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Embracing E-learning in Zimbabwe's Science Teacher Capacity Development Programmes: A Systematic Literature Review

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Abstract : This paper explores the embracing of e-learning in Zimbabwe's science teacher capacity development programmes, probing the opportunities and challenges. The discussion in this paper grounded in a systematic literature review to provide a holistic view through the use of the PRISMA 2020 checklist ensured transparency and consistency in selecting the 64 sources from databases (DOAJ, DHTE, IBSS, Scielo SA, Scopus and WoS). This provides a comprehensive interrogation of the issue at the centre of discussion. The paper highlights e-learning and how to embrace it in science teacher capacity development. In addition, it outlines approaches used to embrace e-learning in science teacher capacity development. This creates the need to look at how e-learning can enhance accessibility, reduce costs, and improve science teacher capacity development outcomes. However, substantial challenges such as limited access to the internet connection, scarce technological set-up and resistance to transformation from both science teachers were acknowledged. In conclusion, by embracing e-learning in Zimbabwe's science teacher capacity development programmes it creates a platform for promoting education and training. It can be recommended that the stakeholders involved in science teacher capacity development programmes need to establish a strong collaboration such that they can address the identified challenges. Therefore, the use of the right approaches to embracing e-learning in science teacher capacity development programmes can be a game changer in science learning activities.

Keywords : E-learning; Embracing; Science; Teacher capacity development programmes.

INTRODUCTION

With the coming of the Industrial Revolution 4.0, science teacher development needs to integrate all technologies into 21st-century education and training activities following current developments (Teo et al., 2021). The embracing of e-learning in Zimbabwe's science

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teacher capacity development programmes represents a transformative shift in the education sector, driven by the need to enhance professional growth (Nherera & Mukora, 2024). Thus, e-learning offers a flexible and cost-effective alternative to traditional teacher training methods, enabling teachers to access resources and training remotely (Magunje, Chigona & Gachago, 2024). This approach is particularly valuable in rural and underserved areas, where access to quality education and professional development opportunities is often limited (Modise, 2022). By embracing digital tools and platforms, e-learning has the potential to bridge gaps in science teacher capacity development programmes, improve instructional quality, and foster innovation in science education (Dzinoreva, Mavunga & Govender, 2023).

However, the embracing of e-learning in Zimbabwe also presents significant challenges (Dube & Scott, 2017). Therefore, it's critical to acknowledge the need to address these challenges through collaborative efforts from policymakers, training institutions, and stakeholders (Brunetti et al., 2020). It calls for a paper that questions how embracing e-learning can be considered indispensable in science teacher capacity development programmes in Zimbabwe (Togo & Gandidzanwa, 2021). Thus, this paper is expected to pave the way for the reader to understand how digital learning tools can bridge gaps in science teacher capacity development programmes. It is against this background that this systematic literature review explores the opportunities and challenges associated with embracing e-learning in Zimbabwe's science teacher capacity development programmes. The paper begins with an account of the research methodology followed by the analysis and discussion of the findings, leading to the crafting of the suggestions and conclusion.

RESEARCH METHODS

The systematic literature review guided the process of creating a solid base for interrogating the issue at the centre of this paper. This enabled an exhaustive search and guaranteed the identification of sources (Monroe et al., 2019) on the topic and keywords from databases (i.e., Scopus, DOAJ, DHTE, WoS, IBSS and Scielo SA).

Table 1. Database search string

Word search string
((“Embracing” OR “adoption”) AND (“Science teacher capacity development” OR “science teacher training”) AND (“e-learning” OR “electronic learning”) AND (“opportunities”) AND (“challenges”) AND (“Zimbabwe”))

The above sought to act as an exhaustive search guide in retrieving the sources meeting the inclusion criteria. The performance of each element against the sources judged relevant for inclusion in this review was scrutinized. This resulted in the preliminary word search availing 150 sources. In a bid to increase the accuracy of the sample, the PRISMA 2020 checklist (Sohrab et al., 2021) was followed as a framework. Fig. 1 below shows the identification, screening, eligibility, and inclusion/exclusion processes that guided the selection of the sources that were reviewed.

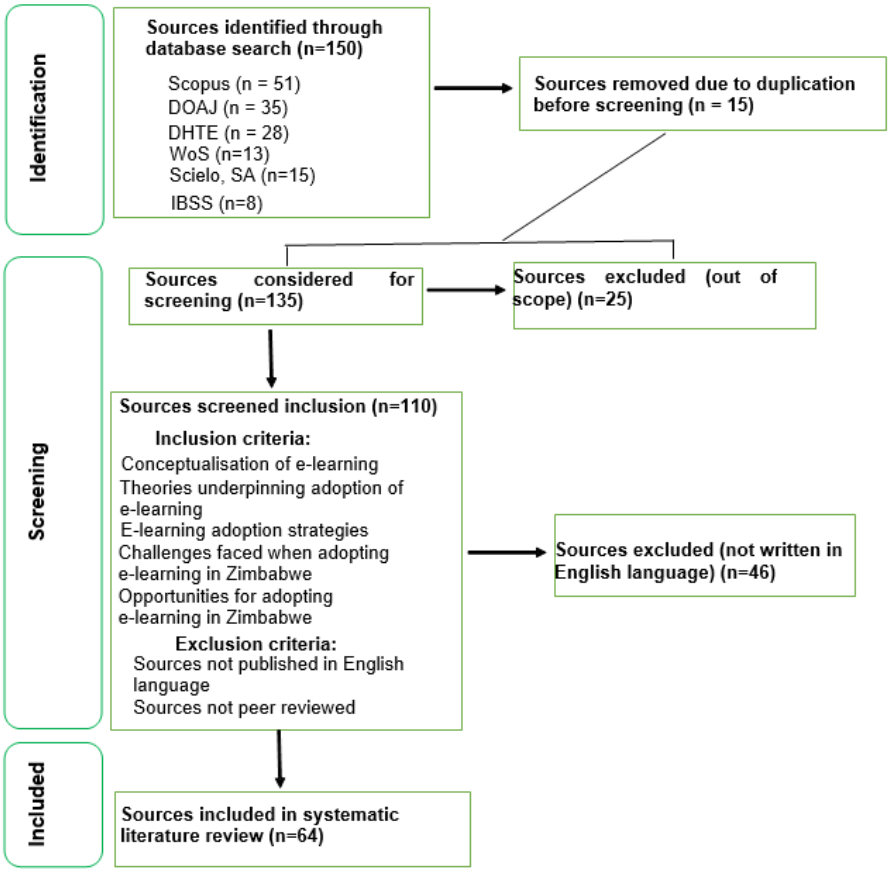

Figure 1. Prisma checklist developed in the systematic literature review

Through the identification, screening and eligibility phases, 86 sources were excluded as they were within the restrictions of the inclusion criteria of this systematic literature review. In addition, the inclusion/exclusion criteria indicated that sources should be in the highlighted databases and written in English language (Amundsen et al., 2018). Upon defining the exclusion criteria 64 sources were considered for review in this paper.

RESULTS AND DISCUSSION

This section centres on gaining a deeper understanding of the following aspects: conceptualisation of e-learning in science teacher capacity development programmes,

articulating the process of embracing e-learning in science teacher capacity development programmes, and opportunities brought about by embracing e-learning in science teacher capacity development programmes. In addition, challenges to effectively embrace e-learning in science teacher capacity development programmes are cross-examined with the view to extend possible strategies to enhance the quality of teacher training in Zimbabwe.

Conceptualisation of E-Learning in the Context of Science Teacher Capacity Development Programmes. E-learning, as a contemporary educational tool, has revolutionized the approach to science teacher capacity development by offering flexible and accessible learning opportunities (Pandey, 2023). For Zimbabwean science teachers, e-learning provides a platform to acquire new pedagogical skills, stay updated with global advancements in science education, and engage in continuous professional development (Boamah, 2025). With access to online resources, virtual labs, and collaborative platforms, educators can enhance their teaching methodologies and meet the demands of a sound modern science curriculum. This learning style also accommodates a variety of learning speeds and schedules, making it a boon for on-the-job teachers who must balance work and study.

In the Zimbabwean context, the integration of e-learning in science teacher capacity development programmes presents unique benefits (Maramba & Mazongonda, 2020). It enables science teachers in remote or under-resourced regions to access training and resources that would otherwise be unavailable (Ndhlovu & Ndhlovu, 2023). Virtual workshops, webinars, and digital content eliminate geographical barriers and foster knowledge sharing among educators from different regions (Chitanana, 2024). Moreover, e-learning allows for the customization of training materials to align with the specific needs of Zimbabwean science teachers, addressing local educational challenges while incorporating global best practices (Dabengwa et al., 2024).

The Theoretical Framework Underpinning the Embracing of E-learning in Zimbabwe’s Science Teacher Capacity Development Programmes. This paper based its argument within the confines of the Technological Pedagogical Content Knowledge (TPACK) and Constructivism learning theory to cross-examine the opportunities and challenges brought about by embracing e-learning in Zimbabwe's science teacher capacity development. In this context, the TPACK framework provided a theoretical basis for comprehending the complex interplay between technology, pedagogy, and content knowledge in science teacher capacity development (Tseng et al., 2022). TPACK framework takes into cognisance three fundamental bodies of knowledge that intersect into Technological

Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK) (Le & Pham, 2023).). In other words, science teacher capacity development programmes are expected to combine technological knowledge (TK) with PCK in their learning activities. Fig. 2 is a diagrammatical illustration of the TPACK framework.

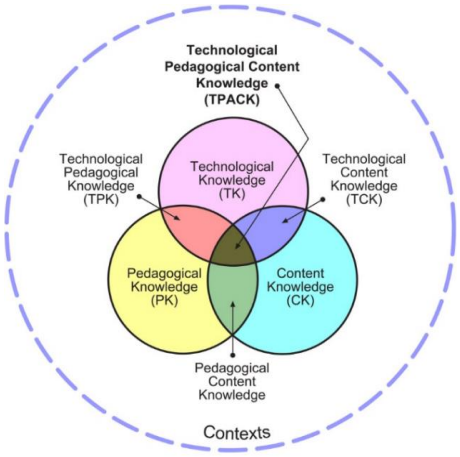

Figure 2. TPACK framework (Source: Alemán-Saravia & Deroncele-Acosta, 2021)

In this discussion, the TPACK framework is intertwined with the constructivism learning theory to unpack the embracing of e-learning in science teacher capacity development programmes. In this case, constructivism emphasizes the active role of science teachers in constructing knowledge through interaction with their environment, making it highly relevant for e-learning platforms during their capacity development programme (Al Abri, Al Aamri & Elhaj, 2024). Therefore, this platform enables science teachers to engage with digital resources, collaborate with peers, and apply new knowledge in practical contexts, fostering a deeper understanding of science education. Thus, it broadens their knowledge and skill base concerning the application of effective instructional methods. By leveraging e-learning and constructivism, science teachers can access diverse learning materials, participate in virtual workshops, and develop skills that are critical for implementing the new curriculum effectively.

The Process of Embracing E-learning in Science Teacher Capacity Development Programmes in Zimbabwe. The embracing of e-learning in Zimbabwe's science teacher capacity development programmes is becoming a crucial innovation in the nation's education system. It provides a flexible and accessible method for science teachers to enhance their skills, particularly in science education, where continuous updates on scientific advancements and teaching methodologies are essential (Guanzon, 2024). Through online courses, virtual seminars, and interactive digital platforms, science teachers can receive high-quality training

and access a wealth of resources. This approach eliminates geographical barriers and offers solutions to the challenges of limited physical infrastructure, enabling science teachers across the country to participate in capacity development programmes (Phulpoto, Oad & Imran, 2024).

Embracing e-learning also aligns with Zimbabwe's broader educational goals, such as the implementation of the Heritage-Based Curriculum, which emphasizes innovation and the use of digital tools in learning (Chasokela & Mangena, 2025). By incorporating digital tools, science teacher capacity development programmes can address specific challenges unique to the Zimbabwean context. For example, digital platforms can be customized to include content that is locally relevant while incorporating global best practices (Nambisan, Zahra & Luo, 2019). These tools also facilitate collaboration among educators, allowing them to share experiences, develop new instructional strategies, and create communities of practice that foster growth and innovation (Zamiri & Esmaeili, 2024).

The following are some of the key steps to consider when embracing e-learning in science teacher capacity development programmes: 1) Planning and strategy: Develop a clear and detailed plan that outlines the goals, objectives, and desired outcomes of the e-learning initiative (Aida, 2023). This should include a timeline, budget, and resource allocation. 2) Stakeholder engagement: Engage all relevant stakeholders to ensure their support and collaboration (Ochieng, 2024). This helps in addressing any concerns and ensuring a smooth implementation process. 3) Infrastructure setup: Establish the necessary technological infrastructure, such as high-speed internet, servers, and learning management systems (Benke & Widger, 2023). This ensures that the infrastructure can support the anticipated user load and is scalable for future growth. 4) Content development: Create high-quality, engaging, and interactive digital content that aligns with the learning objectives (Meng, 2023). This includes multimedia elements such as videos, animations, and simulations to enhance the learning experiences. 5) Training and support: Provide comprehensive training programmes for lecturers to learn teaching in the form of e-learning (Mugizi & Nagasha, 2025). In addition, science teachers need to familiarize themselves with the e-learning platform and tools to enhance their learning. 6) Pilot testing: Conduct a pilot test of the e-learning platform with a small group of users to identify any potential issues and gather feedback (Perotti et al., 2025). Use this feedback to make necessary adjustments before a full-scale rollout. 7) Implementation: Launch the e-learning platform and make it available to all users (Ahmad et al., 2023). This ensures that there is ongoing support and communication to address any

challenges that may arise during the initial implementation phase. 8) Monitoring and evaluation: Continuously monitor the performance and effectiveness of the e-learning platform (Aljawawdeh, 2024). Make necessary improvements based on this evaluation. 9) Continuous improvement: E-learning is an ongoing process that requires regular updates and enhancements (Benkhalfallah, Laouar & Benkhalfallah, 2024).

The above process advances the notion that the quality of instruction in science learning activities through embracing e-learning in science teacher capacity development programmes can be enhanced. However, this can be made possible through fostering a supportive policy environment and encouraging stakeholder collaboration (Mahardhani, 2023). Therefore, with the right strategies, e-learning can play a transformative role in science teacher capacity development programmes in Zimbabwe (Mpofu et al., 2024).

Strategies Used to Embrace E-learning in Zimbabwe's Science Teacher Capacity Development Programmes. Zimbabwe has embraced e-learning in its science teacher capacity development programmes through several innovative strategies, for example, the infusion of Information Communication Technology (ICT) into the education system, as delineated in the National E-Learning Strategy (Tandi, 2023). This initiative focuses on expanding broadband infrastructure, providing standardized gadgets to schools, and equipping teachers with digital skills (Maune, 2023). In this case the government in collaboration with the Postal and Telecommunications Regulatory Authority of Zimbabwe, TelOne and NetOne worked together to ensure internet connectivity in schools, particularly in marginalised areas.

In addition, universities such as the Bindura University of Science Education, Great Zimbabwe University, University of Zimbabwe and Midlands State University have been involved in offering advanced degrees and specialized courses in science education (Ndemo et al., 2024). These universities adopted various online platforms, such as Moodle and Google Classroom, to facilitate virtual learning as they engage science teachers in capacity development programmes (Chinamasa & Ncube, 2023). These efforts together aim to transform traditional instructional methods into student-centred learning experiences, fostering innovation and inclusivity in in science teacher capacity development programmes.

Opportunities for Embracing E-learning in Zimbabwe's Science Teacher Capacity Development Programmes. The embracing of e-learning in science teacher capacity development programmes brings opportunities that can significantly enhance the science learning process in Zimbabwe (Chidakwa & Khanare, 2024). This section articulates the following opportunities for embracing e-learning in Zimbabwe's science teacher capacity

development programmes: 1) Improved access to professional development**:** E-learning bridges geographical gaps, allowing science teachers in remote areas, such as those in Gokwe or Hwange, to access high-quality training resources without the need for travel (Sithole & Mbukanma, 2024). Online courses and webinars provide opportunities for continuous professional growth. 2) Cost-Effective training**:** Unlike traditional workshops that require physical venues and travel allowances, e-learning reduces costs for both teachers and institutions (Mhizha, Tafirenyika & Ejuu, 2022). For example, a teacher in Masvingo can attend a virtual workshop on integrating Science, Technology, Engineering and Mathematics activities into the classroom at an affordable cost (Marenyenya, 2023).

3) Customized learning: Digital platforms enable the tailoring of training programmes to meet the specific needs of Zimbabwean science teachers (Hlongwane et al., 2024). For instance, e-learning courses can include content aligned with the local Heritage-Based Education curriculum, ensuring relevance and practical application (Mutale, 2025). 4) Collaboration and networking: E-learning platforms facilitate connections among educators across the country (Manokore et al., 2023). For example, teachers can engage in discussion forums, share best practices, and collaborate on projects to enhance their teaching strategies (Vlasenko et al., 2023). 5) Access to diverse resources: E-learning provides access to a wide array of teaching materials, such as virtual laboratories and simulation tools (Tandi, 2023). A teacher in Bulawayo, for example, can use interactive simulations to improve their understanding of complex scientific concepts and apply them effectively in the classroom. 6) Flexibility in science teacher development (learning)**:** With e-learning, teachers can learn at their own pace and schedule, balancing professional development with their teaching responsibilities (Dikilitas & Fructuoso, 2023). For instance, an in-service teacher can complete a course on digital teaching methods during school holidays. 7) Global exposure**:** E-learning connects science teachers to global educational practices and trends (Maqbool et al., 2024). For example, Zimbabwean teachers can participate in international webinars or access online resources from global institutions, enriching their teaching approaches (Matiyenga & Khoalenyane, 2025).

8) Increased use of technology in teaching**:** E-learning familiarizes science teachers with digital tools, which they can incorporate into their classrooms (Aliyeva, 2023). For instance, a teacher trained through an online programme may introduce virtual experiments to enhance student engagement in learning. 9) Addressing science teacher shortages**:** E-learning allows for the rapid training of science teachers, addressing shortages in the profession

(Barbour & Hodges, 2024). For example, online teacher training programs can quickly equip new graduates with teaching methodologies and classroom management skills. 10) Support for lifelong learning**:** E-learning encourages a culture of continuous professional development (Ahsan, 2025). For instance, teachers can stay updated on advancements in science and education by enrolling in online micro-credential courses or certifications. By leveraging these opportunities, Zimbabwe can enhance the quality and accessibility of science teacher development programmes, ultimately contributing to improved education outcomes nationwide (Mufanechiya, Kanyopa & Mokhele-Makgalwa, 2024).

Challenges Faced When Embracing E-Learning in Science Teacher Capacity Development Programmes. Embracing e-learning in science teacher development programmes in Zimbabwe encounters several significant challenges that hinder its widespread implementation. This section presents the following challenges: 1) Limited internet connectivity: Many rural areas in Zimbabwe lack reliable internet infrastructure, making e-learning inaccessible for teachers in these regions (Chasokela, 2024). For example, a teacher in remote areas like Binga District may struggle to download training materials or participate in live virtual workshops due to poor or non-existent internet connections (Masimula, 2021). 2) High cost of technology: Digital devices, such as laptops and tablets, and internet data packages are prohibitively expensive for many teachers (Collins & Halverson, 2018). For instance, a science teacher at a poorly funded rural school may not afford a personal laptop or consistent internet access, thereby limiting their participation in e-learning programmes (Madzunye, 2021). 3) Inadequate digital literacy: Some science teachers are not familiar with using digital tools and platforms effectively (Sánchez-Cruzado, Santiago-Campión, & Sánchez-Compaña, 2021). For example, an experienced but technologically novice teacher may find it difficult to navigate learning management systems or use virtual labs, hindering their engagement with e-learning resources.

4) Insufficient infrastructure: Challenges such as frequent power outages disrupt the continuity of online learning programs (Ali, 2020). For instance, teachers in areas prone to load shedding, like certain districts in Matabeleland, often face interruptions when trying to attend webinars or complete online assessments (McGeer & Stremlau, 2024). 5) Cultural and attitudinal barriers: Resistance to change among some educators who are accustomed to traditional teaching and learning methods can slow down e-learning adoption (Hannache-Heurteloup & Moustaghfir, 2020). For example, a teacher might be hesitant to engage in digital platforms, viewing them as unnecessary or overly complicated. 6) Limited support

from institutions and policymakers: A lack of strong policy frameworks and insufficient funding hampers the rollout of e-learning initiatives (Adeniran et al., 2023). For instance, without subsidies for digital devices or comprehensive policies promoting e-learning, many teachers remain excluded from these programmes (Abuali & Ahmed, 2025). 7) Language and content relevance: E-learning materials are often designed using global templates that might not address the specific needs of Zimbabwean teachers (Ithindi, 2019). For example, instructional content may fail to incorporate local examples, making it less relatable or applicable to the challenges faced by science teachers in Zimbabwe (Hungwe, Nyandoro & Madzudzo, 2024).

To overcome these challenges, targeted intrusions are essential, including: improving infrastructure, offering affordable technology solutions, and providing digital literacy training (Yaqoob et al., 2023). In addition, there is a need to create a supportive policy environment tailored to enhance local science teacher capacity development contexts. Such initiatives can ensure that e-learning becomes a transformative tool in science teacher capacity development in Zimbabwe (Magunje, Chigona & Gachago, 2024). Thus, embracing e-learning in teacher capacity development programmes has an impact on teachers' psychic, which can lead to the 'proletarianization' of creativity and knowledge generation.

Suggestions to Ensure Success in Embracing E-Learning in Zimbabwe's Science Teacher Capacity Development Programmes. To ensure the success in embracing e-learning in Zimbabwe's science teacher capacity development programmes, a multi-faceted approach is required. For instance, investments should be made with the view to improve digital infrastructure. In addition, comprehensive training programmes should focus on enhancing science teachers' digital competencies to enable effective use of e-learning platforms in the learning process. Policymakers need to establish supportive frameworks and allocate sufficient funding to promote the widespread use of e-learning in the learning process. Lastly, there is need for a collaboration among stakeholders, including government, private sector, and educational institutions, which is essential to foster innovation and scale up e-learning initiatives sustainably in science teacher capacity development programmes.

CONCLUSION

In conclusion, embracing e-learning in Zimbabwe's science teacher capacity development programmes has proven to be a transformative approach to addressing educational challenges. By integrating ICT infrastructure, providing digital tools, and

fostering teacher training in technology-driven pedagogy, Zimbabwe has laid a strong foundation for modernizing its education system. These efforts not only enhance the quality of science education but also promote inclusivity, ensuring that even teachers in rural and underserved areas benefit from innovative teacher capacity development strategies. The systematic literature review highlights the opportunities of collaboration among stakeholders, including government bodies, educational institutions, and private organizations, in driving the success of initiatives involved in embracing of e-learning in science teacher capacity development programmes. While challenges such as resource limitations and connectivity gaps persist, the progress made demonstrates the potential of e-learning to revolutionize teacher capacity development and contribute to the broader goal of science education excellence in Zimbabwe. Thus, the embracing of e-learning in capacity development programmes empowers science teachers to provide quality and innovative interactions in learning activities.

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