2022).

Theme 3: Bridging the Digital Divides in Zimbabwean Rural Learning Ecologies

The digital divide between urban and rural learning environments in Zimbabwe presents a significant challenge that worsens educational inequality and constrains opportunities for rural students, necessitating intervention. Research by Dube (2020) indicates that urban settings are equipped with computer labs, internet connectivity, and diverse educational technologies, while rural ecologies often face constraints such as a lack of electricity and limited internet access. The educational inequities that intensified during the COVID-19 pandemic underscored the urgency of addressing this

issue to create more equitable learning opportunities for rural students. Chazovachii and Mawere (2021) and Moyo (2022) aimed at enhancing the access to educational technologies for rural Zimbabwean students in order to mitigate the digital gap.

Scholars Nhongo and Siziba (2022), Pokhrel and Chhetri (2021) and Yingi et al. (2022) emphasise that an improved access to technology and internet connectivity has the potential to enhance educational equity by facilitating personalised learning experiences tailored to students' contexts, providing access to needed online resources, platforms, and information, fostering global connections among students (Araune, 2023; Daniel, 2020; Nhongo, 2022), and equipping students with essential digital skills relevant for the contemporary job market (Alghamdi et al., 2020; Mseleku, 2020; Zwane & Mudau, 2023). Substantial government commitments are imperative to facilitate the integration of educational tools and internet infrastructure in rural Zimbabwean learning ecologies to enrich students' educational experiences.

It is crucial to promote equality and justice for all individuals (Afzal et al., 2023; Hamakali & Josua, 2023; Wang, 2022; Zhang et al., 2020) aiming to enhance the access to educational technologies for rural students in Zimbabwe, ultimately bridging the digital divide and fostering more inclusive educational opportunities. As posited by Moyo (2022), a crucial step for the Zimbabwean government before the implementation of digital programmes within rural learning ecologies is to augment teachers' preparedness through personalised training initiatives. These actions involve providing specialised training access (Huang & Wang, 2023; Martin et al., 2020; Tang et al., 2021), online educational platforms, and global networking opportunities to teachers, along with furnishing them with essential digital competencies relevant to the contemporary era. The envisioned teacher development scheme should emphasise the integration of technology within rural classrooms and instructional practices, thereby enabling teachers in rural ecologies to proficiently leverage these tools for the benefit of rural students' comprehension (Heo et al., 2022; Huang & Wang, 2023; Kayembe & Nel, 2019; Nhongo & Siziba, 2022).

Implementing comprehensive pilot programs in specific rural educational environments can effectively showcase the benefits of enhanced digital accessibility in teaching and learning (Zhang et al., 2020). Subsequently, these initiatives could lay the groundwork for obtaining funding for an extensive program encompassing all rural learning ecologies. This strategic approach holds the promise of instigating notable progress towards mitigating Zimbabwe's rural-urban digital disparity over the long term. Equipping teachers in rural Zimbabwe with contemporary educational technologies can help narrow the educational gap between urban and rural teachers (Afzal et al., 2023; Martin et al., 2020; Yingi et al., 2022). Providing teachers with skills in different areas, such as online teaching tools, educational software applications, differentiated teaching methods, personalised learning approaches, digital literacy modules, and device management strategies can assist rural educators in bridging the digital divide for their students. Moreover, the digital disparity between urban and rural ecologies in Zimbabwe is a significant concern that results in educational inequity and diminishes opportunities for rural students. Yingi et al. (2022) propose that soliciting corporate social responsibility (CSR) funds from technology companies and other Zimbabwean enterprises could help generate funds to enhance ICT resources in rural ecologies. This could involve upgrading infrastructure, such as electricity and internet connectivity, through the adoption of renewable energy sources. According to Alharbi (2023) and Moyo (2022), it is imperative to bridge the gap in energy availability between rural and urban communities to facilitate the distribution of internet access and educational technologies in rural ecologies in Zimbabwe. Decentralised renewable energy systems, particularly solar power, present a sustainable "green" solution for rural ecologies. The installation of independent solar panels and batteries to power computer laboratories and charge devices in rural ecologies can reduce expenses

related to infrastructure and grid connections (Heo et al., 2022; Pokhrel & Chhetri, 2021). Solar systems require minimal maintenance and can leverage Zimbabwe's abundant solar resources to provide reliable and affordable off-grid power, particularly in remote communities. Therefore, the adoption of solar power in electrifying rural ecologies in Zimbabwe, employing locally appropriate technologies, supports advancements through leapfrogging rather than catching up with development initiatives (Madimabe & Omodan, 2021; Maphosa, 2021; Yingi et al., 2022). This approach addresses the challenges related to electricity access that have impeded online learning in rural areas. The implementation of decentralised solar solutions in Zimbabwe has the capacity to help bridge the digital gap between urban and rural areas with targeted subsidies from the government and financing from international development partners. CSR funding specifically allocated to closing these digital divides between rural and urban communities could be sourced from Zimbabwean companies as well as international tech giants interested in enhancing global educational access. Moyo (2022) argues that along with constructing such infrastructure, local communities must be educated about the significance of these developments through workshops and social gatherings. It is also recommended that strict laws be put in place to discourage the vandalism of digital resources located in rural environments. Perpetrators should face severe consequences as deterrents within the community.

Conclusion

In conclusion, despite efforts to digitise education in Zimbabwean rural learning ecologies, there is a notable lack of infrastructure compounded by unclear policies, rendering the practical implementation of theoretical concepts in rural ecologies nearly unattainable. Reforms and development initiatives in digital education in rural areas have been held back by a lack of political dedication to direct them towards clear goals. Consequently, the aspiration of providing technology access to enhance teaching and learning in rural ecologies remains subtle, particularly given the ongoing challenges with fundamental infrastructure that hinder rural students from accessing online educational resources. While Zimbabwean rural learning ecologies cannot be detached from the global technological landscape due to associated repercussions, it is imperative to bridge the technology gap by establishing conducive policy frameworks and regulatory structures and enhancing teacher capacities to facilitate information dissemination, innovation, and integration of global knowledge resources into all facets of sustainable development.

Moreover, the study suggests that Zimbabwe should prioritise education by equitably allocating financial and human resources across all contexts. The government should restore its institutions to foster ICT competencies among all teachers, irrespective of their contextual origins. This measure gives the possibility to help foster supportive rural communities that value and protect local wisdom and human potential, as well as establishing an efficient social support system by allocating educational resources to all rural teachers who can facilitate quality education access for rural students through ICT. Policymakers must take action to enhance Zimbabwe's educational system's institutional and governance framework to ensure a just distribution of resources. Advocates for social justice demand immediate action be taken in this regard. The failure to access education could potentially isolate rural learning ecologies from mainstream economic and social progress.

Suggestions for Future Research

As a result, this study suggests that technology has the potential to revolutionise rural education by bridging urban-rural disparities and improving access to high-quality resources and custom learning opportunities via online tools, digital materials, and interactive technologies. Moreover, the challenges can be seen as chances for personal development, creativity, and transformation, fostering resilience

and paving the way for success as catalysts for change. Advocates for social justice argue that policymakers should explore strategies to enhance the institutional and governance framework of Zimbabwe's education system to distribute resources more equitably. This approach could empower rural communities, reduce educational gaps, and prepare the ground for a more inclusive and technologically advanced future.

Furthermore, to gain a deeper comprehension of cultural values and attitudes towards technology and digital education programmes, it is imperative to conduct ethnographic studies and organise focus groups in rural Zimbabwe. It is crucial to establish frameworks that facilitate community participation in digital education initiatives, such as engaging in collaborative solution development, establishing local advisory groups, and mobilising the community. Additionally, it is of paramount importance to explore sustainable approaches for affordable digital content, devices, and internet connectivity, such as community-owned networks, public-private partnerships, subsidies, and innovative funding methods like mobile money. These measures will facilitate the provision and delivery of high-quality, inclusive education for students, parents, teachers, and school administrators.

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Conflict of Interest

The authors declare no conflict of interest.

References

- Abe, J. A. A. (2020). Big five, linguistic styles, and successful online learning. *The Internet and Higher Education*, 45, Article 100724. <https://doi.org/10.1016/j.iheduc.2019.100724>
- Afzal, A., Khan, S., Daud, S., Ahmad, Z., & Butt, A. (2023). Addressing the digital divide: Access and use of technology in education. *Journal of Social Sciences Review*, 3(2), 883–895. <https://doi.org/10.54183/jssr.v3i2.326>
- Alghamdi, A., Karpinski, A. C., Lepp, A. & Barkley, J. (2020). Online and face-to-face classroom multitasking and academic performance: Moderated mediation with self-efficacy for self-regulated learning and gender. *Computers in Human Behaviour*, 102, 214–222. <https://doi.org/10.1016/j.chb.2019.08.018>
- Alharbi, A. M. (2023). Implementation of Education 5.0 in developed and developing countries: A comparative study. *Creative Education*, 14, 914–942. <https://doi.org/10.4236/ce.2023.145059>
- Ali, A. D., & Hanna, W. K. (2021). Predicting students' achievement in a hybrid environment through self-regulated learning, log data, and course engagement: A data mining approach. *Journal of Educational Computing Research*, 60(4), 960–985. <https://doi.org/10.1177/073563312111056178>
- Andrade, H. L., Brookhart, S. M., & Yu, E. C. (2021). Classroom assessment as co-regulated learning: A systematic review. *Frontiers in Education*, 6, 1–18. <https://doi.org/10.3389/feduc.2021.751168>
- Anthonyamy, L., Koo, A., & Hew, S. H. (2020). Self-regulated learning strategies and non-academic outcomes in higher education blended learning environments: A one-decade review. *Education and Information Technologies*, 25, 3677–3704. <https://doi.org/10.1007/s10639-020-10134-2>
- Araune, P. B. (2023). Exploring gender-based disparities in the e-learning journey: An in-depth analysis of student experiences. *International Journal of Research and Innovation in Social Science*, 7(10), 1805–1810. <https://dx.doi.org/10.47772/IJRISS.2023.701138>

- Baranova, T. A., Kobicheva, A. M., Tokareva, E. Y., & Mokhorov, D. (2022). The relationship between students' psychological security level, academic engagement and performance variables in the digital educational environment. *Education and Information Technologies*, 27(7), 9385–9399. <https://doi.org/10.1007/s10639-022-11024-5>
- Besser, A.; Flett, G.L.; Zeigler-Hill, V. (2022). Adaptability to a sudden transition to online learning during the COVID-19 pandemic: Understanding the challenges for students. *Scholarship of Teaching and Learning Psychol*, 8, 85–105. <https://doi.org/10.1037/stl0000198>
- Bouilheres, F., Le, L. T. V. H., McDonald, S., Nkhoma, C., & Jandug-Montera, L. (2020). Defining student learning experience through blended learning. *Education and Information Technologies*, 25(4), 3049–3069. <https://doi.org/10.1007/s10639-020-10100-y>
- Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to Coronavirus pandemic. *Asian Journal of Distance Education*, 15(1), i–vi. <https://doi.org/10.5281/zenodo.3778083>
- Chazovachii, B., & Mawere, M. (2021). *Covid-19 and the dialectics of global pandemics in Africa: Challenges, opportunities and the future of the global economy*. Langaa RPCIG.
- Chigama, T., & Goronga, P. (2022). Exploring teachers' perceptions towards ICT integration in teaching and learning: The case of selected primary schools in Harare, Zimbabwe. *Journal of African Education*, 3(1), 119–146. <https://doi.org/10.31920/2633-2930/2022>
- Chimbunde, P. (2021). Redesigning teacher education in the wake of Covid-19 and future emergencies: A case of Zimbabwe. *Journal of Research in Higher Education*, 5(1), 71–95. <https://doi.org/10.24193/JRHE.2021.1.3>
- Chirisa, I., Mavhima, B., Nyevera, T., Chigudu, A., Makochehanwa, A., Matai, J. ... Mundau, L. (2021). The impact and implications of COVID-19: Reflections on the Zimbabwean society. *Social Sciences & Humanities Open*, 4(1), 100–183. <https://doi.org/10.1016/j.ssaho.2021.100183>
- Crossman, A. (2020, February 2). *An overview of qualitative research methods: Direct observation, interviews, participation, immersion, focus groups*. Thought Co. <https://www.thoughtco.com/qualitative-research-methods-3026555>
- Dalagan, J. (2020). *OVPHEd memo 1920–48: HUB for transformative teaching and learning*. Xavier University.
- Daniel, S. (2020). Education and the COVID-19 pandemic. *PROSPECTS*, 49(1–2), 91–96. <https://doi.org/10.1007/s11125-020-09464-3>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crises. *Journal of Educational Technology*, 49(1), 5–22. <https://doi.org/10.1177/0047239520934018>
- Dhliwayo, A., & Jita, T. (2023). Teachers' perceptions in the potential for ICT integration through smart phones for teaching and learning of English composition writing in secondary school in Gweru, Zimbabwe. *Journal of Research Innovation and Implications in Education*, 7(1), 166–179. <https://jrjiejournal.com/wp-content/uploads/2023/03/JRIIE-7-1-016.pdf>
- Dube, B. (2020). Rural online learning in the context of COVID-19 in South Africa: Evoking an inclusive education approach. *Multidisciplinary Journal of Educational Research*, 10(2), 135–157. <https://doi.org/10.17583/remie.2020.5607>
- Dube, B., Makura, A., Modise, A., & Tarman, B. (2022). COVID-19 and the quest for reconfiguration of disciplines: Unpacking new directions. *Journal of Culture and Values in Education*, 5(1), 1–7. <https://doi.org/10.46303/jcve.2002.12>

- Dunga, H. (2019). The impact of technological revolution on poverty: A case of South Africa. In *Proceedings of the 45th International academic conference* (pp. 47–57). International Institute of Social and Economic Sciences. <https://doi.org/10.20472/iac.2019.045.012>
- Dzinoreva, T., & Mavunga, G. (2022). Integrating ICTs into the Zimbabwean secondary school pre-service teachers' curriculum. *Journal of Education*, (88), 53–68. <https://dx.doi.org/10.17159/2520-9868/i88a04>
- Elfaki, N. K., Abdulraheem, I., & Abdulrahim, R. (2019). Impact of e-learning vs. traditional learning on student's performance and attitude. *International Journal of Medical Research and Health Sciences*, 8(10), 76–82.
- Elharake, J. A., Akbar, F., Malik, A. A., Gilliam, W., & Omer, S. B. (2023). Mental health impact of Covid-19 among children and college students: A systematic review. *Child Psychiatry and Human Development*, 54(3), 913–925. <https://doi.org/10.1007/s10578-021-01297-1>
- Gereluk, D., Dressler, R., Eaton, S. E., & Becker, S. (2020). 'Growing our own teachers': Rural individuals becoming certified teachers. In M. Corbett & D. Gereluk (Eds.), *Rural teacher education: Connecting land and people*. Singapore: Springer. https://doi.org/10.1007/978-981-15-2560-5_6
- Hamakali, H., & Josua, L. (2023). Engendering technology-assisted pedagogy for effective instructional strategy in the University of Namibia Language Centre. *Research in Educational Policy and Management*, 5(1), 18–32. <https://doi.org/10.46303/repam.2023.3>
- Heo, H., Bonk, C. J., & Doo, M. Y. (2022). Influences of depression, self-efficacy, and resource management on learning engagement in blended learning during COVID-19. *The Internet and Higher Education*, 54, Article 100856. <https://doi.org/10.1016/j.iheduc.2022.100856>
- Higherlife Foundation. (2017, July 13). Ruzivo smart learning bringing 21st century learning to rural Zimbabwe. <https://www.higherlifefoundation.com/ruzivo-smart-learning-bringing-21st-century-learning-to-rural-zimbabwe/>
- Huang, L., & Wang, D. (2023). Teacher support, academic self-efficacy, student engagement, and academic achievement in emergency online learning. *Behavioural Sciences*, 13(9), Article 704. <https://doi.org/10.3390/bs13090704>
- Kangara, C. T. C., Gocha, M., & Tsokota, T. (2022). *Assessing readiness for teaching and learning using ICTs in Zimbabwean secondary schools in Gweru District, Zimbabwe*. Research Square. <https://doi.org/10.21203/rs.3.rs-1652431/v1>
- Kayembe, C., & Nel, D. (2019). Challenges and opportunities for education in the Fourth Industrial Revolution. *African Journal of Public Affairs*, 11(3), 79–94. <https://journals.co.za/doi/pdf/10.10520/EJC-19605d342e>
- Keche, K. (2021). Relevancy of new higher education approaches in 'Second Republic Zimbabwe'. In L. Waller & S. Waller (Eds.), *Higher education*. IntechOpen. <https://doi.org/10.5772/intechopen.99934>
- Kerkhoff, S. N., & Makubuya, T. (2021). Professional development on digital literacy and transformative teaching in a low-income country: A case study of rural Kenya. *Reading Research Quarterly*, 57(1), 287–305. <https://doi.org/10.1002/rrq.392>
- Liao, H., Zhang, Q., & Yang, L. (2023). Investigating relationships among regulated learning, teaching presence and student engagement in blended learning: An experience sampling analysis.

Education and Information Technologies, 28, 12997–13025. <https://doi.org/10.1007/s10639-023-11717-5>

- Lopres, J. R., Niadas, G. Y., Minez, G. P., Lopres, G. M., Gutierrez, M. I., Quiap, A. M. Q., & Bangot, S. R. O. (2023). Divulging the lived experiences of public school teachers in the U.S.A. during COVID-19 Pandemic: Phenomenological analysis. *International Journal of Learning, Teaching and Educational Research*, 22(5), 180–205. <https://doi.org/10.26803/ijlter.22.5.9>
- Lubinga, S., Maramura, T., & Masiya, T. (2023). The fourth industrial revolution adoption: challenges in South African higher education institutions. *Journal of Culture and Values in Education*, 6(2), 1–17. <https://doi.org/10.46303/jcve.2023.5>
- Mabika, P., & Maireva, C. (2022). Education 5.0 in the face of Covid-19: Zimbabwe higher education institutions' response – 2 years on. *Dzimbabwe Journal of Multidisciplinary Research*, 3(2), 165–191.
- Macheke, M., Taru, J., & Sibanda, F. (2022). Emergency Remote Instruction (ERI) in times of COVID-19 pandemic: Experiences of educators at Zimbabwean higher education institutions. In E. Mogaji, V. Jain, F. Maringe, & R. E. Hinson (Eds.), *Re-imagining educational futures in developing countries* (pp. 221–240). Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-88234-1_12
- Madimabe, M., & Omodan, B. (2021). Investigating the effects of e-learning as a method of curriculum dissemination for rural TVET college students. *Research in Social Sciences and Technology*, 6(3), 82–92. <https://doi.org/10.46303/ressat.2021.27>
- Magocha, J. C. (2021). Zimbabwe's social policy response to COVID-19 and implications for social work. *African Journal of Social Work*, 11(4), 216–222. <https://www.ajol.info/index.php/ajsw/article/view/215260>
- Manda, M. I., & Dhaou, S. B. (2019). Responding to the challenges and opportunities in the 4th industrial revolution in developing countries. In *Proceedings of the 12th International conference on theory and practice of electronic governance* (pp. 244–253). Association for Computing Machinery. <https://doi.org/10.1145/3326365.3326398>
- Mandikiana, M. R. V. (2020). Rethinking Zimbabwean education during and beyond the Covid-19 pandemic. *Quest Journal of Management and Social Sciences*, 2(2), 290–306. <https://doi.org/10.3126/qjmss.v2i2.33302>
- Mangeya, H., & Makoni, C. (2021). Multi-media technology as strategic mediation in knowledge transfer: Towards a paradigm shift in knowledge-mediation in the 'classroom' in the face of COVID-19. In A. M. Rusero, N. Mashavira, & M. Mawere (Eds.), *Covid-19 ramifications in Zimbabwe, Africa and beyond: An interdisciplinary perspective*, (pp. 155–182). Langaa RPCIG.
- Mangundu, J. (2022). Social media for teaching and learning: A technology acceptance model analysis of preservice teachers' perceptions during the Covid-19 pandemic. *International Journal of Learning, Teaching and Educational Research*, 21(5), 182–203. <https://doi.org/10.26803/ijlter.21.5.10>
- Maphosa, V. (2021). Teachers' perspectives on remote-based teaching and learning in the Covid-19 era: Rethinking technology availability and suitability in Zimbabwe. *European Journal of Interactive Multimedia and Education*, 2(1), Article e02105. <https://doi.org/10.30935/ejimed/9684>
- Maphosa, V., Dube, B., & Jita, T. (2021). Sustainable information and learning access at a rural university in Zimbabwe through a mobile application. *International Journal of Information and Education Technology*, 11(2), 82–87. <https://doi.org/10.18178/ijiet.2021.11.2.1493>

- Mark, N. K., Saunders, P. L., & Thornhill, A. (2023). *Research methods for business students* (9th ed.). Pearson.
- Martin, A. J., Mansour, M., & Malmberg, L. (2020). What factors influence students' real-time motivation and engagement? An experience sampling study of high school students using mobile technology. *Educational Psychology*, 40(9), 1113–1135. <https://doi.org/10.1080/01443410.2018.1545>
- Mathende, A. M., & Beach, J. (2021). The integration of information communication technology in education: A review of policies and practices in Angola, South Africa, and Zimbabwe. *Journal of Special Education Preparation*, 2, 80–89. <https://doi.org/10.33043/JOSEP.2.1.80-89>
- Mavengano, E., & Marevesa, T. (2022). Distance and blended learning: A troubled but necessary pedagogical terrain in Zimbabwe in the challenging context of the Covid-19 pandemic. In T. Driscoll III (Ed.), *Designing effective distance and blended learning environments in K-12*, (pp. 282–295). IGI Global. <https://doi.org/10.4018/978-1-7998-6829-3.ch016>
- Mhlanga, D., & Ndhlovu, E. (2020). *Socio-economic implications of the Covid-19 pandemic for smallholder livelihoods in Zimbabwe*. Preprints. <https://doi.org/10.20944/preprints202004.0219.v1>
- Ministry of Primary and Secondary Education. (2020). *Zimbabwe's education sector's Covid-19 response plan*. Government Publications.
- Moorhouse, B. L., & Wong, K. M. (2022). Blending asynchronous and synchronous digital technologies and instructional approaches to facilitate remote learning. *Journal of Computers in Education*, 9(1), 51–70. <https://doi.org/10.1007/s40692-021-00195-8>
- Moyo, Z. (2020). Can social justice be achieved through decolonisation?. In A. Masinire & A. P. Ndofirepi (Eds.), *Rurality, social justice and education in Sub-Saharan Africa Volume I* (pp. 217–235). Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-030-57277-8_10
- Moyo, Z. (2022). The Fourth Industrial Revolution: A literature study of challenges associated with access to education in rural schools in Zimbabwe. *Journal of Educational and Social Research*, 12(3), 125–136. <https://doi.org/10.36941/jesr-2022-0072>
- Moyo, A., Tsokota, T., & Ruvinga, C. (2022). An e-safety framework for secondary schools in Zimbabwe. *Technology, Knowledge and Learning*, 27, 1133–1153. <https://doi.org/10.1007/s10758-021-09545-y>
- Moyo-Nyede, S., & Ndoma, S. (2020, June 30). Limited internet access in Zimbabwe a major hurdle for remote learning during pandemic. *Afrobarometer Dispatch*, No. 371. https://www.afrobarometer.org/wp-content/uploads/2022/02/ab_r7_dispatchno371_hurdles_for_remote_learning_during_pandemic_in_zimbabwe.pdf
- Mseleku, Z. (2020). A literature review of e-learning and e-leaching in the era of Covid-19 pandemic. *International Journal of Innovative Science and Research Technology*, 5(10), 588–597. <https://www.ijisrt.com/assets/upload/files/IJISRT20OCT430.pdf>
- Mupfumira, E. B. (2023, July 6). *Re-imagining education in Zimbabwe - a collaborative effort: Providing access to digital learning for all school children is a key priority of Zimbabwe's drive to transform education*. UNICEF Zimbabwe. <https://www.unicef.org/zimbabwe/stories/re-imagining-education-zimbabwe-collaborative-effort>

- Muzira, D. R., & Bondai, B. M. (2021). Perception of educators towards the adoption of education 5.0: A case of a state university in Zimbabwe. *East African Journal of Education and Social Sciences*, 1(2), 43–53. <https://www.ajol.info/index.php/eajess/article/view/218640>
- Mwiinde, L., & Muzingili, T. (2020). Education on the edges: reflection on satellite schools in Binga District, Zimbabwe. *African Journal of Social Work*, 10(2), 101–108. <https://www.ajol.info/index.php/ajsw/article/view/198849>
- Mwila, K., Mudenda, S. & Kampamba, M. (2021). Factors affecting access to e-learning during the coronavirus disease 2019 pandemic among rural-based pharmacy students in Zambia: A qualitative study. *Epidemiol Open Journal*, 6(1), 25–34. <https://doi.org/10.17140/EPOJ-6-124>
- Netsianda, M. (2020, June 6). *Covid-19: Government launches radio lessons for pupils*. Chronicle. <https://www.chronicle.co.zw/covid-19-govt-launches-radio-lessons-for-pupils/>
- Nhemachena, A. (2021). Hakuna mhou inokumira mhuru isiri yayo: Examining the interface between the African body and 21st century emergent disruptive technologies. *Journal of Black Studies*, 52(8), 864–883. <https://doi.org/10.1177/00219347211026012>
- Nhongo, R. (2022). Challenges in teaching and learning in Zimbabwe’s rural settings during the Covid-19 lockdown. *Alternation*, 29(1), 92–117. <https://doi.org/10.29086/2519-5476/2022/v29n1a6>
- Nhongo, R., & Siziba, L. (2022). Adopting virtual classes during the Covid-19 lockdown: Interrogating new approaches to teaching and the exclusion of learners in rural settings. *International Journal of Learning, Teaching and Educational Research*, 21(2), 18–33. <https://doi.org/10.26803/ijlter.21.2.2>
- Nhongo, R., & Tshotsho B. P. (2021). The shortcomings of emergency remote teaching in rural settings of Zimbabwe during COVID-19 school closures: Lessons from China’s experience. *Africa’s Public Service Delivery and Performance Review*, 9(1), e1-e9. <https://doi.org/10.4102/apsdpr.v9i1.482>
- Nyagadza, B., Pashapa, R., Chare, A., Mazuruse, G., & Hove, P. K. (2022). Digital technologies, Fourth Industrial Revolution (4IR) & Global Value Chains (GVCs) nexus with emerging economies’ future industrial innovation dynamics. *Cogent Economics & Finance*, 10(1), 1–14. <https://doi.org/10.1080/23322039.2021.2014654>
- Nyika, R., & Modise, M. A. (2022). Experiences and challenges of adapting to online learning during Covid-19 induced lockdown: The case of Gweru urban tertiary students in Zimbabwe. *International e-Journal of Educational Studies*, 6(12), 272–281. <https://doi.org/10.31458/iejes.1164927>
- Nziramasa, C. T. (1999). *Zimbabwe: Report of the presidential commission of inquiry into education and training*. Government Publications.
- Pedler, M., Yeigh, T., & Hudson, S. (2020). The teachers’ role in student engagement: A review. *Australian Journal of Teacher Education*, 45(3), 48–62. <http://dx.doi.org/https://doi.org/10.14221/ajte.2020v45n3.4>
- Phiri, K., Ndlovu, S., Dube, T., Nyathi, D., Ncube, C., & Tshuma, N. (2020). Access to formal education for the San community in Tsholotsho, Zimbabwe: Challenges and prospects. *Heliyon*, 6(7), Article e04470. <https://doi.org/10.1016/j.heliyon.2020.e04470>
- Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, 8(1), 133–141. <https://doi.org/10.1177/2347631120983481>

- Rocconi, L. M., Liu, X., & Pike, G. R. (2020). The impact of person-environment fit on grades, perceived gains, and satisfaction: An application of Holland's theory. *Higher Education*, 80, 857–874. <https://doi.org/10.1007/s10734-020-00519-0>
- Rudhumbu, N., Parawira, W., Bhukuvhani, C., Nezandoyi, J., Majoni, C., Chikosha, F. & Chingwanangwana, B. (2021). Insight into online teaching behaviour of lecturers in Zimbabwean universities during the Covid-19 era and beyond: Issues and challenges. *International Journal of Information and Learning Technology*, 38(5), 518–539. <https://doi.org/10.1108/IJILT-07-2021-0104>
- Schleicher, A. (2020). *The impact of covid-19 on education insights from education at a glance 2020*. OECD. <https://web-archive.oecd.org/2020-09-08/562941-the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf>
- Shava, E. (2022). Reinforcing the role of ICT in enhancing teaching and learning post-Covid-19 in tertiary institutions in South Africa. *Journal of Culture and Values in Education*, 5(1), 78–91. <https://doi.org/10.46303/jcve.2022.7>
- Stoianoff, N. (2021). Research methodologies and methods to effect change in law and social systems. *Journal of Behavioural Economics and Social Systems*, 3(1), 19–32. <https://doi.org/10.5278/ojs.bess.v3i1.6808>
- Tang, Y., Chen, P., Law, K., Wu, C., Lau, Y., & Guan, J. (2021). Comparative analysis of student's live online learning readiness during the coronavirus (Covid-19) pandemic in the higher education sector. *Computers & Education*, 168, Article 104211. <https://doi.org/10.1016/j.compedu.2021.104211>
- The Herald. (2018, November 22). *ED launches e-learning kits*. <https://www.herald.co.zw/ed-launches-e-learning-kits/>
- Tsimba, G., Mugoniwa, B., & Mutembedza, A. N. (2020). A mobile Ad-hoc strategy to enhance ICT based education in Zimbabwean rural schools. In *2020 IST-Africa Conference (IST-Africa)* (pp. 1–7). IEEE. <https://ieeexplore.ieee.org/abstract/document/9144014>
- UNICEF, (2020, May 4). *Schools remain locked for more than 127 million children in Eastern and Southern Africa*. <https://www.unicef.org/esa/press-releases/schools-remain-locked-more-127-million-children-eastern-and-southern-africa>
- United Nations Zimbabwe, (2020). *Immediate socio-economic response to Covid-19 in Zimbabwe*. UN Zimbabwe.
- Van Wyk, D. M., & Waghid, Z. (2022). South African pre-service teachers' preparedness for fourth industrial revolution teaching and learning. *Education and Information Technologies*, (28), 2887–2907. <https://doi.org/10.1007/s10639-022-11287-y>
- Viner, R. M., Russell, S. J., Croker, H., Packer, J., Ward, J., Stansfield, C. ... Booy, A. (2020). School closure and management practices during coronavirus outbreaks including COVID-19: A rapid systematic review. *The Lancet Child & Adolescent Health*, 4(5), 397–404. [https://doi.org/10.1016/S2352-4642\(20\)30095-X](https://doi.org/10.1016/S2352-4642(20)30095-X)
- Wang, Y. (2022). Effects of teaching presence on learning engagement in online courses. *Distance Education*, 43(1), 139–156. <https://doi.org/10.1080/01587919.2022.2029350>
- Wang, Y., Stein, D. J., & Shen, S. (2021). Students' and teachers' perceived teaching presence in online courses. *Distance Education*, 42(3), 373–390. <https://doi.org/10.1080/01587919.2021.1956304>

- Yingi, E., Hlungwani, P. M., & Nyagadza, B. (2022). The Fourth Industrial Revolution (4IR) in the heart of the SDG Agenda: The role of education in Zimbabwe. *Africa Review*, 14(2), 213–229. <https://doi.org/10.1163/09744061-01402001>
- Yu, Z. (2021). The effects of gender, educational level, and personality on online learning outcomes during the COVID-19 pandemic. *International Journal of Educational Technology in Higher Education*, 18(14), 2–17. <https://doi.org/10.1186/s41239-021-00252-3>
- Zhang, J., Zou, L., Miao, J., Zhang, Y., Hwang, G., & Zhu, Y. (2020). An individualized intervention approach to improving university students' learning performance and interactive behaviours in a blended learning environment. *Interactive Learning Environments*, 28(2), 231–245. <https://doi.org/10.1080/10494820.2019.1636078>
- Zhong, Q., Wang, Y., Lv, W., Xu, J., & Zhang, Y. (2022). Self-regulation, teaching presence, and social presence: Predictors of students' learning engagement and persistence in blended synchronous learning. *Sustainability*, 14(9), Article 5619. <https://doi.org/10.3390/su14095619>
- Zimbabwe Ministry of Primary and Secondary Education. (2015). *Curriculum framework for primary and secondary education 2015–2022*. Zimbabwe MoPSE.
- Zinyemba, L., Nhongo, K., & Zinyemba, A. (2021). Covid-19 induced online learning: The Zimbabwean experience. *African Journal of Social Work*, 11(4), 223–230. <https://www.ajol.info/index.php/ajsw/article/view/215261>
- Zwane, S. A., & Mudau, P. K. (2023). Student teachers' experiences of open distance e-learning support in a Posthuman era: A learner engagement perspective. *Journal of Curriculum Studies Research*, 5(1), 13–33. <https://doi.org/10.46303/jcsr.2023.3>