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ORIGINAL RESEARCH

Innovations and Strategies During Online Teaching in an EdTech Low-Resourced University

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Abstract

The study focused on identifying innovations deployed by lecturers when teaching online during the COVID-19 pandemic at the University of Zambia. The interpretivist worldview anchors the study. Researchers adopted a descriptive qualitative case study design. Purposefully and conveniently sampled lecturers ($n=21$) took part in key informant interviews from the university faculties: the school of education, the school of humanities and social sciences and the school of health sciences. Thematic analyses were applied to the data collected using face-to-face and telephone interview schedules. Results show that all lecturers fully know online instruction's possible challenges. Lecturers have devised innovations that are lecturer-oriented, lesson-oriented, resource-oriented and student-oriented in managing online teaching and learning. The success of online teaching in an EdTech low-resourced university depends on the lecturers' desire to learn, the availability of essential ICT devices, the use of open educational resources-OER, the potential of the use of devices and the availability of internet connectivity. However, intermittent internet connectivity, student absenteeism, a lack of primary ICT devices, and EdTech illiteracy persist. External support—such as continuous professional development programs (CPDs), import duty exemptions or corporate sponsorships and donations—should be sought to facilitate online lessons. Innovation in teaching and learning does not only entail high-tech educational technologies but the use of what works best for a community of learners in a particular context. Though focused on Zambia, the study results reflect the situation and experience of universities in other countries with similar characteristics.

Keywords Innovations · Strategies · Online teaching · COVID-19 · EdTech · Low-resourced university

Introduction

Innovation is essential to confronting a severe crisis, such as the COVID-19 pandemic [1, 2]. While all domains of life have been directly and indirectly affected by the pandemic and the resulting socioeconomic impacts, the pandemic has led to the rapid adoption of educational technologies (EdTech) in education as a means of survival. Technologies have firmly entered all aspects of our life, not bypassing education. Arthur [3] defines technology as the orchestration of phenomena for some purpose. To orchestrate is to intentionally bring different things – actions, tools, methods and processes together in an organized form. As such, all educators are educational technologists because they systematically orchestrate the learning processes, although the technologies available may vary [4]. Literature [4, 5] has shown that there are two forms of educational technologies (traditional and innovative). Traditional technologies entail lectures and storytelling through posters, slides and charts. Traditional technologies require the learners to reproduce the teachers' knowledge accurately.

On the other hand, innovative technologies are more collaborative. The teachers and learners work collaboratively to produce knowledge. The teacher innovatively engages learners in knowledge generation and dissemination taking the

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role of a facilitator. Some innovative tools of learning and teaching include Simulation-based training; Virtual Reality (V.R.) and Augmented Reality (A.R.); Flipped classrooms; Teleconferencing; and Social-media based platforms [6]. Education for the 21st Century recognises that technology positively transforms society and all its facets, including education [7]. However, several micro and macro level challenges thwart the success of educational technology adoption in Africa. The challenges range from personal to community, cultural, infrastructural, policy and inadequate training, or an absolute lack of training [8, 9].

A common problem for developing countries has been limited EdTech knowledge, skills, devices, and software to facilitate 21st-century teaching and learning skills [10–12]. For example, data from Internet World Stats show that at least one-half of the Sub-Saharan African countries have less than 50% of their population without access to the internet. Only 10% of the population of poorly developed Sub-Saharan countries like Rwanda, Burundi, Chad, Madagascar, South Sudan, and Western Sahara have access to the internet. These limitations further complicate the need to implement remote learning or other instructional methods facilitated by the internet. Such disadvantages, which affect most Sub-Saharan African countries, necessitate comprehensive measures in terms of preparedness and resource allocations to limit the negative educational consequences of epidemics and pandemics [13]. Nevertheless, the COVID-19 pandemic stimulated the adoption of various EdTech actions, tools, methods, and processes. In Sub-Saharan Africa, including Zambia, lecturers in higher education institutions have had to leverage the most cost-effective and efficient EdTech resources to expand access to education during the pandemic.

The status of information and communications technologies (ICT) infrastructure and skills among educators in Zambia places the education system in a low EdTech resource category. A close examination of the ICT status of the country shows that Zambia's ICT status is not sophisticated [14, 15]. Zambia has a modest ICT infrastructure concentrated in urban centers [16–19]. The Ministry of General Education (MoGE) states that insufficient investment in ICT in education in Zambia is due to the general under-resourcing of the education system.

Regarding financial resources, Zambia's ICT for development strategy strongly depends on external donor funding. While educational institutions are happy to participate in externally funded projects, this area is of grave concern, as sustainability may be an issue going forward [17]. Nonetheless, Zambia has made significant strides on its path to digital transformation over the past few years. Progress is particularly evident in digital infrastructure, digital financial services, and digital platforms, while more significant gaps remain in digital skills and digital entrepreneurship [20]. MoNDP [21] indicates that Zambia's 7th National Development Plan (7NDP) aims to mainstream ICT in learning institutions. Also, the increasing rollout of competitive fiber to Africa and within African countries and greater penetration of wireless and mobile platforms have expanded opportunities for connectivity and broadband access, enabling lecturers and students in rural and urban areas to be in touch via online classes. From the perspective of minimalism, Zambia has basic ICT infrastructure in institutions of learning and minimal ICT skills among educators, which is essential to enable both learners and teachers to have meaningful engagement in a time of crisis such as the COVID-19 pandemic. The minimalist approach is explained in a section below.

Percy and Van Belle [22] believe that most online instructional resources are free for educators and learners without an associated need to pay royalties or license fees. However, the status of ICT in education and open educational resources (OER) is constrained by a lack of innovative strategies for online teaching. The William and Flora Hewlett Foundation states that OER are teaching, learning, and research materials in any medium – digital or otherwise (explicitly including both digital and non-digital resources) – that reside in the public domain and are released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restriction [23]. Any digitized educational resource requiring users to observe particular limits and regulations on use, revision and redistribution may not qualify as OER [24, 25]. This understanding of OER raises pedagogical problems of using technology to access materials in the public domain under open licenses such as the Creative Commons (CC). In this sense, OER is grounded in the well-established path of liberal education that seeks to improve the human condition [26, 27]. Nonetheless, in Africa, the use of education through liberal means for development remains problematic because schools, colleges and universities are still grappling with political ideologies and identity politics which make teaching and learning rigid [59].

To remain relevant and competitive during the COVID-19 pandemic, universities worldwide, especially those in developing countries, have had to adopt and adapt to technologies that were previously not a part of their teaching and learning process. In South Africa and India, moving from the traditional forms of teaching and learning saw an increase in the use of online alternatives such as Zoom, WhatsApp, Moodle, Blackboard, Microsoft Teams and emails for teaching and learning across all educational spaces [12, 28, 29]. The effectiveness of these technologies and their educational impact on the educational sector have been the concern of researchers. Research evidence in developing countries suggests that OER has significantly contributed to the survival of formal education in higher learning institutions during

the COVID-19 pandemic. Two years of the pandemic has attracted studies [10, 30–32] examining the challenges lecturers face in using different online instructional tools and resources. Keep among these is that educators lack online teaching methodological skills.

The identified challenges mentioned above of ICT in higher education merits the need to conduct research examining what innovations and strategies educators deploy in their teaching. Therefore, this current study aims to investigate strategies and innovations lecturers in higher learning institutions in developing countries like Zambia have used to ameliorate the challenges of teaching in an EdTech low-resourced university like the University of Zambia-UNZA. This study is essential because it points out how higher learning institutions in developing countries continue to respond to the COVID-19 pandemic in an EdTech low-resourced university. It further highlights the prospects of online instruction and the innovative measures that support the successful integration of technologies in teaching and learning. Without these insights, universities in developing countries may continue to lag and struggle with navigating online instruction in an EdTech low-resourced university in a crisis without making any positive strides towards improved online and blended teaching and learning.

Let us begin with a conceptual understanding of online instruction in the context of higher education. This paper is divided into three main sections. The first part gives a theoretical position of online instruction through minimalist lenses while reviewing key literature on the topic. The second section focuses on the methodological approach used in collecting, presenting and analyzing data for this study. In the third part, results are presented using a thematic approach as given by the participants. The final and fourth section discusses findings, which leads to a conclusion highlighting strategies and challenges of online teaching and learning in precarious situations during a public health crisis or pandemic.

Theorisation: Online Instruction Through a Minimalist Approach

Understanding Online Instruction Through a Minimalist Approach

A minimalist approach entails finding an essential possible starting point which includes adding components only as obligatory and circumventing as far as possible factors which would necessitate the agents to have abilities extra to those already essential [58]. This approach relates to this study because online instruction and learning are utilized here by looking at access to learning experiences via available technology. The minimalist approach is linked to this current study because the pandemic has enhanced distance learning which brings into question the issues of access to educational opportunities for learners described as nontraditional and disenfranchised [33]. Development, monitoring and evaluation programs have used the minimalist approach. Studies [38, 39, 59] have found that the minimalist approach has elements that determine administrative effectiveness and that this approach backs a range of complementary interventions. The implications that can be drawn from the previous studies for this current research are that minimalism is used in teaching and learning using online platforms with an awareness that it is susceptible to assumptions. Some propositions cannot be backed by empirical evidence when applying this approach to data. The justification of how the approach is used is explained in a section below.

The work by Akram [11] on online teaching shows the following fundamental principles: (1) asynchronous and synchronous learning, (2) learning that takes place through technology and shared documents, (3) interactions between the teachers and learners are through computer-technology media, (4) the teacher facilitates learning through live chats, videos chat, phone calls, emails and it entails several tools, resources, instructional methodologies, responsibilities, institutional framework, and modes of engagement facilitated by monitoring and guidance. Therefore, a minimalist approach used here differs from past studies in other fields such as business, psychology, linguistics and others areas, in that there are subtle differences in the definitions of e-learning, online learning, and distance learning when seen through a minimalist lens of these terms that are used interchangeably and rooted in distance education [33].

Online teaching and learning have undoubtedly become a solution to the disruption of educational systems amid the COVID-19 pandemic. Universities in developing countries had to operate with existing resources to effectively transform formal education into online education with the help of virtual classes and other pivotal online tools. Universities with low EdTech resources authorized faculty to move their courses online to remain relevant. Therefore, with minimal EdTech resources, universities in the third world remained relevant during the COVID-19 pandemic. Hence, the present study used a minimalist approach to distinguish joint actions from events involving multiple agents acting in parallel.

Minimalism in EdTech Low-Resourced Universities

Minimalism is based on constructivism, encouraging creativity and using available resources to function. The theory states that adult learners are not blank slates. They already have a wealth of experience and prior knowledge tucked away in their memory as invaluable assets [34]. Minimalism is all about finding the essentials in life. Minimalists' theories argue that online instruction should only include

that which provides significant and demonstrable benefits to a student's course [10, 35]. Instructors and learners do not require several sophisticated gadgets and software resources to have a successful online lesson but minimal essential ICT tools and software in the public domain.

Minimalism promotes using limited online resources and has proven to foster creative behavior. Consequently, lecturers and students can interact online with minimal instruction tools and resources. The intention is not to imply that the investment of resources is unnecessary. Instead, by adopting a minimalist approach, an institution can become more intentionally resourceful, seeking to achieve its goals with the resources it already possesses more than it seeks additional resources, which it assumes will improve online instruction [10].

The minimalist approach encourages and hopes to persuade lecturers and students to be intentionally resourceful by using what they already possess than seeking additional resources, which they assume will improve online teaching and learning. Therefore, in an EdTech low-resource environment like the University of Zambia, seeking more sophisticated technologies to improve teaching and learning during the COVID-19 pandemic may not be attainable due to competing needs, priorities and financial constraints. Thus, the focus should be on identifying available technologies that can deliver lessons using minimal online teaching and learning tools and resources.

Wolverton and Hollier [35] reason that three vital conditions should be present during online instruction. The first is the availability of a reliable internet connection, then the use of laptops and smartphones, and the last is specific software applications. These three components are essential for enabling communication between lecturers and students. For instance, in the presence of internet connectivity, laptops and smartphones are essential tools for lecturers and students to be in touch. Even though most students in developing countries cannot afford laptops, they join classes and access their course materials using smartphones [10, 36]. Even though some parts of Zambia have intermittent internet, other parts of the country have reliable internet services. The leading internet service providers include Airtel Zambia, Mobile Telephone Network-MTN, Zambia Telecommunications Company Limited ZAMTEL and Liquid Telecom. Through these service providers, lecturers and students stay in touch online. Mobile internet is easily accessible in Zambia because of lowered costs for mobile broadband data and the spread of cheap, easy-to-use internet-capable mobile handsets [37, 38].

Fast-growing COVID-19-related literature provides some helpful insight into minimalism in the face of the COVID-19 pandemic in EdTech low-resourced universities. Some practices and initiatives for mid and low-income countries could include: Using 'old' technologies (like radio and television) in new ways, sharing one device with lots of people, caching online content for offline use, promoting literacy and learning, and supporting teachers with mobile phones, using low-cost video to support peer learning, self-directed learning-SDL and support and developing content and tools locally [39–42]. Rahman, Jalil [43] show that to avoid leaving students behind, using a simple application like Google Meet, which everyone can access for free, is the best option. Another study has shown that Moodle is one of the effective platforms used where students have shown a positive impression [44]. Similarly, Pal and Vanijja [28] adopted a survey among university students that measured the usability of Microsoft Teams as a reference platform using the Technology Acceptance Model (TAM). The study concludes that the effectiveness of these platforms is highly evident, especially in developing countries where perceived usability is highly evident.

Al-Maroof, Alshurideh [29] Found out that the effectiveness of online platforms largely depends on the ease of use, usefulness, perceived value, and enjoyment. Access to particular EdTech devices and platforms and the suitability of the systems to students and staff is a determinant of online teaching and learning success [45, 46]. These have a positive role in reducing fear and skepticism of using online platforms. Simply put, the perceived fear of using the online platform is reduced whenever students and teachers implement a technically sound, easy-to-use platform. Furthermore, when teachers and students enjoy using an online platform, this affects the communication process among teachers and students, resulting in better learning styles, efficient e-course material, and positive perception on behalf of students and ultimately improves the teaching and learning process.

Methods

The interpretivist worldview anchors this study. The approach endeavors to understand the subjects under study and to interpret what the subject is thinking or the meaning s/he is making of the context [47]. Its greatest strength is the wealth and depth of investigations and descriptions it yields [10]. This study uses an interpretivist approach to investigate innovations and strategies used by lecturers in higher education institutions in developing countries such as Zambia to address the challenges of teaching in an EdTech low-resource university. The interpretivist way of thinking enabled the researchers to study the subjects' (lecturers') experiences and actions in their natural environment (UNZA).

A qualitative approach and case study design were utilized. The researchers used the case study as their research method. Starman [48] elucidates that case studies are valuable in practice-oriented fields (such as education,

management, public administration, and social work). This research creates a holistic picture of the phenomena under study using the lived experiences of the lecturers at the University of Zambia as a case in point. A total of 21 purposively sampled participants from three faculties of the University of Zambia were recruited for this study. These include; the school of Education, the school of Humanities and the Social Sciences and the school of Health Sciences. Face-to-face interviews, phone interviews, and WhatsApp were used to collect data using an interview schedule. The data collection procedures were based on the availability and preferences of the participants. The benefit of using interview schedules is that they enable the researchers to collect the same information from each participant. The interviews enable the researchers to remain focused and in control of the interview [10, 49, 50].

Thematic analysis has been employed to analyze the data sets. Thematic analysis is a method for analyzing qualitative data that entails searching across a data set to identify, analyze, and report repeated patterns [51]. It is a method for describing data but also involves interpretation in selecting codes and constructing themes [52]. Thematic analysis is an appropriate and powerful method to use when seeking to understand a set of experiences, thoughts, or behaviors across a data set [53]. Using the recursive thematic analysis, the researchers generated three themes. First, online teaching devices and platforms used by lecturers in EdTech low-resourced Universities, second, lecturers' perceptions and experiences teaching online in an EdTech low-resourced University; and third, innovations and strategies of online teaching in an EdTech low-resourced university. The recursive analytical approach is flexible, allowing the researchers to deal with the data with elements of discourse analysis. The generated themes are supported by quotes and supplemented by descriptive statistics from the data. Unlike content or narrative analysis, the thematic approach made the researchers generate theory through a bottom-up data approach as given by participants.

Participants Characteristics Matrix

The participants' characteristic matrix Table 1. shows participants' number, gender, the generation of technology behaviors, age cohort, work experience and status of involvement in online instruction. A total of 21 participants participated in the interviews between January and April 2022. The study comprised ten females and eleven males. The generational differences in technology behaviors of the participants show that sixteen millennials and five Gen X took part in the study. Millennials are technologically literate

Table 1 Characteristics of Participants

Participant	Gender	Generation	Born	Current age	Work experience	Involved in online teaching
P1	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P2	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P3	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P4	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P5	Male	Gen X	1965–1980	42–57	Above 16 years	Yes
P6	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P7	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P8	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P9	Female	Gen X	1965–1980	42–57	Above 16 years	Yes
P10	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P11	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P12	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P13	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P14	Female	Gen X	1965–1980	42–57	Above 16 years	Yes
P15	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P16	Male	Millennials	1981–1996	26–41	Below 16 year	Yes
P17	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P18	Male	Gen X	1965–1980	42–57	Above 16 years	Yes
P19	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P20	Female	Millennials	1981–1996	26–41	Below 16 year	Yes
P21	Male	Gen X	1965–1980	42–57	Above 16 years	Yes

Note: Interviews conducted between January and April 2022

and savvy, as they have grown up and have been immersed in technology all their lives, constantly in contact with digital media, technologies and the internet. In contrast, Gen X individuals use technology for utilitarian purposes and information searches [54]. Both Millennials and Gen X are appropriate for a study on innovations and strategies used to teach online in an EdTech low-resourced university because both generations have the potential to be technologically literate and savvy. Table 1 shows that all participants selected for this study participated in online teaching at an EdTech low-resourced university.

Results

Online Teaching Devices and Platforms Used by Lecturers in EdTech Low-Resourced Universities

Lecturers combine onsite teaching and online teaching. Two years into the COVID-19 pandemic, lecturers in higher education institutions in Zambia have continued to teach online alongside the onsite classes. At the University of Zambia, blended learning, which until 2020 was "business unusual", has become the "new normal". On the question of available devices used by lecturers, the results show that all the lecturers interviewed used minimal personal devices to conduct the lessons. As shown in Table 2, the lecturers explicitly indicated that they used personal laptops and smartphones to engage and interact with their students. None of the lecturers interviewed used institutional devices to teach.

The results show that Lecturers do not use institutionally provided devices to conduct lessons but use personal devices to teach online. When commenting on the use of institutional devices versus personal devices, participant P3 commented:

> *Two years into the pandemic, many of us teaching staff have never been empowered with a desktop computer in our offices or laptops by the university management. What we have is based on what we can afford, so accessing or using online tools effectively depends on what we have. So, we use what we have.*

While results show that lecturers used personal devices to teach as opposed to institutional devices, the institutional devices were reported to be either outdated or not working at all. Participant P11 indicated that *"My laptop has been the most convenient gadget. I once used the phone as well. The institutional computers do not work. Most are outdated, and some are damaged. They have not been replaced in the longest time"*. Apart from using personal devices (laptops and Phones), evidence from the study indicated that institutional internet has usually been problematic to the extent that lecturers cannot rely on it for delivering online classes. As such, the lecturers have had to bear the cost of internet services to teach. Participant P2 indicated that:

> *UNZA internet is usually unreliable for online classes, so I use my internet."* Commenting on the same issue, participant P6 affirmed, "*I use my resources to deliver online classes at UNZA because the university management has not given us incentives and proper devices*

Table 2 Lecturers' experiences with online instruction two years into the pandemic

Experience with online instructional resources	Responses
Easy (1 out of 21participants)	It is easy to conduct online lessons challenges are encountered mainly by students. These include a lack of gadgets and finances for internet services to connect to class Helps with managing time Students give views during lessons without disruption It is efficient I easily navigate online devices and platforms It is very convenient Teaching without the need for physical presence
Mixed bag (7 out of 21 participants)	It has been exciting making the transition The online crash course helped but was not followed up with other training sessions Training is dependent on better-exposed colleagues and self-taught The university internet is unreliable, but the personal internet works despite being expensive Never empowered with gadgets provided by the institution, personal gadgets did the job
Challenging (13 out of 21 participants)	Students from rural areas have challenges with internet connectivity. In my class of 90 students, only 19 were able to connect Teaching using own data is demotivating Limited financial resources Limited knowledge of the use of online platforms such as Moodle and Astria No knowledge in terms of pedagogy and methods of teaching online Challenging to keep students engaged Students' participation is low Students absenteeism remains high

to deliver online classes even though we are expected to teach online." Similarly, participant P19 stated, "*I use my phone for a hotspot when institutional internet fails and my laptop for projecting and teaching.*

From the results presented, the lecturers continued using personal laptops, phones and internet connectivity to deliver the lessons online. While laptops are commonly used to deliver online classes, mobile phones are also used because they are portable and used in the most challenging circumstances. Results in a study by Goundar [55] showed that, according to the International Telecommunication Union (ITU, 2010), the share of total mobile subscriptions in the developing world increased by one-fifth between 2005 and 2010 at 73%. In Africa, penetration rates were projected to reach an estimated 41% at the end of 2010 (compared to 76% globally), leaving a significant potential for growth. The evidence further shows that mobile devices are a leading technology to watch for in the near future.

The results show that in a university without sophisticated EdTech resources, lecturers use available personal resources such as laptops and Mobile phones to deliver lessons. Moreover, the market has various mobile devices, operating systems, applications and accessories –all with different capabilities, against a backdrop of issues relating to communication coverage, infrastructure and equipment, bandwidth and usage costs. The comprehensive access feature of mobile devices and the great opportunity represented by the modern applications it offers in learning, regardless of place and time, make mobile learning essential tools for lifelong learning during the pandemic [57].

Further findings indicate that lecturers in EdTech low-resourced universities primarily rely on OER platforms and a few none free platforms, such as Astria, to teach online. The commonly used platforms, in this case, are free Zoom Sessions, Google Meet, Moodle, Astria and WhatsApp.

The participants indicated that they use Zoom sessions, Google Meet and WhatsApp the most, followed by moodle and Astria for those teaching postgraduate students and students that enrolled under the distance mode of delivery even before the COVID-19 pandemic. Evidence shows that Zoom and Google Meet are used for synchronous learning Fig. 1.

All twenty-one participants indicated that they alternate between using Zoom and Google Meet. The use of Zoom and Google meet at a particular time depend on different factors such as students' preferences, internet connectivity issues and several activities that can be done with students while online on the free plans. Providing reasons for the use of Zoom, participant P18 indicated that.

I use Zoom because it is convenient for most students, and we can do several activities on the free plan, such as breakout rooms. All students can access it easily, even without having an account. They also find it easy to download our lesson recordings which they use after the synchronous lessons.

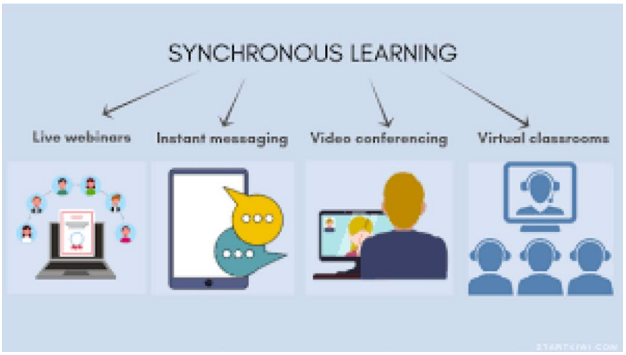

Fig. 1 Image of Synchronous Learning Environment. Source https://taketwotechnologies.com/synchronous-learning/

In contrast to the use of Zoom, evidence from the results shows that sometimes lecturers use Google Meet, especially students that have Gmail accounts. Google Meet's free plan does not have a 40-min limit for free sessions like Zoom. However, only users of google services benefit more from using Google Meet, without which its use is impossible. Comparing Zoom and Google meet for teaching and learning, Dagher [56] argues that when trying to decide between Google Meet or Zoom for classes or training sessions, Zoom is preferred by most. Zoom's free plan offers breakout rooms, meeting recordings, a whiteboard and a higher capacity for participants. Google Meet only provides breakout rooms, meeting recordings, and a whiteboard with paid plans. Zoom is a tool geared toward education as it offers education plans which support a minimum of 20 hosts and up to 149 hosts, with each host having the ability to hold unlimited meetings with up to 300 attendees.

The findings have established that lecturers in EdTech low-resourced universities mainly use Zoom and Google Meet for synchronous classes. However, evidence shows that most gravitate towards using Zoom due to its easy accessibility and ease of use by both lecturers and students. Coupled with the use of Zoom and Google Meet, evidence from the study shows that two years into the pandemic, lecturers have embraced course management systems (CMS) such as Moodle. However, results show that Moodle is chiefly used to post course content such as handouts, power points, articles and books. The full potential of the CMS is yet to be utilized by both lecturers and students. Commenting on the use of Moodle, participant P15 indicated that:

I also uploaded a few materials on Moodle. However, when you look at the interaction of students with materials on Moodle, it is very minimal. Some students do not even access their materials on Moodle. So, I

use WhatsApp for sharing documents Like slides and handouts.

Beyond posting course material on Moodle, few lecturers use its other features, such as setting tests, quizzes and discussions. Findings further show that WhatsApp is an easy and fast way for lecturers to communicate with students. In the case of a small class of up eight students', synchronous classes are delivered using the video feature of WhatsApp. Some participants indicated that besides posting announcements, course notes and assignments are posted through the WhatsApp platform. To exemplify the preceding statement, participant P1 stated:

I use Moodle, WhatsApp and Zoom. WhatsApp is used for sharing documents, it is fast in information sharing, and most students have resorted to using their phones for studying because they cannot afford laptops. The use of Zoom and perhaps Google Meet is good. The visual aspect of it is good. I communicate in real-time and create a simulated virtual classroom experience.

Results show that two years into the COVID-19 pandemic, universities in developing countries like Zambia have made significant strides towards blended learning. Lecturers combine traditional onsite teaching with online learning amidst challenges associated with teaching in an EdTech low-resourced university. In universities with few EdTech resources, online teaching and blended learning are possible using lecturers' laptops, mobile smartphones and footing internet costs. On the other hand, OER platforms and resources are significant resources to the survival of higher education in developing countries during the COVID-19 world pandemic. The participants indicated that using personal devices and resources is not by design but because the government and university management has not provided online teaching resources.

Lecturers' Perceptions and Experiences Teaching Online in an EdTech Low-Resourced University

Lecturers shared their perceptions about delivering classes online two years into the COVID-19 pandemic. Despite being worried, shocked, and pressured at the onset of the COVID-19 pandemic, their attitudes have changed. Most had negative attitudes towards online teaching without proper EdTech resources to support the modality. Although lecturers have accepted the reality of teaching online, they are not complacent about teaching online in an EdTech low-resourced university. The participants perceived that to survive and remain competitive as a university, online instruction during COVID-19 and beyond is inevitable. They further perceived that orientation, preparation and discovery are prerequisites for the effective and efficient implementation of online lessons. Results further show that even though classroom management has been complicated and sometimes catastrophic, improvement can be detected. The participants also indicated that with stakeholder support from the government, the university management and donor agencies, the provision of essential ICT devices necessitates effective and efficient online instruction of the twenty-one participants, Table 2. One perceived online instruction as easy, seven as a mixed bag (exciting, sometimes easy but challenging), and thirteen indicated that online instruction in an EdTech low-resourced environment is challenging. The lecturers also gave reasons for their perceptions towards the online instructional resources. Summaries of participants' responses are highlighted in Table 2. below.

Findings in Table 3. further show that participants' experiences and perceptions towards online instructional resources related to the advantages and disadvantages of each online teaching platform and resource.

On experiences and perceptions of lecturers towards using online instructional resources, results demonstrate that the experience has been challenging for the most part. However, despite the difficulties encountered, the lecturers innovate and use strategies that enable them to continue delivering online lessons.

Innovations and Strategies of Online Teaching in an EdTech Low-Resourced University

The findings show that despite the challenges of online teaching, lecturers have managed to conduct online classes and continue to do so in an EdTech low-resource University. The main innovations and strategies indicated in Figs. 2 and 3 demonstrate what is used to mitigate the challenges of online instruction. The themes include Lecturer-oriented innovations and strategies, Lesson-oriented innovations and strategies, resource-oriented innovations and strategies and student-oriented innovations and strategies. These innovations and strategies are not mutually exclusive and, thus, should be considered holistically.

Lecturer-Oriented Innovations and Strategies

Lecturers must self-train and, sometimes rely on colleagues better versed in EdTech to conduct classes. Participants highlighted innovations and strategies driven by the individual lecturers' orientation. Participant P5 mentioned the following:

The training about online teaching, use of moodle and other online platforms and resources organized by management was hastily conducted. After the training, I could barely remember much. So, I

Table 3 Advantages and disadvantages of using Zoom and Google Meet

Online teaching platform	Advantages	Disadvantages
Zoom	Synchronous classes Classes can are recorded and shared with students All students can have access without having an account Variety of learning styles Efficient Accessibility of time/space The free plan offers different features	The institution does not pay for subscriptions The free session only lasts 40 min Some students do not reconnect after the free session elapses
Google Meet	Synchronous classes Classes are recorded Affordable The free plan has no time limit Variety of learning styles Efficient Accessibility of time/ space The free plan allows up to 250 participants	Only Lecturers and students with Gmail have access The free plan has basic features. There are no breakout rooms
Moodle	Convenient for posting course material Convenient for giving tests	Some features are not user friendly The institutional network did not work well with this platform Most students are inactive on Moodle
Astria	Convenient for posting course material Convenient for giving tests	Only used by distance students and postgraduate students. It is not available for regular students at UNZA
WhatsApp	Easily accessible to students of different economic status Appropriate for simple discussions	Video conferencing is limited to 8 people Not appropriate for complex discussions Managing the chats can be challenging

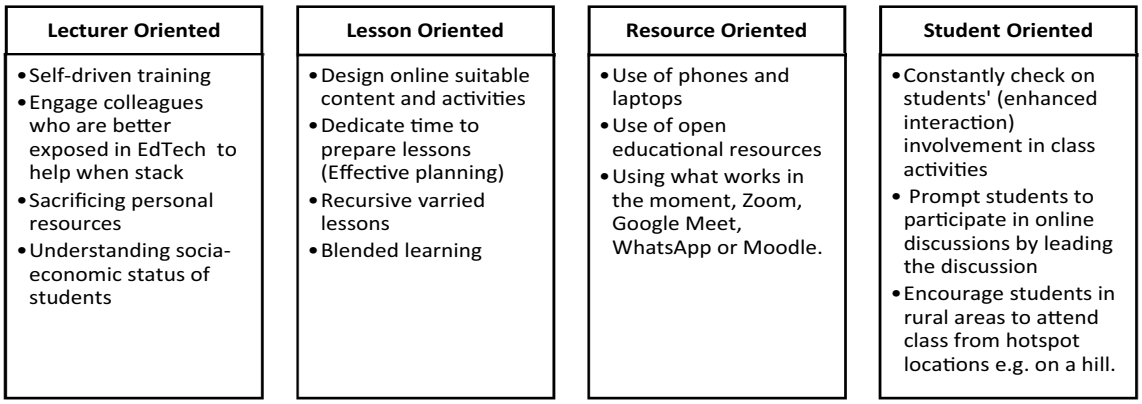

Fig. 2 Innovations and Strategies lecturers use to mitigate online teaching challenges

devoted time to self-training and engaged colleagues better exposed to education technologies.

Another standard innovation and strategy among the participants, as seen in Fig. 2. is the need to sacrifice personal resources for online lessons. Resources sacrificed include time, finances and devices. A further critical finding relating to the success of online classes in an EdTech low-resourced university is the need to understand students' social and economic status. The dynamic nature of the student populace (rural, peri-urban and urban based) enables lecturers to schedule classes and use platforms that are favorable for most students.

Lesson-Oriented Innovations and Strategies

Results from the lecturer's lived experiences show that in an EdTech low-resourced university, blended learning (the use of online and onsite modalities) works better. Exclusively relying on online classes may not produce the desired results. Also, participants indicated that ample time must

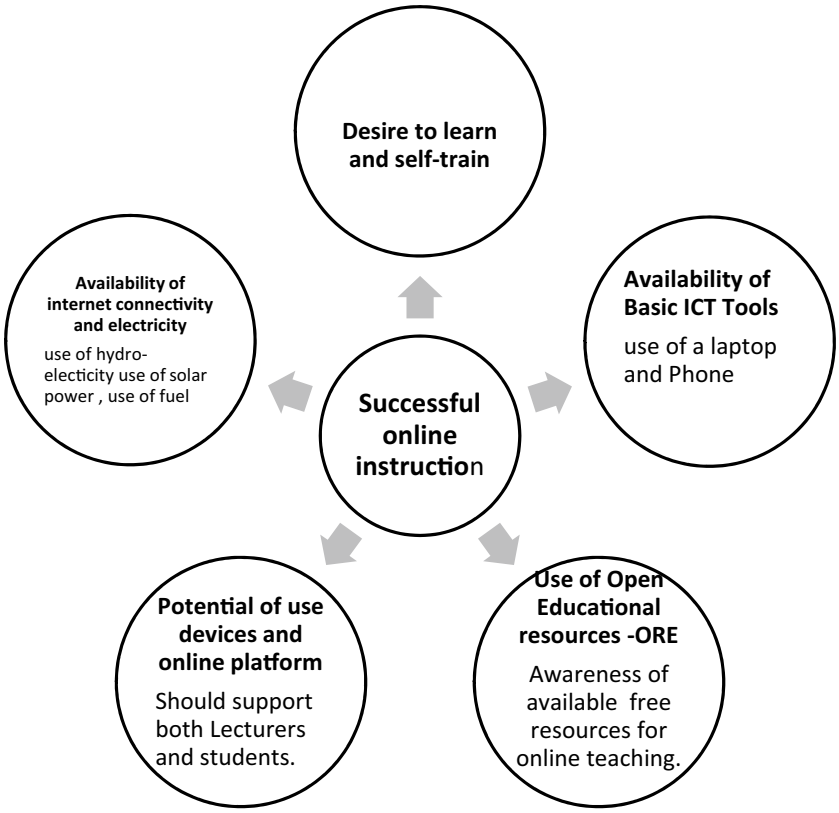

Fig. 3 Main components that support online instruction in an EdTech-challenged environment

be spent designing the lesson content and delivery. Lecturers ought to include points of student engagement and collaboration in the planning. The lessons should be suitable for online engagement. Apart from recording the lessons in some instances, lecturers engage in recursive instruction to accommodate absent students.

Resource-Oriented Innovations and Strategies

Successful delivery of online classes in an EdTech low-resourced university entails using what works best at a particular time. Participants illustrated that dependence on one gadget or online teaching platforms during teaching does not always produce optimal learning results. Lecturers can sometimes change devices (laptop to phone or vice versa) and platforms (google meet to zoom) during a lesson for optimal learning results. To illustrate this further, participant P7 commented;

> *Most students cannot afford laptops and computers; thus, they have resorted to using their phones for studying. The students' behaviors of constantly staring at their phones is an interesting phenomenon because staring at their phones means they are studying. After all, that is the only way for some of them to access the course content easily.*

The other strategy is using OER, which is usable and accessible to lecturers and students. Lecturers encourage students to navigate the internet to access resources in the public domain and relevant to their studies.

Student-Oriented Innovations and Strategies

The study's findings revealed that the student is at the center of every online teaching decision made by the lecturer. Lecturers always have to consider what online resources are easy-to-use and accessible to the students—lack of student consideration results in students' lack of participation and absenteeism during classes. Furthermore, lectures indicated that constant engagement with students enhances students' participation. The fastest way to engage and involve students in EdTech low-resourced universities is via the WhatsApp messaging system. Participant P9 indicated that:

> *If you want quick access to students, use the WhatsApp messaging system. While some students do not have laptops, almost every student I teach has a smartphone. They use it for logging into class and accessing course material and announcements via WhatsApp.*

For students in rural and peri-urban areas that experience intermittent internet connectivity, lecturers engage and encourage them to attend classes from hot spot locations. To exemplify this, participant P17 mentioned *that I wait*

for a student who can only access the class from a hilltop. I encourage the students to do so each time we have a scheduled class. Figure 3. below gives a condensed version of the innovations and strategies lecturers use to teach online in an EdTech low-resourced University.

Findings demonstrate that for an online lesson to be successful in an EdTech low-resourced university, the following basics should be available: the lecturer's desire to learn and self-train, availability of essential ICT tools and resources such as a laptop and smartphone, Lecturers should be aware of OER at their disposal, the ICT tools should be user friendly for lecturers and students, and finally, there should be internet connectivity and electricity (hydro-electricity, solar or fuel).

A Question of Transferability

Considering all the findings, it becomes crucial to reflect on the generalizability of these findings or how transferable they are concerning other education technology (EdTech) low-resourced Universities. The study's findings, though focused on Zambia, do rather easily reflect the situation and experience of other countries with similar characteristics. From the lack of access to institutionally sourced equipment and the concomitant lack of technical support to the internet access challenges, other resource-poor countries are likely to show similar findings because of these shared challenges. The Zambian case presented in this paper is a mere indication of the many digital and learning inequalities that are prevalent in many countries in the Global South. While the benefits of EdTech are significant, they are less appreciated in places where the digital divide is far-reaching and structurally entrenched. However, it must be acknowledged that different countries have their idiosyncrasies that would make this debate and overall experience more complex and nuanced. Sadly, as Beaunoyer, Dupéré [57] have observed, COVID-19 has exacerbated an escalation in digital inequalities even more.

Discussion

The current paper studied the innovations and strategies used to teach online in an EdTech low-resource university two years into the COVID-19 pandemic. While keeping the minimalist theoretical perspective at the base, the researchers provide innovations and strategies lecturers in an EdTech low-resourced university use to teach online. The qualitative case study identified the most preferred ICT devices used by both lecturers and students, the preferred online platforms used to teach online, and the innovations and strategies used to mitigate challenges experienced when teaching online in an EdTech low-resourced University. The study casts new insights on online teaching during the COVID-19 pandemic using perspectives from the global south.

Online Teaching Devices and Platforms Used by Lecturers in an EdTech Low-Resourced University

Empirical evidence in Table 1. above shows laptops and smartphones as devices commonly used by lecturers to deliver online lessons in an EdTech low-resourced university during the COVID-19 pandemic. Zambia's general ICT uptake can be seen from using mobile phones, computers, televisions and radios [14]. Yonazi, Kelly [15] suggests that it is crucial first to harness devices that teachers and learners already own. The proliferation of smart mobile phones has meant that more learners have access to ICT devices than ever before, offering opportunities in terms of sustainability and scalability. This way, more students are enabled to join online classes successfully. During the COVID-19 pandemic, laptops and smartphones have been primary devices for lecturers and students in EdTech low-resourced African universities to stay in touch and engage meaningfully during online lessons [10]. In education systems with low EdTech resources, online teaching and learning should only provide significant and demonstrable benefits to students [10, 35].

In minimalism, a limited amount of online resources has the potential to foster creativity amongst lecturers and students [10, 35]. One persistent challenge for educational policymakers and planners related to the potential use of ICT in low-income communities is that most products, services, usage models, expertise, and research related to ICT use in education come from high-income contexts and environments [39]. As such, studies conducted in EdTech low-resource environments help guide the planning and implementation of educational technology initiatives in such environments.

The COVID-19 pandemic has significantly changed the education system around the world from traditional in-class lessons to blended learning. Two stakeholders, particularly lecturers and students, work in tandem to successfully experience and utilize online teaching and learning resources. To be relevant and competitive, EdTech low-resourced universities and colleges, through initiatives of lecturers, use essential devices, as shown in Table 1. and OER resources, as stated earlier, to conduct online lessons. This study casts light on OER (free Zoom plan, Google Meet, WhatsApp and Moodle) as platforms lecturers use to teach online in an EdTech low-resourced university. A similar study conducted by Al-Maroof, Alshurideh [29] demonstrates that online platforms such as Google Meet have been highly evaluated as helpful since they are easy-to-use. Lecturers could harness several other OER to enhance their teaching experience, such as Microsoft Teams [28]. Teachers generally find OER flexible, can

easily be used for student engagement in the classroom and an excellent supplement to existing traditional curriculum [27]. The widespread use of OER in EdTech low-resourced universities is due to accessibility, availability and affordability merits. The best technology is the one you already have, know how to use, and can afford [39]. OER is a relatively new concept used pragmatically. Apart from being accessible and affordable to stakeholders in education institutions OER could be visualized as a part of a larger trend towards openness and globalization in higher education [24, 25]. Despite its limitations, lecturers unanimously agreed that their desire to make online classes happen, and the efforts of better vested colleagues in technological innovations in teaching, enabled them to teach via, Zoom, Google Meet, Moodle and WhatsApp.

Lecturers' Perceptions and Experiences Teaching Online in an EdTech Low-Resourced University

Two years into the COVID-19 pandemic, lecturers' perceptions and experiences towards delivering online lessons are a mixed bag but an opportunity to be EdTech literate, as shown in Table 3. While lecturers' experience with using Zoom, Google Meet, WhatsApp and Moodle is a mixed bag, all the participants in this study can now comfortably use their laptops and smartphones to engage online with their students successfully. Over the last two years, Lecturers have gained some confidence in using EdTech devices and platforms, leading to increased usability of available EdTech resources. Acceptance of technology is closely related to the perceived value of its benefits, especially the technical usefulness, enjoyment and higher perception of usability leads to adopting EdTech resources [29, 46]. Bekelea [7] argues that if students and faculty have dependable access to an ample variety of technologies and internet connections, then that should have a favorable impact on the how, when, where, and even what of learning.

The emergency of COVID-19 pandemic has stimulated lecturers' EdTech skills despite operating in EdTech low-resourced universities. However, support from governments, university management and donor agencies are needed to provide online teaching devices, internet connectivity and continuous development EdTech program. Notwithstanding the challenges, substantial development of Internet infrastructure and connectivity, institutional support for both lectures and students and wiliness to harness available open educational resources can play a decisive role in improving and sustaining online instruction in African universities [7, 10, 24]. The world, including the African Union, its member countries and universities, consider technology as one of the strategic pillars for catalyzing significant institutional and societal transformations [7].

Innovations and Strategies of Online Teaching in an EdTech Low-Resourced University

The study has shown that the challenges of online teaching and using online tools and resources are mitigated from four different fronts. These innovations and strategies are lecturer-oriented, lesson-oriented, resources oriented and student-oriented. So, for an online lesson to take off in an EdTech low-resource environment, the lecturers should mutually consider these innovations and strategies. To mitigate the challenge of training glitches, rather than waiting on the institutions to organize training, lecturers have resorted to self-driven training and the engagement of colleagues better exposed to EdTech knowledge. This way, lecturers overcome the challenges and difficulties encountered with the online tools and resources without waiting for the institution to organize training.

A similar study conducted by Wang, Xiong [41] considered whether culture or self-directed learning amongst students drives online performance? Findings established that self-directed learning-SDL abilities predict learning performance. The commonly understood concept of SDL incorporates several vital skills. For instance, the learner needs to choose learning materials, set learning goals and rank them in order of priority, assess their progress and achievements, cope with challenges and practice self-discipline [40]. Similarly, the current study shows that lecturers have had to decide on what online tools and resources to use, set knowledge goals and assessed their progress over the two years of the pandemic and learnt to cope with the challenges of online instruction.

Several studies have shown that the use of personal gadgets and internet broadband amongst academics in African universities is standard. Besides dedicating time to self-driven learning of online devices and resources, the study also establishes that lecturers have used personal resources to conduct online lessons and have understood their students' various social and economic circumstances. Without using their resources to teach, online learning would have been more catastrophic than it currently is. du Plessis, Jansen van Vuuren [2] state that worldwide faculties in different learning institutions are compelled to identify and implement various strategies that contribute to sustaining the academic project.

This study has further established that other strategies pertain to lesson preparation and presentation, the resources used and the student's welfare. Lecturers indicated that, among other issues, they are steadily learning to design suitable online content and activities, engage in effective lesson planning, and use blended learning. Online education is not just an oral presentation by lecturers on the computer/laptop/mobile phone, and it is not just listening at the other end by a student [45]. It requires effective designing

and preparation of the lessons by the lecturers, even in an EdTech low-resource environment. Online tutors need three things to succeed and reach greater levels of expertise: preparation, discipline and procedural coherence [9]. In terms of available resources, the study confirms the findings by Naik, Deshpande [45] that the secret to success in the online teaching–learning process is that the system has to be accessible for both students and staff.

Finally, this study casts light on the central issues that lecturers in an EdTech low-resource environment should consider to conduct online lessons. The lecturers should have the desire to learn the ropes of online instruction. For a lesson to take off, lecturers and students should have virtual devices like laptops and phones. The lecturers should know the open educational resources available and harness them to enhance their teaching experience.

Conclusion

In this paper, we have discussed that to be relevant as higher learning institutions operating in low-resourced EdTech environments, using minimal and basic ICT devices and platforms in the form of OER is imperative. The available minimal EdTech resources catalyze the creativity of both lecturers and students. The most common and available EdTech resources in universities in developing countries are lecturers' devices such as laptops and smartphones. Also, lecturers and students in low-resourced EdTech universities rely on OER, such as free Zoom plan, Google Meet, Moodle and WhatsApp. The study has established that lecturers in EdTech low-resource environment are fully aware of the possible challenges online instructions offers. The study has also demonstrated that lecturers have devised coping strategies that enable them to teach amidst the struggles of online teaching. The strategies are lecturer-oriented, lesson-oriented, resource-oriented and student-oriented. Using these strategies helps mitigate the challenges of online teaching and learning and further enables learning to take place. These strategies are not mutually exclusive and thus should be dealt with as such. According to Yonazi, Kelly [15], the future development of Africa and its participation in the knowledge society will be significantly influenced by how Africa delivers quality education to its citizens. The importance of this study is that it offers solutions on how higher learning institutions can cope and successfully offer an online lesson amid challenges, therefore, continuing with the education agenda with little or no disruption during a crisis such as the COVID-19 pandemic. The study concludes that innovation in teaching and learning entails not only high-tech educational technologies but the use of what best works for a community of learners in a particular context.

The study recommends that universities continually provide institutional-based training to lecturers on emerging developments in EdTech to ensure effective and quality university education for the students. Further, higher learning institutions must equitably provide the necessary EdTech devices, software and other tools to lecturers to enhance the online teaching experience. External support – such as import duty exemptions or corporate sponsorships and donations—should be sought to enable universities and colleges to facilitate learning. For further research, the study recommends an examination of lecturers' awareness and use of various open educational resources apart from Zoom, Google Meet, WhatsApp, and Moodle.

Despite the insightful contribution this study makes to the use of online innovations and strategies for online teaching using GERs, especially for universities in low-income countries, this study is not devoid of limitations that are mainly methodological. This study was largely qualitative and might be limited in generalizing its findings and implications. However, depending on the setting of universities, the theoretical contribution made here can be applied in different country contexts.

Also, COVID-19 restrictions made fieldwork of face-to-face interviews hard. The method of data collection, which involved online interviews such as WhatsApp calls, was limited in terms of follow-up questions and probing responses for more in-depth information on issues raised by participants.

Data availability The raw data used in this study is available upon request from the corresponding author. Due to privacy concerns, the data has been de-identified to protect the confidentiality of the participants. The data has been organized in clear and consistent themes. We have taken appropriate measures to ensure the security and privacy of the data, and all requests for data access will be reviewed on a case-by-case basis.

Declarations

Conflict of Interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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