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Review article

Review on the use of eLearning in teacher education during the coronavirus disease (COVID-19) pandemic in Africa

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ABSTRACT

This study explored the use of eLearning in teacher education during COVID-19 in Africa. The literature review was an important source of information for this study and employed a historical design. From the review, the findings indicate that eLearning accommodates all people regardless of their geographical background and enhances learner-centeredness and self-study opportunities. Findings also indicate that it enhances access to updated content for students and is cost-effective as opposed to conventional methods that need the presence of the teacher, buildings, teaching and learning materials, and physical libraries. However, the findings indicate that eLearning faces the challenges such as health-related problems because of excessive use of computers for a long time which may result in low vision. Findings also indicate the challenge of the digital divide and a lack of stable Internet services and connectivity as they are rarely accessed in many teacher colleges and universities including, a lack of availability of computers for students in African countries. Further, the findings indicate the other challenge of eLearning based on its vulnerability to online attacks on the websites that may lead to questioning the quality of education provided through the eLearning model. The key argument in this study is that eLearning will remain an unavoidable option for the provision of teacher education in the world and African countries in particular at the threshold of a global pandemic similar to COVID-19 regardless of the risks involved. African Governments need to invest in digital learning by strengthening Internet connectivity and improving the Information, Communication, and Technology (ICT) infrastructure, i.e., the provision of computers and Televisions (TVs) to educational institutions to sustain students' learning during pandemics similar to COVID-19 and other unpredictable situations.

1. Introduction

The world has witnessed an alarming spread of the Coronavirus Disease (COVID-19) pandemic within a short time (World Health Organization [WHO], 86). COVID-19 has claimed many lives of people in the world since its first occurrence in 2019 in China, and the pandemic grew quickly from its first emergence to a truly, global phenomenon [62]. It threatens the survival of educational systems all over the world [16,27]. COVID-19 has created and imposed unique challenges that impede education provision [62]. Thus, the use of eLearning has received censurable support in educational systems, especially during COVID-19, because it is believed to sustain the students' learning when both teachers and students are separated in time and space [16,27,74,84]. Africa receives special interest

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regarding the eLearning because while at least every country has been impacted by this pandemic differently, it was initially anticipated that African countries would be more vulnerable to the COVID-19 pandemic and severely affected due to the poor economy and a lack of the copying strategies such as health infrastructure, professional doctors, and technology [16,64,78]. However, countries that experienced a high rate of cases and deaths during the COVID-19 pandemic, although they have stable and well-established health systems are; the United States of America (USA), the United Kingdom (UK), France, Germany, India, Italy, and many other western countries [4,13,70,84]. Almost every sector of human life, including education, has been affected by this life-threatening COVID-19 pandemic.

In many countries in the world, schools and other educational institutions were closed for a substantial amount of time [44,61]. Thus, countries of the world have to re-think their educational systems for the survival of the educational systems and teacher education programs during terrible times similar to the COVID-19 pandemic. Nevertheless, the increased intensity of the COVID-19 pandemic requires countries to prioritize their investment in ZOOM, Google meetings, and digital tools for the classes to take place regularly [60]. eLearning is global, unlimited, and open to the public, and it presents a new learning environment for students to succeed in their studies [24,29].

Indeed, during the pandemic, it is where educational systems have to be reformed, instead of relying on traditional ways especially the face-to-face and paper and pencil methods of teaching when offering teacher education. Governments of the world have to re-think the alternative ways including employing eLearning in their programs. As observed by Dorovolomo et al. [27], Górska [39], and Renes [74], eLearning plays a significant role in widening access to education and the enrolment of students. The Internet has become one of the vital ways to ensure the availability of materials for both research and students' learning [11,78]. To sustain teacher education during pandemics similar to COVID-19, eLearning has been thought to be the best alternative, including other development sectors, through knowledge sharing with students and their teachers [64]. As pandemics similar to COVID-19 tend to destabilize the normal timetable for teaching and learning, it leads to registration delays for the students, and ultimately denies preparation of teachers who are the special group that prepares the future generation [17,56,64].

The literature on the use of eLearning in education during the COVID-19 pandemic has been abundant. See, for example, Abdelfattah et al. [3], Adeoye et al. [4], Agarwal et al. [5], Barron et al. [15], Coman [22], Dorovolomo et al. [27], Elumalai et al. [32], Favale et al. [33], Flores and Gago [34], Georgiadou et al. [36], Heng and Sol [42], Ingram [43], Lavonen and Salmela-Aro [53], Liang [52], Mwakyusa and Ng'webeya [61], Mukhtar et al. [56], Murphy [60], Nikou et al. [67], Suru and Matete [79], Tan and Chua [80] and Zhang et al. [86]. Many developed countries use ICT such as ZOOM, Skype, Google groups, Google meetings, and other eLearning programs, especially when the students and their teachers are separated in time and space during the COVID-19 pandemic and in similar situations [5,27,34,53,86]. Most of these studies, however, have concentrated in developed countries. The studies by Mwakyusa and Ng'webeya [61] and Ndibalema [66] in Tanzania concentrated on the constraints of the transition to online distance learning, response, and the applicability of eLearning in Higher Learning Institutions [HLIs]. Adeoye et al. [4]'s study in Nigeria focused on COVID-19 and eLearning in Tertiary Education (TE), and that of Suru and Matete [79] in Tanzania was concerned with the equitable eLearning in Higher Education Institutions (HEIs) during the pandemic beyond Covid-2019. Kibuku et al. [46]'s review study in Kenya focused on challenges faced by eLearning in universities, and that of Baker et al. [14] and Kisanga [47] in Tanzania concentrated on eLearning for teacher training and the promotion of students' involvement in eLearning policies respectively. The latter three studies, however, were conducted before the COVID-19 pandemic outbreak.

In developing countries, the literature on the use of eLearning in teacher education during COVID-19 is scanty, and the application of advanced facilities to ensure that teacher education is smoothly offered has been a challenge, unlike in the developed world [39,50,57]. Nevertheless, the strategies and measures undertaken by the most developed world to counterbalance the effects of the COVID-19 pandemic may not necessarily be suitable for the developing countries context due to the level of the economy, the expenses involved, and the lack of computers and Internet connectivity [12,16,39,43,64]. African countries may opt for local eLearning that suits their environment, such as Radio and Television (TV) programs. This study explored the use of eLearning in teacher education during the COVID-19 pandemic in Africa. The main research question was: Why do teacher education institutions in Africa need to employ eLearning as an alternative to conventional face-to-face delivery of learning during COVID-19 and in similar situations? Teacher education here relates to the education offered to train individuals to become teachers in both universities and teachers' colleges. It should be noted that not all universities provide teacher education.

1.1. The meaning of eLearning

eLearning is conceptualized in different ways by different individuals because people have different lenses when viewing a phenomenon. Chitra and Raj [24], [p. 11], for example, define eLearning as "the intentional use of networked information and communication technology in teaching and learning". According to Arkorful and Abaidoo [11], [p. 398], eLearning can also be regarded as "the use of information and communication technologies to enable […] access to online learning/teaching resources". According to Dorovolomo et al. [27], [p. 88], eLearning can be viewed as "the use international use of networked information and communication technology in teaching and learning". A simple definition of eLearning is given by Goyal [40], [p. 240], who defines eLearning as "the science of learning without using paper printed instructional material". In this paper, eLearning can be regarded as a science and system in which the flow of information takes place through communication technology under various networks to enable the students to access the learning resources in an online form instead of printed materials or hard copies.

2. Combating the COVID-19 pandemic worldwide and in Africa

The COVID-19 pandemic and a world health challenge have received considerable efforts to control its further spread worldwide. Up to the present time, there is no known full medical treatment and vaccines to fight against this alarmingly killer pandemic. The challenge is likely to be more serious for African countries because of a lack of health facilities and doctors [12,16,43,57]. However, some people in both developed and developing countries do not accept the COVID-19 vaccines because the coronavirus changes over time with different variants and names such as Alpha, Delta, and Omicron [20,53,84]. Some have even also argued why they should take the vaccines while they are not immune to being infected after being vaccinated [21,35,49].

Various strategies have been initiated so far to control the spread of the COVID-19 killer pandemic. Many countries have been using clinical guidelines for the preventive purpose of the pandemic against further contamination of their people. Some strategies include the educational systems closure, hand-wash, lockdown, social distancing, self-isolation, and quarantine [22,26,62,63,69]. However, some of these measures have been irrelevant to African countries such as the issues related to lockdowns and quarantine. Schleicher [76], states that the school closures and lockdowns as a response to the COVID-19 pandemic interrupted conventional schooling in most Organization for Economic Cooperation and Development (OECD) countries, and students were to rely more on the Internet, TVs, or Radio to continue learning. For African countries, it might be worse because the citizens cannot afford to remain in their homes for two or three days as the majority are poor and they do not have savings and the storage of food that can sustain them during the lockdown or quarantine moments. Kenya and Uganda, however, closed their schools for a long time, where Uganda closed its schools for almost two years and it was the most affected by the pandemic in the East African countries [65]. African countries have to opt for strategies that tend to be relevant to their contexts and economic levels i.e., educating people to strengthen the body's immunity through proper diet uptake, having daily related health exercises and games that reduce the chance of being at risk, educational institution closure, practicing hand-washing as routine behavior and social distancing to avoid COVID-19 virus contamination.

To fight against the COVID-19 pandemic, the Tanzanian government and that of Kenya, Nigeria. Rwanda and Uganda closed all primary and secondary schools and universities in March 2020 to prevent students and teachers from being affected by the killer COVID-19 pandemic in schools and communities in its totality [62,65,69,81]. Normal activities of the universities and schools including the teachers' colleges were generally halted, and the course instructors were not supposed to undertake face-to-face or conventional classroom teaching which had some impact on students' learning. This suggests a need for an eLearning model to protect teacher education and students and at the same time, stabilize the education system at the time of crisis and similar pandemics outbreaks such as the COVID-19 pandemic. It is, thus, important that the governments in Africa consider employing eLearning in teacher education to sustain the continuity of the studies for the registered students.

3. Types of eLearning

There are different types of eLearning. In this paper, only three main types are considered. These are; text-driven, interactive, and simulation.

3.1. Text-driven eLearning

Text-driven eLearning is simple, and it includes texts, graphics, audio, and test questions [24]. Some examples of text-driven eLearning could be language teaching and grammar [7]. Students can be given the text for them to read or given the audio to listen to it carefully and answer the given questions and sometimes being given the text. They can work on the given assignments at their own time, although it is equally important that the instructor provides the time limit for the students to accomplish the tasks.

3.2. Interactive eLearning

This is similar to text-driven, except that in this interactive eLearning, the concentration has been on the interactive components that enhance learning [24]. As observed by Chitra and Raj, the greater use of visuals such as graphics, charts, and diagrams is more likely to have interactive components for learning. According to Maton and Kervin (2008), as cited in Pradono et al. [72], [p. 46], those people born between the years 1980 and 1994, are characterized as the '*digital native's generation*' as they are familiar with and rely on the Information and Communication Technology (ICT).

3.3. Simulation

Simulation involves the creation of "a model which imitates the behaviors of interest; experimenting with the model to generate observations of these behaviors […] and attempting to understand, summarize, and/or generalize these behaviors" [83], (p. 2). In other words, it is the imitation of the operation of a real-world process or an operating system of a model [55]. As observed by Chitra and Raj [24], eLearning employs graphics, videos, audio, and gasification using 3D components and is highly interactive. According to Chitra and Raj, training people on how to use new software can be a good example of a course with a high degree of interactivity and simulations for student-teachers.

4. Conceptual framework for effective use of eLearning in teacher education in Africa

For eLearning to be implemented in teacher education effectively, various strategies need to be considered. These include; strengthening power supply, strengthening Internet services, strengthening eLearning policies in education, provision of computers, TVs, and Radios in teacher education colleges, and provision of the in-service training. The double-directional arrows indicate the relationship that exists among the components (Fig. 1).

4.1. Strengthening power supply

If teacher education has to implement eLearning programs, it needs a stable power supply [4]. eLearning takes place in an environment that has consistent availability of power. However, power supply has been a lamented issue in most African countries [64,78]. African countries experience frequent cut off of power, and some households do not have electrical power at all. In Tanzania, for example, power cut has been an experience that affects many activities including academic writing.

4.2. Strengthening Internet services

The use of eLearning requires stable Internet services for students to download the given tasks and assignments and sending back to the instructor [11]. The study by Suru and Matete [79] on equitable eLearning in Higher Education Institutions (HEIs) in Tanzania revealed that both instructors and students hesitated to use eLearning services because of a lack of Internet accessibility. The study by Lestiyanawati and Widyantoro [52] in Indonesia also found that there was an inadequacy of school infrastructure to support eLearning, and students faced difficulty accessing Internet services.

4.3. Strengthening eLearning policies

If eLearning has to be employed in teacher education, the African governments have to strengthen their eLearning policies that will foster and enhance an acceptance of this model of delivery in educational systems. Not only that but also governments in the region need to commit their resources to strengthen the digital tools that in turn are likely to facilitate the use of eLearning in the educational system and teacher education in particular.

4.4. Provision of training both for instructors and students

For teachers and students to use eLearning in teacher education, they need training on how to use eLearning in teaching [64,77]. For this to be in place, then there is a need to ensure the availability of power supply and Internet connectivity.

4.5. Provision of computers, TVs and radios in teacher education

For teacher education in Africa to employ eLearning as a model of teaching and learning, it requires the provision of computers, TVs, and Radios. However, experience indicates that in Africa, such types of equipment are lacking [64,79].

5. Methodological issues

The study was based on the literature review as the main source of the information and it was carried out qualitatively using historical design. Literature review allowed the collection of huge information both at the international and national levels. The literature review study enabled the collection of information on what has been taking place in different countries since the occurrence of this life-threatening COVID-19 pandemic in China. The literature review gave information on the trend of the pandemic all over the world and how countries' economy has been affected. It was also possible to learn about the leading countries that have been heavily hit by this killer pandemic and what have been the efforts to combat it all over the world. The literature review further gave

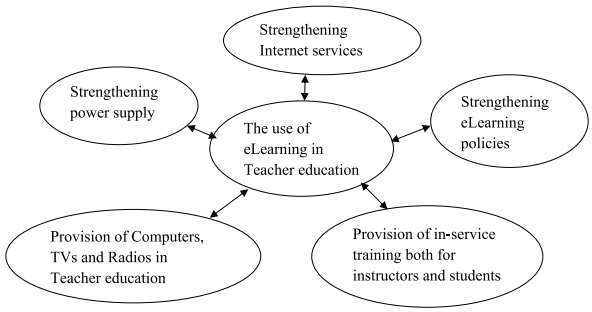

Fig. 1. Conceptual framework for effective use of eLearning in teacher education in developing countries.

information on how different countries of the world have been able to sustain their educational systems during the pandemic. eLearning and teacher education were the units of analysis in this study. The findings that come from qualitative studies, however, are not generalized, although COVID-19 is a global problem with varying degrees of occurrence. Yet, some contextual problems that face Tanzania as a country about eLearning and COVID-19 may not necessarily be the case in the developed world and other African countries. Problems that face the country are context-specific as far as its culture and level of economy are concerned. For example, issues related to lack of Internet connectivity and computers for most teachers' colleges and schools might not be the case for developed countries although some African countries such as Rwanda have a one laptop per child policy [59].

5.1. Validity and methods of data collection

Validity of the study can be achieved by the trustworthiness of the findings, the use of triangulation of the methods of data collection, and the sources of the data matters to improve the quality of collected findings [18,28,70]. However, this study employed solely the literature reviews as the main source of the information to inform the findings. Historical studies and designs are also acceptable in the field of research. Since COVID-19 is a recent problem, data for this study, were collected from empirical studies conducted from 2020 to 2022. Although the developed world has been using eLearning for centuries such as the USA, UK, Japan, and other European countries, to cement what we were saying in the discussion of the findings, we had to include even the articles that have been published even before the pandemic. Indeed, the use of literature reviews as a method of data collection grounded the investigation of the issue in question and gave a worldview picture of what is studied based on different contexts and backgrounds. Through the literature survey, it was possible to discern the knowledge gap so that the study could contribute to the learning society and how countries need to sustain teacher education during the COVID-19 pandemic and similar situations in the near future.

5.2. Document reviewed

The first step in the literature search was scoping the review. The searching process started by developing explicit criteria for specifying the studies to be included in the review process for the findings. The inclusion/exclusion criteria were as indicated in Table 1.

The initial search resulted in 89 articles. After examining them against the inclusion/exclusion criteria, 20 articles were included in the study (Fig. 2).

The second step was searching for the documents to be reviewed. These include academic journals, international reports such as that of WHO, empirical studies, editorial words, individual papers, dissertations, government policies, and other COVID-19 and eLearning-related materials. Data collected from the reviewed literature provided important information that could have been obtained through questionnaires or interviews and they gave international data and contextual information relevant to this study. Searching through prescribed set of search terms was carried out from various scientific databases to obtain articles related to eLearning in teacher education in Africa. The key terms used to search the articles were; eLearning, eLearning and teacher education, teacher education, eLearning and teacher education, eLearning during COVID-19 in the developing countries and eLearning and teacher education during COVID 19 in Africa. The articles were searched from four scientific databases such as, Google scholar, Scopus, Google search engine and science direct. Other materials were obtained through the Internet and some by hand search in the library. Both soft and hard copies from different countries were useful in the collection of the data to inform the findings of this study. Information on the COVID-19 pandemic was collected from empirical studies carried out in both developed and developing countries. Documents and the related information collected are indicated in Table 2.

Some surveyed literature, however, was old and some were used for a specific context. Since COVID-19 has been a global phenomenon, and eLearning has been mostly thought to be the only alternative when students and their instructors' interaction has been restricted, they were extracted based on their relevance to the issue under investigation. Sometimes, some data were specific to individual countries, and how they managed to run their educational programs, and some were very short with only three pages, and there were just for knowledge sharing. However, it was important to sort out and screen the sources of information to obtain the contextual meaning and enhance the coherence of ideas. It was also necessary to survey as many documents as possible to get relevant data and cross-check and scrutinize them to ensure that they suited the study context to communicate the findings from the informed

Table 1
Inclusion/Exclusion criteria.

S/N	Inclusion	Exclusion
1	Articles related to eLearning/online education/distance learning and must include COVID-19 pandemic.	• Articles on eLearning but not talk about COVID-19. • Articles written in languages other than English. • Not empirical or primary research • Articles published before 2020 were excluded even if they had important information for this literature review study.
2	Articles related to teacher education	
3	Articles published during COVID-19 from 2020 to 2022.	
4	Empirical studies and literature review papers.	
5	Articles published in reputable journals.	
6	Articles written in English language.	

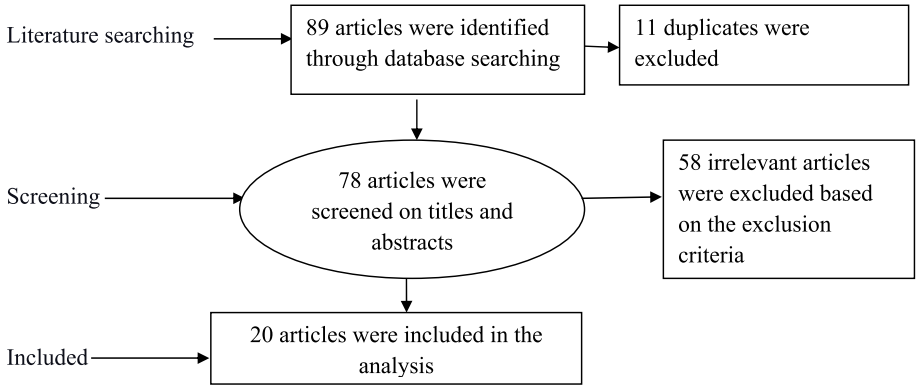

Fig. 2. Flow chart of systematic literature review.

Table 2
Documents reviewed.

S/N	Documents	Type of information collected
1	Academic journal papers	• Background information • Altitudes towards COVID-19 vaccination • Online teaching • Types on eLearning • Online/eLearning experience • Data on why sustaining human resources • Rationales for eLearning • Challenges of eLearning • Global/regional efforts towards COVID-19 pandemic
2	World Health Organization (WHO)	• Countries mostly affected by the COVID-19 pandemic • Status and trends of the COVID-19 pandemic
3	Institutional reports	• Status of pandemic • Pandemic control
4	Books	• Research methodology
5	Media reports	• Reasons for refusing COVID-19 vaccines • Pandemic control mechanisms

data.

5.3. Data analysis and ethical considerations

Data were organized by using themes and sub-themes based on emerging themes from the literature. This was done by coding their resemblance and relevance to the issue under discussion. All themes and sub-themes provided in this study were coded as interpreted by the authors based on the research objective. The final analysis was based on only imperial research on eLearning during the COVID-19 pandemic. Nevertheless, the acknowledgment and verification of the sources of information were equally imperative to avoid plagiarism, adhere to ethical issues, and enhance the trustworthiness of the findings. All the surveyed literature was listed in the reference list to appreciate the authors' potential contribution to the eLearning field and teacher education, the ever-learning society, and knowledge sharing.

Table 3
Rationales of eLearning.

S/N	Source	Rationales
1	Agarwal et al. [5], Alqahtani and Rajkhan [9], Elumalai et al. [32], Murphy [60] and Tan and Chua [80].	Enhancing the self-study opportunity
2	Elumalai et al. [32] and Heng and Sol [42].	Open access to learning materials
3	Murphy [60] and Mukhtar et al. [58].	eLearning is cost-effective
4	Dorovolomo et al. [27], Favale et al. [34] and Yikici et al. [85].	Enhancing the student-centeredness educational system

6. Findings

6.1. Rationales of eLearning in teacher education

The findings are based on the review of the existing studies published in the area of eLearning during the COVID-19 pandemic outbreak. In this literature review paper, only four reasons for adapting eLearning during COVID-19 are provided. These include: eLearning allows self-study for students, open access to learning materials, eLearning is cost-effective and eLearning is a student-centered educational system (Table 3).

6.1.1. Enhancing the self-study opportunity to the students of all geographical background

eLearning gives an opportunity to students to discuss their problems and solve them by cooperating when charting [5,9,12,32] as they can use their WhatsApp groups, Twitter, Instagram, Face book through Internet technology and mobile smart phones in discussing their academic matters and come up with a some solutions with a common understanding [32,48]. According to Murphy [60], a face-to-face class is a security threat for the pandemic to spread to the students and thus, eLearning is an ideal choice. However, in African countries and the developing world, specifically in Sub-Saharan countries, access to computers and Internet services has been reported to be an obstacle to the provision of eLearning to students [64, 78]. According to Asio et al. [12], for teacher education to take place through eLearning in times of pandemics similar to COVID-19, it needs Internet connectivity all the time, which for this part of the world is lacking.

6.1.2. Enhancing the open access to the updated content and learning materials

Since the Internet is globally accessed, although some problems in African countries, students may have access to learning materials that can be downloaded from the Internet when doing their assignments [32,42,58]. eLearning enables quick delivery of the lessons to the students compared to the traditional classroom teaching methods [73]. eLearning does not require a presence of a teacher and learners at the same time and place [58]. It can also be accessible to full-time and part-time students, and they can access learning from any location, and users can interact with online content at their own time and pace [73].

6.1.3. eLearning is cost-effective for education provision

Students in teacher education colleges can access learning materials that could be purchased at a high cost and do not need transport costs or accommodation [58,60]. A teacher can reach as many students as possible with minimal cost. It enables the students to learn without meeting with their teachers in the face-to-face mode of delivery of the learning materials [58]. It has been possible for people in developing countries to access updated materials for the improvement of teaching and learning, and it terminates the necessity of space and time for learning purposes [73]. As observed by Murphy [60], teacher education has to opt for online studies as social distancing has been a health requirement for avoiding coronavirus contamination and transmission among people. There is also no need for learners to travel or buildings [11]. Many countries across Europe have taken massive school closures as a necessary measure to safeguard their people and limit the disruption of the pandemic towards humankind's survival and opted for distance learning and online learning in primary and secondary schools [77]. Since Africa severely lacks trained teachers, eLearning is likely to facilitate access to education by a large number of students by blending both on-campus, and eLearning as a single teacher is more likely to reach a large number of students at the same time [37].

6.1.4. Enhancing the student-centeredness educational system

eLearning enables the students to learn at their own pace and styles, and it widens their understanding as they learn a lot from the Internet and by sharing with their fellow students. Social or physical distancing has helped to reduce interpersonal contact and to minimize the pandemic community transmission [27,33,85]. The empowerment of using digital technologies and web-based or Internet enhances learner-centered learning that helps the learners to receive individualized support, and it is self-spacing as the student can study at his/her own pace and speed whether quickly or slowly [11,51]. eLearning helps the students display independence and resilience spirit in learning and gain experience in using technological tools for their learning such as through Zoom or administering online examinations [27]. As observed by Rawashdeh et al. [73] and Favale et al. [33] eLearning offers flexibility and increased collaboration between students and teachers, and it is for self-paced learning.

Table 4
Challenges facing eLearning.

S/N	Source of information	Challenges
1	Agarwal et al. [5] Elumalai et al. [32], Lavonen and Salmela-Aro [53].	The need for training of teachers and students
2	Agarwal et al. [5], Dorovolomo et al. [27], Flores and Gago [34].	eLearning leads to health problems
3	Adeoye et al. [4], Aini et al. [8], Ingram [43], Mwakyusa and Ng'webeya [61], Ndibalema [66] Nikou et al. [67], Suru and Matete [79].	Digital divide in Africa
	Abbasi et al. [1] and Heng and Sol [42].	Online attacks or cyberbullying on eLearning

6.2. Challenges of eLearning

Some challenges that face the implementation of teacher education through eLearning in both developed and developing countries include that teachers need intensive training on eLearning, eLearning leads to health problems, issues related to the digital divide in African countries, and cyberbullying and website attacks (Table 4).

6.2.1. Teachers of eLearning and students need training

For teachers to be able to employ eLearning in teaching the students, they need serious in-service training in ICT for them to have virtual classrooms as an alternative way of learning during COVID-19 [4,32,54]. According to Algahtani and Rsjkhsn [9], the support given to teachers and students from the management on the use of technology creates awareness of the use of eLearning. Students as well have to be oriented on eLearning if they are to take advantage of eLearning. eLearning requires the establishment of virtue interaction and techniques including the availability of computers and TVs and Internet connectivity [32,48] which in developing countries are missing. As observed by Rawashdeh et al. [73], eLearning needs self-discipline and higher self-responsibility. Learners who lack self-regulation and organization may not be able to attend to their assigned tasks and can even submit the assignment late and delay the accomplishment process of their studies. Thus, training for them to succeed in their learning remains necessary.

6.2.2. eLearning leads to health-related problems

To succeed in eLearning, one needs to use the computers several times and sometimes use them intensively which results in poor vision [5,27,34]. According to Agarwal et al. [5], eLearning leads to mental illness because of self-isolation and poor academic performance which may result in anxiety and depression among students. Agarwal et al. also state that eLearning affects eyes and neck muscles leading to deteriorated physical health. The Centers for Disease Control [23] recommends someone avoid the excessive use of computers to stand against the effects on people's vision. However, eLearning plays an important role in knowledge spreading among different people during pandemics similar to COVID-19 [27]. As stated earlier, in African countries, teacher education can use TVs and Radio programs as alternative and user-friendly online learning to minimize the excessive use of computers and the effects of health problems related to poor vision.

6.2.3. The digital divide in African countries

African countries face a digital divide problem. Many instructors and their students do not have personal computers, and Internet connectivity is a serious problem [4,43,61,66,69,79]. Schools and teacher education colleges lack stable online services because of a lack of computers to accommodate all students that are connected to the Internet. Studies by Cristia et al. [25] in countries such as the USA, Uruguay, Peru, and Mexico indicate that they have adopted a-one laptop per child policy for a long time, and it helps them in offering eLearning smoothly to their students. African nations and poor countries mostly tend to lack access to eLearning materials because of a lack of Internet connectivity services and face poor power supply in their schools, universities, and teachers' colleges [64, 78].

A recent study by Suru and Matete [79] in Tanzania revealed that both instructors and students were not ready to shift to the eLearning model of course delivery because of a lack of power supply and Internet connectivity in Higher Education Institutions (HEIs). According to this study, lack of ICT infrastructure affected eLearning acceptance in HEIs, and it was more likely to create inequality in accessing information in HEIs in rural areas. The review study by Ndibalema [68] on developing countries revealed the existence of digital inequalities, lack of access to the reliable Internet, and low technological competence and readiness for both instructors and students. Innocent and Masue [44] also found that there was inadequate and limited applicability of eLearning in Tanzania because of negative attitudes, lack of skills among the instructors and students, and insufficient ICT infrastructure in HEIs. The findings in the same study also revealed that most students faced social-emotional challenges due to the rapid and blind transition to online distance learning. Mwakyusa and Ng'webeya [61] also found that there was limited use of eLearning in HEIs in Tanzania.

The study by Baker et al. [14] again in Tanzania revealed a lack of well-qualified teachers so that they could employ eLearning in their instructions to their students. Kisanga's [47] study in Tanzania indicated that teachers used teacher-students and students-content strategies in teaching, which were ineffective for students' learning. Universities in developed countries and particularly teachers' education institutions are always equipped and fully furnished with Internet connectivity services and the online learning materials can be outsourced from external libraries from all over the world. It is good, however, to learn as reported by Munyantore and Mabalire [59] that Rwanda has also adopted the one laptop per child policy in their educational system. Rwanda again has the advantage of having low population rates. The estimates indicate that it has about only 13 million populations of people by 2022, while Tanzania's mainland was projected to have a population of more than 65 million people in the same year, where 10.6 million pupils were estimated to be enrolled in primary schools pre-primary education pupils being excluded. Rwanda had only 5 million enrolments of primary school pupils by 2020 [59,75,82].

6.2.4. Online attacks or cyberbullying on eLearning

Cyberbullying or online attacks are also a big challenge that faces eLearning in different countries [1,42]. Online programs may be attacked and the quality of the examinations offered through online studies may leak which brings the question of the authenticity of eLearning for teacher education [2,6,42]. According to Edwards [31], Internet usage increases the risks on online content insecurity and exposes learners to illegal materials. As observed by Khan et al. [48], there is an increased cyber security threat as people continue working and interacting online while working from home. Online attacks on websites are likely to raise the question of the quality of the graduates from teacher education colleges that have effects on the type of people that are required in the labor market economy

place [2]. If teacher education colleges and universities are not well equipped to safeguard against cyberbullying in their institutions and are not strong in cybersecurity the online examinations can be hacked and be at stake [48]. Educational stakeholders and parents may start questioning the quality of teachers prepared through online or eLearning model and their competence to meet the challenges facing them in the dynamic world that change every day and is being accepted in the competitive labor market economy across the countries and the cross border job opportunities.

7. Discussion of the findings

As can be seen from the findings, it indicates that eLearning plays a great role in accommodating all people from all backgrounds, enhances learner-centeredness and self-study opportunities. The findings also indicate that eLearning facilitates access to the updated content for students and appears to be cost-effective compared to conventional methods that always require the presence of the teacher, infrastructures such as classrooms, physical libraries, and availability of teaching and learning materials. These findings are in line with what has been stated by Agarwal et al. [5], Alqahtani and Rajkhan [9], Asio et al. [12], Elumalai et al. [32], Khan et al. [48], Murphy [59] and Tan and Chua [80], that eLearning is for self-study and does not need physical infrastructures, and it does not disrupt teaching and learning. The findings again confirm what Dorovolomo et al. [27], Favale et al. [33], and Yikici et al. [85], revealed in their studies that eLearning enhances learner-centeredness and it is for self-pacing for students to study in their own space and speed. In addition, Dorovolomo et al. [27] also state that eLearning helps students work independently and facilitates a resilience spirit among them. This is so because, as observed by Tan and Chua [80], students may access learning materials by downloading them from the Internet, although sometimes accessing the service is somehow a challenge. Indeed, as observed by Mondal and Roy [56] and Mwiya et al. [64], eLearning can help the preparation of the human capital needed for future generations. Thus, as argued by Gunga and Ricketts [37], African countries need eLearning to facilitate access to education given a large number of students while trained teachers are lacking. Further, as indicated by Sivalingam et al. [77], for teachers to use eLearning and virtue classrooms, they need in-service ICT training which is, in most cases, problematic in African countries. It requires the countries to have a strong economy with proper plans, which as well are missing in most developing countries [16].

The findings further indicate that eLearning faces the challenges of increased health problems, such as low vision due to excessive use of computers as observed by Agarwal et al. [5], Dorovolomo et al. [27], and Flores and Gago [34]. It is important, therefore, that people use computers with caution by having some time intervals and using protective gear such as glasses to reduce the amount of light coming from the computers. Because of the poor economy, African countries may opt for TVs and Radios as an alternative to computers and use some gadgets that protect the eyes. The findings also indicate the challenges of the digital divide and connectivity as stable Internet services are rarely accessed in many teachers' colleges and universities in African countries, including the lack of computers for all students that hinder the utilization of eLearning. These findings are the same as that of Mwakyusa and Ng'webeya [61] in Tanzania, who found that a lack of computers hindered the effective use of eLearning in HEIs. The findings are also in line with that of Adeoye et al. [4] in Nigeria, who found that tertiary education faced the challenge of irregular power supply, high Internet subscription costs, and poor Internet connectivity.

Pokhrel and Chhetri [71] in their literature review study on the impact of the COVID-19 pandemic on teaching and learning in HEIs revealed that Internet bandwidth was relatively low and data packages were costly in many developing countries which resulted in inadequate Internet accessibility. Coman et al. [22] also found that teachers lacked technical skills, and their teaching style was improperly adapted to the online environment, students lacked interaction with teachers, and there was poor communication with them. Aini et al. [8] on other hand found that students faced the challenge of a lack of Internet connectivity and self-regulation for learning, and teachers faced the challenge of competence in issues related to eLearning and isolation. The findings further indicate another challenge related to an online website attack that makes education offered through eLearning questionable. According to Abed [2], people may lack trust in the education provided through eLearning, something which is dangerous in the world labor economy place. Thus, as suggested by Khan et al. [48] and Edwards [31], it is important, therefore, to have strong cyber-security and control online examinations to maintain the credibility of education or teacher education offered through eLearning.

Regardless of all these problems, however, as it has been stated by Murphy [60], face-to-face classes threaten the students' security during the COVID-19 pandemic and as observed by Hamad et al. [41], since we live in an age of informatics featured by rapid development and changes resulted from the scientific and technological processes in the 21st century, the use of eLearning is a necessary evil. As observed by Edelhauser and Lupu-Dima [30], the Internet is inconceivable in the 21st century education system because human beings are subjected to technological transformation. Carrillo and Flores [19] state that educational institutions should quickly adopt remote teaching to respond to the impacts and survive in pandemics similar to COVID-19 rather than face-to-face sessions. According to Aljaber's [10] historical overview analysis of the development and evolution of eLearning in Saudi Arabia, the adoption of distance learning and eLearning across HEIs safeguards the country's education systems and economy. Thus, governments of African countries whether they like it or not, have to opt for eLearning to sustain teacher education in the region. The challenge of the digital divide also needs some concerted efforts from governments. They need investment in education by providing computers to schools, teachers' colleges, and universities. As stated by Cristia et al. [25], the USA, Uruguay, Peru, and Mexico have invested in a one-laptop per-child policy for facilitating eLearning. Although African countries have poor economies, they should prioritize and proportionally increase the budget for education. According to Munyantore and Mabalire [59], the Rwanda Ministry of Education implemented a one-laptop policy for their pupils/students in 2019, although it is one of the African countries.

This implies that African countries have to learn from Rwanda and other parts of the world and invest in education and teacher education if they have to survive during pandemics similar to COVID-19 in the future. However, the students' population in Rwanda is low, although commitment to education is needed if countries are to ensure that teacher education continues. As observed by Block

et al. [17], Mondal and Roy [56], and Mwiya et al. [64], teacher education is the very one that prepares the future generation for countries. It is also equally imperative to safeguard the cyber security of the eLearning and online examinations if the quality and standards have to be maintained in the provision of teacher education as it is argued by Abed [2] and Gupta and Anad [38]. However, this does not mean that people should abandon face-to-face teaching and learning, especially when there are no pandemic threats. As observed by Kaur et al. [45], online learning may be effective but not superior to conventional classroom teaching. Lepp et al. [51], give caution that although eLearning is a learner-centered approach, it may increase inequalities and be difficult for learners from disadvantaged population segments. Kaur et al. [45] also conclude that eLearning can supplement teaching and learning, but it cannot be a substitute for well-established educational systems. As observed by Tan and Chua [80], however, while the COVID-19 pandemic has been an unfortunate occurrence, some silver lessons are drawn from it because the pandemic accelerates a shift in the mode of learning, where many educational institutions have to consider hybrid teaching and learning for the future. Thus, as suggested by Heng and Sol [42], blended learning that combines face-to-face and online learning is equally important.

8. Conclusion and implications

This literature-based study explored the use of eLearning in teacher education during the COVID-19 pandemic in Africa. The findings indicate that eLearning accommodates all learners regardless of their geographical background and enhances learner-centeredness and self-study opportunities. The findings also indicate that eLearning enhances access to updated content for students and is cost-effective as opposed to conventional or face-to-face methods that need the presence of the teacher, buildings, teaching and learning materials, and physical libraries. However, the literature indicates that eLearning faces the challenges such as health-related problems because of excessive use of computers for a long time which may result in low vision. Findings also indicate that eLearning faces challenges related to the digital divide and a lack of stable Internet connectivity in many teachers' colleges and schools include; the lack of availability of computers for all students in African countries. Further, the findings indicate that eLearning faces the challenge of its vulnerability to online attacks on the websites and that people may question the quality of education provided through this model of education delivery. For teachers to use eLearning for their students, however, they need intensive in-service training on the use of ICT. The other implication is that cyber security is required if teacher education is to safeguard the quality of its graduates. It is equally important that the African Governments increase their education budgets to facilitate eLearning in teacher education. They also need to provide computers that are connected to Internet services and ensure that rural teachers' colleges and universities are provided with TVs and Radios to prepare the country for any unexpected killer pandemics beyond COVID-19.

As the literature has indicated that China has sustained its education system and economy through digital learning during the COVID-19 pandemic, it implies that countries of the world have to learn from the Chinese. Otherwise, if other countries are not careful, China may control the world economy because when they close their educational systems, China's economic business continues as usual. However, some other developed countries such as the USA, UK, Germany, Japan, France, Norway, Sweden, South Africa, and other western countries have traditions of employing eLearning in their educational systems. It is important, therefore, that African countries learn from these countries' educational systems. They can also learn from Rwanda which has invested heavily in education by ensuring that every pupil/student has a laptop although it is one of the African countries. However, it may be difficult for countries with high population rates, although they can relatively improve the budget for education and provide TVs and Radios to teachers' education institutions and universities in both rural and urban areas. If African countries do not adopt eLearning or digital technology in their educational systems, specifically in teacher education, their economy may collapse. This is so because education, and teacher education, in particular, has been acknowledged to prepare the human capital of nations all over the world which in turn, tends to have a spillover effect on countries' socio-economic, scientific, and technological development. Indeed, eLearning in teacher education will remain imperative if countries' educational systems are to be sustained at the threshold of the related killer and life-threatening pandemics similar to COVID-19 and beyond.

9. Limitations of the study

Some of the literature included in this paper is outdated because eLearning has been in place before the COVID-19 outbreak. The discussion section involves some empirical studies on eLearning undertaken before COVID-19 to give evidence for the arguments, especially on issues related to laptops and eLearning in the developed world.

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References

[1] S. Abbasi, T. Ayoob, A. Malik, S.I. Memon, Perceptions of students regarding eLearning during Covid-19 at a private medical college, Pak. J. Med. Sci. (2020), https://doi.org/10.12669/pjms.36.COVID19-S4.2766.
[2] E. Abed, Electronic learning and its benefits in education, Eurasia J. Math. Sci. Technol. Educ. 15 (3) (2019) 1–8.
[3] F. Abdelfattah, N.Y.A. Mashaikhya, K.A. Dahleez, A Systematic Review of eLearning Systems Adoption before and during the COVID-19, Global Knowl., Memory Commun. (2022), https://doi.org/10.1108/GKMC-02-2022-0033.
[4] I.A.1 Adeoye, A.F.Z. Adanikin, A. Adanikin, COVID-19 and eLearning: Nigeria tertiary education system experience, Int. J. Res. Innov. Appl. Sci. (IJRIAS) 5 (5) (2020) 2454–6194. https://www.researchgate.net/publication/341574880.
[5] A. Agarwal, S. Sharma, V. Kumar, M. Manjit Kaur, Effect of E-learning on public health and environment during COVID-19 lockdown, Big Data Min. Anal. 4 (2) (2021) 104–115, https://doi.org/10.26599/BDMA.2020.9020014.
[6] R.O. Andrade, I. Ortiz-Garcés, M. CazaresCybersecurity, Attack on smart home during COVID-19 pandemic, in: IEEE, Fourth World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4), 2020, pp. 398–404.
[7] H.I.R. Agustien, Implementing a text-based approach in English language teaching, in: Universitas Nasional Karangturi Semarang, TEFLIN Publication Division, Indonesia, 2020.
[8] Q. Aini, P.O.H. Putra, M. Budiarto, U. Rahardja, Exploring eLearning challenges during the global COVID-19 pandemic: a review, J. Sist. Inf. (J. Inf. Syst.) 16 (2) (2020) 57–65.
[9] A.Y. Alqahtani, A.A. Rajkhan, eLearning critical success factors during the COVID-19 pandemic: a comprehensive analysis of eLearning managerial perspectives, Educ. Sci. 10 (216) (2020) 1–16, https://doi.org/10.3390/educsci10090216.
[10] A. Aljaber, eLearning policy in Saudi Arabia: challenges and successes, Res. Comput. Int. Educ. 13 (1) (2018) 176–194, https://doi.org/10.1177/1745499918764147.
[11] V. Arkorful, N. Abaidoo, The role of eLearning, the advantages and disadvantages of its adoption in higher education, Int. J. Educ. Res. 2 (2014) 397–410.
[12] J. Asio', E. Gadia, E. Abarintos, D. Paguio, B. Melner, Internet connection and learning device availability of college students: basis for institutionalizing flexible learning in the new normal, Stud. Human. Educ. 2 (1) (2021) 56–69, https://doi.org/10.48185/she.v2i1.224.
[13] B. Aylward, W. Liang, Report of the WHO-China joint mission on corona virus disease 2019 (COVID-19), in: The WHO-China Joint Mission on Corona Virus Disease 2019, 2019, 2020, pp. 16–24. https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf.
[14] D. Baker, A. Bliss, R. Chung, C. Reynolds, eLearning for Teacher Training in Tanzania: Policy, Players, Models and Recommendations for the Asante Africa Foundation, University of California, Berkeley, 2013. https://asanteafrica.org/wp-content/uploads/2016/12/E-Learning.-TZ-Teachers.2013.pdf.
[15] M. Barron, C. Cobo, A. Munoz-Najar, I.S. Ciarrusta, The Changing Role of Teachers and Technologies amidst the COVID 19 Pandemic: Key Findings from a Cross-Country Study, Education for Global Development, 2021.
[16] R. Blundell, D.M. Costa, R. Joyce, X. Xu, COVID-19 and inequalities, Fisc. Stud. 41 (2) (2020) 291–319, https://doi.org/10.1111/1475-5890.12232.
[17] E. Block, A. Burt, T. Papa, L. Peterson, G. Stall, A. Theriot, An innovative approach to observational field experiences in higher education, Creativ. Educ. 3 (8) (2012) 1409–1418, https://doi.org/10.4236/ce.2012.38206.
[18] A. Bryman, Social Research Methods, second ed., Oxford, New York, 2004.
[19] C. Carrillo, M.A. Flores, COVID-19 and teacher education: a literature review of online teaching and learning practices, Eur. J. Teach. Educ. 43 (4) (2020) 466–487, https://doi.org/10.1080/02619768.2020.1821184.
[20] T. Chen, D. Wu, H. Chen, W. Yan, D. Yang, G. Chen, K. Ma, D. Xu, H. Yu, H. Wang, T. Wang, W. Guo, J. Chen, C. Ding, X. Zhang, J. Huang, M. Han, S. Li, X. Luo, Q. Ning, Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study, BMJ 1091 (2020) m109, https://doi.org/10.1136/bmj.m1091.
[21] M. Cordina, M. A Lauri, J. Lauri, Attitudes towards COVID-19 vaccination, vaccine hesitancy and intention to take the vaccine, Pharm. Pract. (2021), https://doi.org/10.18549/PharmPract.2021.1.2317.
[22] C.T. Coman, L.G. îru, L. Meses, an-Schmitz, C. Carmen, M.C. Bularca, Online teaching and learning in higher education during the coronavirus pandemic: students' perspective, Sustainability 12 (10367) (2020), https://doi.org/10.3390/su122410367.
[23] Centers for Disease Control and Prevention, Health, United States 2011: with Specific Feature on Socioeconomic Status and Health, Library Congress, Washington DC, 2011.
[24] A.P. Chitra, M.A. Raj, eLearning, J. Appl. Adv. Res. 3 (1) (2018) 11–13.
[25] J. Cristia, P. Ibarraran, S. Cueto, E. Severin, Technology and child development: evidence from the one laptop per child program, Am. Econ. J. Appl. Econ. 9 (3) (2017) 295–320, https://doi.org/10.1257/app.20150385.
[26] L. Domenico, G. Pullano, E. Chiara, C. Sabbatini, P. Pierre-Yves-Boëlle, V. Colizza, Impact of lockdown on COVID-19 epidemic in île-de-France and possible exit strategies, BMC Med. 18 (240) (2020), https://doi.org/10.1186/s12916-020-01698-4.
[27] J. Dorovolomo, P. Rodie, B. Fito'o, L. Rafiq, COVID-19 and online learning experiences of Solomon Islands students at the University of the South Pacific, Waikato J. Educ. 26 (2021) 88–102. https://wje.org.nz/index.php/WJE/article/view/768/683.
[28] M. Duffy, Methodological triangulation: a vehicle for merging quantitative and qualitative research methods, J. Nurs. Scholarsh. 19 (3) (2007) 130–133.
[29] S. Duggal, Factors Impacting Acceptance of E-Learning in India: Learners' Perspective, Management Development Institute, Gurgaon, India, 2022.
[30] E. Edelhauser, L. Lupu-Dima, Is Romania prepared for eLearning during the COVID-19 pandemic? Sustainability 12 (5438) (2020) 1–29, https://doi.org/10.3390/su12135438.
[31] S. Edwards, Cyber-safety and COVID-19 in the Early Years: A Research Agenda, 19(3), 2021, pp. 396–410, https://doi.org/10.1177/1476718X211014908.
[32] K.V. Elumalai, J.P. Sankar, R. Kalaichelvi, J.A. John, N. Menon, M.S.M. Algahtani, M.A. Abumelha, Factors affecting the quality of eLearning during the COVID-19 pandemic from perspective of higher education students, in: C. Cheong, J. Coldwell-Neilson, K. MacCallum, T. Luo, A. Scime (Eds.), CoVID-19 and Education: Learning and Teaching in a Pandemic Constrained Environment, Informing Science Press, California, 2021.
[33] T. Favale, F. Soro, M. Trevisan, I. Drago, M. Mellia, P. Torino, Campus traffic and e-Learning during COVID-19 pandemic, Comput. Network (2020) 1–9, https://doi.org/10.1016/j.comnet.2020.107290.
[34] M. A Flores, M. Gago, Teacher education in times of COVID-19 pandemic in Portugal: national, institutional and pedagogical responses, J. Educ. Teach. (2020) 1–10, https://doi.org/10.1080/02607476.2020.1799709.
[35] J. Fieselmann, K. Annac, F. Erdsiek, Y. Yilmaz-Aslan, P. Brzoska, What are the reasons for refusing a COVID-19 vaccine? A qualitative analysis of social media in Germany, BMC Publ. Health 22 (846) (2022).

[36] A. Georgiadou, S. Mouzakitis, D. Askounis, Working from home during COVID-19 crisis: a cyber security culture assessment survey, Secur. J. 35 (2022) 486–505.
[37] S.O. Gunga, I. Ricketts, Facing the challenges of eLearning initiatives in african countries, Br. J. Educ. Technol. 38 (5) (2007) 896–906, https://doi.org/10.1111/j.1467-8535.2006.00677.x.
[38] A. Gupta, A. Anand, Ethical hacking and hacking attacks, Int. J. Eng. Comput. Sci. 6 (4) (2017) 21042–21050, https://doi.org/10.18535/ijecs/v6i4.42.
[39] D. Górska, eLearning in higher education. The person and the challenges, J. Theol., Educ., Canon Law Social Stud. Inspired Pope John Paul II 6 (2) (2016) 35, https://doi.org/10.15633/pch.1868.
[40] S. Goyal eLearning, Future of education, J. Educ. Learn. 6 (4) (2012) 239, https://doi.org/10.11591/edulearn.v6i4.168.
[41] A. L Hamad, H.M. Abouelnaga, A.B. M Metwally, H. ShoShan, N. F Moawad, The importance of eLearning to the students and teachers, J. Lang. Linguist. Stud. 18 (2) (2022), 053-968.
[42] K. Heng, K. Sol, Online learning during COVID-19: key challenges and suggestions to enhance effectiveness, Cambodian Journal of Educational Research 1 (1) (2021) 3–16.
[43] G. Ingram, Bridging the Global Digital Divide: A Platform to Advance Digital Development in Low- and Middle-Income Countries, Brookings Global Working Paper #157, Center for Sustainable Development, 2021.
[44] W.A. Innocent, O.S. Masue, Using information and communication technology, Int. J. Educ. Dev. 16 (2) (2020) 242–249. https://files.eric.ed.gov/fulltext/EJ1268804.pdf.
[45] N. Kaur, D. Dwivedi, J. Arora, A. Gandhi, Study of the effectiveness of e-learning to conventional teaching in medical undergraduates amid COVID-19 pandemic, Natl. J. Physiol. Pharm. Pharmacol. 10 (7) (2020) 563–567.
[46] R.N. Kibuku, D.O. Ochieng, A.N. Wausi, eLearning challenges faced by universities in Kenya: a literature review, Electron. J. eLearn. 18 (2) (2018) 150–161, https://doi.org/10.34190/EJEL.20.18.2.004.
[47] D.H. Kisanga, Promoting teachers and students' involvement in eLearning in Tanzania: a case of two higher learning institutions, AJOL 25 (25) (2018) 37–53.
[48] N.A. Khan, S.N. Brohi, N. Zaman, Ten Deadly Cyber Security Threats amid COVID-19 Pandemic, 2020.
[49] H. Küçükali, Ö. Ataç, A.S. Palteki, A. Z Tokaç, O. Hayran, Vaccine hesitancy and anti-vaccination attitudes during the start of COVID-19 vaccination program: a content analysis on twitter data, Vaccines 10 (2) (2022) 161, https://doi.org/10.3390/vaccines10020161.
[50] J. Leidenfrost, Ombudsmen in higher education: helping the single student, contributing to the universities' institutional changes, Creativ. Educ. 4 (7) (2013) 8–10, https://doi.org/10.4236/ce.2013.47a2002.
[51] L. Lepp, T. Aaviku, N. Leijen, M. Pedaste, K. Saks, Teaching during COVID-19: the decisions made in teaching, Educ. Sci. 11 (47) (2021) 1–21, https://doi.org/10.3390/educsci11020047.
[52] R. Lestiyanawati, A. Widyantoro, Strategies and problems faced by Indonesian teachers in conducting eLearning system during COVID-19 outbreak, J. Cult., Liter., Linguist. Engl. Teach. 2 (1) (2020) 71–82.
[53] F. Liang, COVID-19 and health code: how digital platforms tackle the pandemic in China, SAGE J. 6 (3) (2020), https://doi.org/10.1177/2056305120947657.
[54] J. Lavonen, K. Salmela-Aro, Experiences of moving quickly to distance teaching and learning at all levels of education in Finland, in: F.M. Reimers (Ed.), Primary and Secondary Education during Covid-19: Disruptions to Educational Opportunity during a Pandemic, Springer, USA, 2020, https://doi.org/10.1007/978-3-030-81500-4.
[55] A. Maria, Introduction to modeling and simulation, in: S. Andradottir, K.J. Healy, D.H. Withers, B.L. Nelson (Eds.), Proceedings of the 1997 Winter Simulation Conference, 1997, pp. 7–13.
[56] P. Mondal, R. Roy, Professional ethics and accountability of teaching, Rev. Res. 2 (10) (2013) 1–8.
[57] W. Mugizi, G. Tumuhaise, B. Samanya, A.O. Dafiewhare, Leadership styles and retention of teachers in private primary schools in bushenyi-ishaka municipality, Uganda, Open J. Leader. 8 (4) (2019) 167–187, https://doi.org/10.4236/ojl.2019.84009.
[58] K. Mukhtar, K. Javed, M. Arooj, A. Sethi, Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era, Pakistan J. Med. Sci. 36 (4) (2020) 27–31, https://doi.org/10.12669/pjms.36.COVID19-S4.2785.
[59] J.D. Munyamtore, M. Mbalire, The role of one laptop per child project in academic performance in primary schools, Int. J. Manage. Appl. Sci. 3 (6) (2017) 41–45.
[60] M.R.A. Murphy, COVID-19 and emergency eLearning: consequences of the securitization of higher education for post-pandemic pedagogy, Contemp. Secur. Pol. 41 (3) (2020) 492–505, https://doi.org/10.1080/13523260.2020.1761749.
[61] W.P. Mwakyusa, L.M. Ngwebeya, The response of Tanzania higher learning institutions to eLearning during covid-19 pandemic, East Afr. J. Educ. Social Sci. 3 (1) (2022) 19–28, https://doi.org/10.46606/eajess2022v03i01.0142.
[62] Mwananchi, Tanzania Extends School Closure to Universities Due to Virus, 2020.
[63] Mwananchi, Waziri Mkuu Kassim Majaliwa Ametangaza Kufungwa Kwa Vyuo Vikuu na Vya Kati nchini Kufuatia uwepo wa Virusi Vya Corona, TBCOnline, 2020. https://youtu.be/hmkH-KPmo9s?t=48.
[64] B. Mwiya, J. Bwalya, B. Siachinji, S. Sikombe, H. Chanda, M. Chawala, Higher education quality and student satisfaction nexus: evidence from Zambia, Creativ. Educ. 8 (7) (2017) 1044–1068, https://doi.org/10.4236/ce.2017.87076.
[65] National Planning Authority, Technical note: towards safe opening of the education sector in covid-19 times, Uganda Vision 2040 (2021).
[66] P. Ndibalema, Constraints of transition to online distance learning in Higher Education Institutions during COVID-19 in developing countries: a systematic review, E-Learn. Digital Media (2022) 1–24, https://doi.org/10.1177/20427530221107510.
[67] S. Nikou, I. Maslov, An Analysis of Students' Perceptions on eLearning Participation- the Case of COVID-19 Pandemic, ABo Academic University, Turku-Finland, 2021.
[68] OECD, OECD Interim Economic Assessment Coronavirus: The world Economy at Risk March, 2020. https://www.oecd.org/berlin/publikationen/Interim-Economic-Assessment-2-March-2020.pdf.
[69] C. Okello, Tanzania and Somalia became the latest East African countries on monday to confirm their first coronavirus cases, as neighboring countries shut borders and schools amid fears of contagion, RFI, http://www.rfi.fr/en/africa/20200316-coronavirus-spreads-to-tanzania-somalia-as-east-africa-goes-into-lockdown, 2020.
[70] M. Patton, Qualitative Research and Evaluation Methods, third ed., Sage Publishers, London, 2002.
[71] S. Pokhrel, R. Chhetri, A literature review on impact of COVID-19 pandemic on teaching and learning, Higher Educ. Fut. 8 (1) (2021), https://doi.org/10.1177/2347631120983.
[72] I.S. Pradono, M.S. Astriani, J. Moniaga, A method for interactive learning, Int. J. Commun. Inf. Technol. (CommIT) 7 (2) (2013) 46–48. http://msi.binus.ac.id/commit.
[73] A.Z.A. Rawashdeh, E.Y. Mohammed, A.R.A. Arab, M. Alara, B. Al-Rawashdeh, Advantages and disadvantages of using e-learning in university education: analyzing students' perspectives, Electron. J. eLearn. 19 (2) (2021) 107–117. www.ejel.org.
[74] S. Renes, Increasing Access to Higher Education through eLearning, eLearning-Instructional Design, Organizational Strategy and Management, 2015, https://doi.org/10.5772/60906.
[75] Rwanda Ministry of Education, Educational Sector Strategic Plan 2019/2019 to 2023/2024.Kigali: Republic of Rwanda, 2019.
[76] A. Schleicher, The impact of COVID-19 on education: insights from education at a glance, OECD. https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf, 2020.
[77] D.R.R. Sivalingam, P. Balachandar, B.P. Ajith, eLearning approach in teacher education, J. Appl. Adv. Res. (2018) 14–16, https://doi.org/10.21839/jaar.2018.v3S1.159.
[78] G.V. Stam, eLearning in Africa and the Opportunity for Innovative Credentialing, Scientific and Industrial Research and Development Center, Harare, 2013.
[79] M.H. Suru, R.E. Matete, Equitable eLearning in Tanzania's higher education institutions during the pandemic beyond covid-2019, in: A. Mare, E. Woyo, E. Amadhila (Eds.), Teaching and Learning with Digital Technologies, Routledge, London, 2022, https://doi.org/10.4324/9781003264026.

[80] O.T. Tan, J.J.E. Chua, Science, social responsibility, and education: the experience of Singapore during the COVID-19 pandemic, in: F.M. Reimers (Ed.), Primary and Secondary Education during Covid-19: Disruptions to Educational Opportunity during a Pandemic, Springer, USA, 2021, https://doi.org/10.1007/978-3-030-81500-4.
[81] The Citizen, 2020. https://www.thecitizen.co.tz/news/-Tanzania-extends-school-closure-to-universities-due-to-virus-/1840340-5495352-qgiccoz/index.html.
[82] URT, Educational Sector Performance Report 2018/2019, MoEST, Tanzania Mainland. Dodoma, 2019.
[83] K.P. White, R.G. Ingalls, Introduction to simulation, in: Proceedings of the 2009 Winter Simulation Conference, December 2009, 2009, pp. 12–13, https://doi.org/10.1109/WSC.2009.5429315 (Source: DBLP).
[84] Who, Clinical Management of Severe Acute Respiratory Infection when Novel Coronavirus (nCoV) Infection Is Suspected, WHO, Geneva, 2020.
[85] B. Yikici, F. Altinay, Z. Altinay, R.C. Sharma, G. Dagli, Adoption of online education and pedagogy as new codes of life for new future in rural regions betul, Sustainability 14 (5528) (2022) 1–19, https://doi.org/10.3390/su14095528.
[86] W. Zhang, Y. Wang, L. Yang, C. Wang, Suspending classes without stopping learning: China's education emergency management policy in the COVID-19 outbreak, J. Risk Financ. Manag. 13 (3) (2020) 55, https://doi.org/10.3390/jrfm13030055.