



M-learning During COVID-19: A Systematic Literature Review

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Abstract. Mobile learning (m-learning) offered opportunities for learning before COVID-19 disease (COVID-19) but experienced a significant surge in usage since learning moved to the homes. This systematic review collates studies published between 2020 and 2021 to understand the impact, challenges, opportunities, and gaps in m-learning during COVID-19. The key findings from the 26 papers reveal the extent to which many families, educators, and governments were caught off guard, some glaring family challenges, and social and digital divides inscribed in technology infrastructure, especially in developing countries. M-learning assumes adequate internet and digital technology infrastructure which means that developing countries continue to be affected the most. A research agenda is created for how m-learning can be better leveraged for future disruptions.

Keywords: COVID-19 · Higher education · m-learning · Online learning · Online education

1 Introduction

Digital technologies play a significant role in education today [1], with m-learning enabling education anytime and anywhere. There was as a tremendous increase in the use of digital technologies, especially mobile, since the COVID-19 outbreak around January 2020. COVID-19 affected every sector including education [2–5], from nursery school to university. Most education communities and campuses were forced to shut and suspend classes and scrambled to shift classes from traditional platforms to online formats [2, 6–8] to limit the spread of the virus through social distancing [9]. According to UNESCO, 99.4% of the students in the world were affected by COVID-19 with the economic and societal consequences being far-reaching [10, 11].

The government and private education sectors attempted to use m-learning tools such as the Educator’s Room, Learning House, Telegram, Zoom, Kahoot, YouTube, Google Meet [3, 12], and many others. Mobile learning refers to e-learning via portable computing devices, such as Windows CE devices, Palms, or even a digital cell phone. E-learning is a substitute for conventional education and can also be used in conjunction

with it. Both traditional education and e-learning are supplements to mobile learning. M-learning is a subset of e-learning, which is a larger term that encompasses both online and mobile learning environments. Despite the difficulties in implementing it, m-learning is the best alternative now available to ensure that epidemics do not spread because it guarantees spatial distance [13]. This paper focuses on m-learning during COVID-19.

M-learning was already popular especially for higher education due to its ubiquity and effectiveness in enabling learning anywhere and anytime [4]. M-learning allows for collaborative learning where peers can share their learning experience and be a part of the communication of specific practice, have immersive experiences, and offers greater flexibility. M-learning means that every student can access high-quality education at an affordable price [2, 5, 14, 15] and experience education [16], increased family time, personal improvement and gaining new skills [2], autonomy, and self-learning [14, 17].

Nonetheless, the unexpected transition to m-learning for many institutions because of COVID-19 exposed challenges, inequalities, and benefits. One of the challenges was failing to concentrate at home [3, 17]. The home environment has many distractions such as noise, family members, and housework. Also, home is associated with rest, which makes concentration difficult [2]. Other challenges included the lack of resources and internet accessibility in many outlying areas, the unavailability of internet access [2, 18], lack of supporting academic resources [2] inadequate prior training on m-learning for both students and educators [2, 11, 14, 17], fieldwork courses that needed the usage of labs [2, 14], and the sudden heavy demand on internet services [17]. Also, m-learning was difficult [2] as some students experienced less personalized contact with educators and with each other [2, 14].

This paper, therefore, sought to understand how m-learning during COVID-19. Specifically, the study sought to answer the following research question using a systematic review: “*What did COVID-19 reveal about m-learning?*”

The remainder of the paper is formatted as follows: the next section presents the method used to conduct the systematic review and is followed by the classification method used to extract meaning from the identified papers. The last two sections present the analysis of the findings and conclusions and set a research agenda.

2 Methodology

A systematic literature review (SLR) method was adopted for the study using Okoli and Schabram’s [19] method. The purpose of the study was to answer the following main question: *What did COVID-19 reveal about m-learning?*

Due to the multidisciplinary nature of the question, and to cover the most extensive scope, the following electronic search engines were used:

- Elsevier Science Direct (<https://www.sciencedirect.com>)
- Research gate (<https://www.researchgate.net/>)
- IEEE Explore (<https://ieeexplore.ieee.org/Xplore/home.jsp>)
- Google Scholar (<http://scholar.google.com/>)

The search terms which were used in this study include two sets of keywords as shown in Table 1 below:

Table 1. Phrases in the Search Terms

No	Category	Keyword
1	Learning	Online learning E-learning Online Education M-learning Mobile learning
2	Coronavirus disease	COVID_19 Coronavirus disease Coronavirus Pandemic

2.1 First Stage. Collecting the Relevant Papers

The search elements were combined using the logical operator (AND) resulting in the following search string: (“Online learning” OR e-learning OR “online education” OR m-learning OR “mobile learning”) AND (COVID-19 OR coronavirus disease).

2.2 Second Stage. Screening Using Inclusion and Exclusion Criteria

COVID-19 is a recent concept and hence there was no need to include data older than 2020 [9, 20]. The inclusion criteria were therefore related to the type of data included in the research papers as Table 2 below:

Table 2. Inclusion & Exclusion criteria

Criterion	Inclusion criteria	Exclusion criteria	Quality criteria
Focus	Peer-reviewed research papers about m-learning during COVID-19 from student’s and educator’s perspectives	Research papers about m-learning during COVID-19 from parent’s perspective	

(continued)

Table 2. (continued)

Criterion	Inclusion criteria	Exclusion criteria	Quality criteria
Level of Education	All levels from nursery schools to higher education		The educational context for students and educators
Period of Research	Published between January 2020 - July 2021		The period during which Corona disease appeared
Geographical spread	Open		
Sources	Published in journals, scholarly outlets such as conferences, and academic publications	Published in reports, books, or have not been peer-reviewed	Predatory publications were excluded

2.3 Third Stage. Data Extraction

All the titles, abstracts, and keywords of the studies that resulted from the inclusion and exclusion criteria stage were scanned. Articles with no relevance to the scope of the SLR were excluded. For the papers that were included, the introduction and conclusions of each article were reviewed to determine their relevance. The three steps resulted in the hits as described in Table 3 below:

Table 3. Study and report selection process

Electronic database	Initial search (1 st order selection)	2 nd order selection	3 rd order selection
Elsevier Science Direct	25	14	5
Google Scholar	21	20	11
IEEE Explore	13	13	9
Research gate	6	4	0
AIS Electronic Library	1	1	1
Total	66	52	26

3 Classification Framework

A classification framework from Amui et al. [21] was adapted, which uses closed coding to analyze and classify the selected papers. Table 4 shows the classification framework used for the paper.

Table 4. Coding and classification Framework for analyzing the studies

Classification	Context	Codes
Context	Primary schools	1A
	Secondary schools	1B
	Higher education	1C
Opportunities (m-learning resource)	Flexibility in time, place, characteristics, and psychological conditions	2A
	Financial Affordability	2B
	Having the new technology for m-learning	2C
	Accessibility	2D
Opportunities (related to students)	Enhanced Learning Experience	3A
	Develop Future Skills	3B
	Working remotely	3C
	Educational equity	3D
	Communication	3E
Opportunities (related to educators)	Practice technology and gaining skills	4A
	Creating online platforms for educators	4B
	Broadcasting educational lessons on TV and radio platforms	4C
	Working remotely	4D
	Increase educators' role	4E
Opportunities (related to contents of m-learning)	Creating comprehensive m-learning resource sites	5A
	Increase in the use of available resources	5B
	Education system development	5C
Resources challenges	Internet access	7A
	No computers	7B
	Digital devices are not good enough	7C
	Digital skills	7D
	Poor infrastructure	7E
	Inconsistent power supply	7F
Educator readiness challenges	Lack of training in online teaching	8A
	Lack of training in teaching	8B
	difficult to determine the state of students	8C

(continued)

Table 4. (continued)

Classification	Context	Codes
Challenges Facing Students	Lack of training in online teaching	9A
	Lack of Interaction	9B
	Negative emotions	9C
	Lack of family support	9D
Learning content challenges	Academic Resources	10A
	Coverage of the curriculum	10B
	Security	10C
	Lack of standards for quality content delivery	10D
	Laboratory activities	10E
Origin	Developing countries	11A
	Developed countries	11B

3.1 A Summary of the Selected Papers

Table 5 summarizes each of the resulting 26 papers.

Table 5. Brief Summary of the Selected Papers

NO	Authors & year	Brief Summary
1	Cotero, Karina (2021)	The paper identified and defined those skills which are basic to carry out the teaching-learning process virtually and online. It was found that students did not have the necessary skills to achieve their learning objectives as they had been doing in the face-to-face learning modality
2	Dhawan, Shivangi (2020)	The study focused on the Strengths, Weaknesses, Opportunities, & Challenges (SWOC) of m-learning. The key findings are that the academy experienced greater flexibility with online teaching
3	Humayun, Mamoona (2020)	The article offers guidelines to practitioners in the selection of suitable M-learning equipment and furnishes a tightly closed framework for the safety of M-learning records and the environment. The proposed framework is expected to furnish a promising answer for developing trustworthy and open instructing online instructing surroundings and may prefer to overcome the deficiencies delivered about by university closures for the duration of COVID-19
4	Suryaman, et al. (2020)	This article aimed to obtain and identify knowledge about the effect of the COVID-19 disease on the educational method. The findings point to several obstacles experienced by learners, and educators in learning activities and online teaching namely mastery of technology is still lacking, additional internet quota costs

(continued)

Table 5. (continued)

NO	Authors & year	Brief Summary
5	Surendra, et al. (2020)	This study explored the factors that predict the use of e-learning during COVID-19 among students of sports science education in institutions of higher education in Indonesia, the study identified aspects of access where many students do not have sufficient resources for mobile technology associated with facilitating learning, especially Internet access
6	Section, Early Career (2020)	The paper described the capabilities, implementation, and challenges of virtual learning for cardiology fellows-in-training (FITs) and fellowship programs in the COVID-19 era and beyond. Many novel tools had been used in the education of trainees. For example, the group chats application WhatsApp by Facebook was, and continued to be, used by many trainees for both sharing of medical knowledge and collaboration
7	Joko, Joko (2020)	The study analyzed supporting and inhibiting factors, the effectiveness of m-learning, and preventing the spread and impact of COVID-19 among students. The results refer to M-learning can prevent the spread and impact of COVID-19, 100% of students are not exposed and are not affected by COVID-19
8	Al-okay, et al. (2020)	There is a dilemma in accepting the new educational system “e-learning” by students within educational institutions. The result has confirmed the positive of direct effect variables (subjective norm, perceived ease of use, and perceived usefulness) on the student’s intention to use the e-learning system
9	Harida, Eka Sustrri (2020)	This paper explored the confidence of the students in m-learning in the Covid-19 situation. It found that some students did not feel confident with this kind of learning, some are enthusiastic, and others felt bored
10	Luh, et al. (2020)	The goal of this study was to describe how primary school m-learning solutions for COVID-19 pandemics worked. One of these solutions is to provide programming on a television station in areas where internet access is limited. Another option is to provide education via radio
11	Adnan, et al. (2020)	This research study examines the attitudes of Pakistani higher education students toward compulsory digital and distance learning university courses amid COVID-19. The findings of the study highlighted that a majority of students are unable to access the internet due to technical as well as monetary issues
12	Anderson, Nicole (2021)	The study investigated if some of the assumptions established regarding online learning remained true. While the COVID-19 responses showed that m-learning is feasible on a large scale, the study found there was still much room for improvement
13	Maulana, et al. (2020)	The study analyzed the COVID-19 impact on Islamic Higher Education (IHE). The finding revealed that Prior to COVID-19, the majority of Indonesian educators lacked significant mobile learning experience, although they were prepared for it
14	Jima’ Ain, et al. (2020)	COVID-19 was studied in relation to the Industrial Revolution 4.0 (IR 4.0), and the associated teaching style. The finding revealed that extensive preparation on the part of both the educator and the student is required. For education to continue, educators innovation and students’ tenacity are absolutely essential, and it’s time to demonstrate how IR 4.0 can improve education

(continued)

Table 5. (continued)

NO	Authors & year	Brief Summary
15	Murad, Dina Fitria (2020)	The study looked into how organizers, conferences, and students were prepared for the current conditions, their readiness to go through the learning process while keeping educational quality, and how satisfied users (trainers and students) were with their learning. The findings suggested that online education has improved the preparation of education professionals in Indonesia
16	Wan Hassan, et al. (2020)	This article aimed to identify the challenges students face when using Google Classroom as a T&L method amid the COVID-19. The study showed that the average level of challenges students face when using Google Classroom
17	Liu,Zhen (2021)	This study identified user requirements to experience the online scene,and that students with poor self-control cannot complete their study plans effectively
18	Mishra, et al. (2020)	This article aims to process the fundamentals required for educational learning and m-learning amid COVID-19. It offered comprehensive picture of the continuing online teaching activities amid the lockdown, including the relationship between the change management process in the education system and the online education process during the COVID-19 epidemic
19	Awan, Muhammad Ta veer (2020)	The study aimed to elucidate the effect of virtual classrooms on student learning outcomes. More than 67% of participants felt they were negatively affected by the closure of schools, universities, and colleges in the education sector
20	Edy, Leksono (2020)	The study found that m-learning activities using different mediums such as Google Meet, WebEx, and Google Zoom. During COVID-19, influence learner motivation differently
21	Oyedotun, Temitayo Deborah (2020)	The paper provided suggestions for improving learning and teaching using online facilities in times of turmoil and epidemics, especially in developing and least-developed countries. During a crisis, comfort must be the priority for both students and staff
22	Agung, et al. (2020)	This study is a cohort case study about perceptions of their m-learning amid COVID-19. The result refers to the main factor that affects the success of m-learning is accessibility
23	Toquero, Cathy Mae (2020)	This study suggests preparing studies from educational institutions to document and reduce the impact of COVID-19.The paper also provided policy implications of formulating environmental policies that can strengthen university health management systems
24	Aguilera-hermida, A Patricia (2020)	The article detected perceptions of students' colleges of their use, acceptance, and adoption of m-learning in emergencies. The results refer to how attitude, self-efficacy, motivation, and technology usage of play a significant role in students' cognitive engagement and academic performance
25	Pratama, et al. (2020)	This study investigated the feasibility of an online class based on Edmodo. The findings show that the online class instead of class meetings was well advertised by the students
26	Xie, Xin Siau, Keng (2020)	This study found that students who experiment with m-learning experience a change in their perception are more likely adopt it after the panademic

3.2 Structuring the Findings

The coding was done using the classification framework and placed in Appendix A (<https://data.mendeley.com/datasets/v5p9wh9hfj/draft?a=3f2049ea-1bbc-48a8-9650-b29daf250edf>). The results are then discussed in the following section.

4 Analysis and Discussion of Findings

4.1 Context

Figure 1 shows the context in which the research was done.

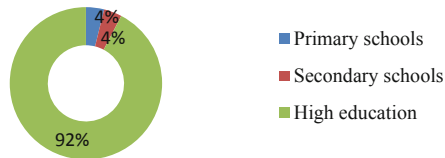


Fig. 1. The Context of the Research

The findings suggest that majority of the research has been done in higher education contexts. There is little research on m-learning during COVID-19 in primary and secondary schools. This could be a result of many factors including the age group which requires much more strict ethics requirements. Within the scope of this study m-learning during the pandemic has mainly been studied from a Higher Education perspective and much less at the primary and secondary levels.

The way that students and educators at the primary and secondary levels interact with m-learning is different. Even though students at younger ages are regarded as digital natives, it was found that they too needed to learn to use m-learning in the same way as digital illiterates. There is therefore a gap in research on m-learning at the primary and secondary levels during the pandemic.

4.2 Opportunities (M-learning Resources)

The descriptions below show the most important characteristics that mobile devices contribute as a resource to m-learning (Fig. 2).

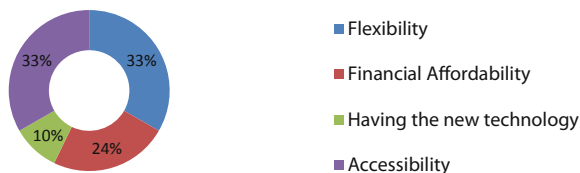


Fig. 2. Opportunities Related To M-learning Resource

Most of the research papers indicated flexibility (the ability to engage with learning from any location and at any time, and in any manner required) and accessibility (enabling students to attend lectures and seminars from anywhere at any time and access m-learning resources and can even be accessed in rural and remote areas) as the most important characteristics that mobile devices contribute as a resource to m-learning.

4.3 Opportunities (Related to Students)

Figure 3 below shows the m-learning opportunity for the students



Fig. 3. Opportunities Related To Students

The majority of the research papers (14 papers) mentioned m-learning as a big opportunity for students to enhance the learning experience. M-learning presents an opportunity to change the existing learning strategies to give students a flexible approach to managing their learning experiences most of the students become self-directed learners. It also provides course scheduling flexibility that enables students to plan their time for completion of courses available online and encourages and enhances peer learning. Nine papers revealed that m-learning provides more opportunities for online students to participate in real-time interaction and to communicate with off-online students as there is satisfactory interaction too among educators and students. The students can share their opinions and provide peer learning opportunities with communication capabilities via email and social media such as WhatsApp for inquiries, and feedback. Only two papers mentioned that m-learning provides opportunities for students to work remotely.

4.4 Opportunities (Related to Educators)

Figure 4 below shows how m-learning is an opportunity for educators.

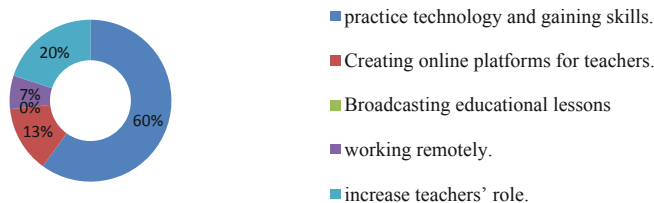


Fig. 4. Opportunities Related To Educators

Educators as the main element in formal education are encouraged to adapt to the implementation of learning that originally used conventional face-to-face methods and switched to m-learning. The opportunity is for educators to practice with technology to acquire the necessary technical skills. Digital technologies enable educators and mentors to blend m-learning with traditional learning and ensure face-to-face and easy access to online content. Rather than only facilitating communication, educators could be coaches, mentors, and evaluators and enable them to share materials and videos for the benefit of educators by colleagues and university administration. M-learning also enables educators to create online platforms. No research papers mentioned broadcasting educational lessons via radio or TV.

4.5 Opportunities (Related to Contents of M-learning)

The descriptions below show that m-learning a big opportunity for content (Fig. 5).

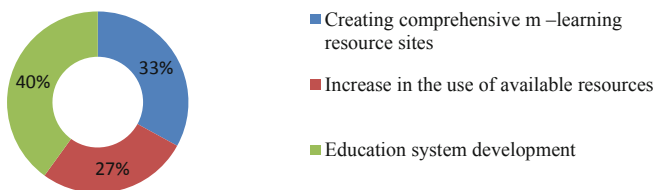


Fig. 5. Opportunities Related To Contents Of M-learning

The content of m-learning as one of the main pillars of the success of m-learning. 40% of the papers indicated an opportunity to make the curriculum responsive to the needs of the changing times. The content is then more persuasive because it makes the learner more interested in the material provided by the lecture, for example through creative video. 33% indicated an opportunity for creating a comprehensive m-learning resource site with live cloud recordings of teachings, meetings, lectures, and other interactions. 27% indicated an opportunity for an increase in the use of available resources.

4.6 Resources Challenges

The descriptions below indicate resources challenges (Fig. 6).

Thirty-four percent mentioned the challenges facing m-learning during COVID-19 related to limited internet access, slower internet speeds at home, heavy internet bills, and students do have not good internet data at home. 28% also indicate poor infrastructure additionally to the inconsistent power supply. 26% indicate the unavailability of computers, laptops, and/or tablet facilities for all participants in the educational process.

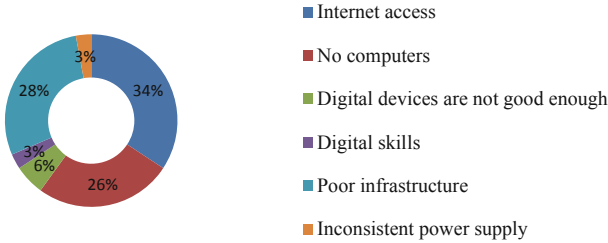


Fig. 6. Challenges Related to Resources

4.7 Educator Readiness Challenges

The descriptions below reveal the challenges facing educator readiness (Fig. 7).

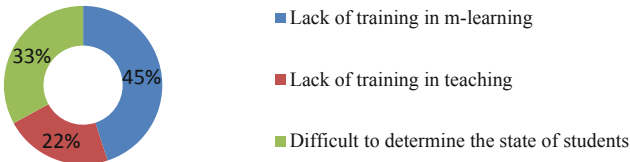


Fig. 7. Challenges Related to Educator Readiness

Forty-five percent found that educator readiness was missing, and the educators lacked training in m-learning. 33% indicates the difficulty that educators find in determining the status of students at the other end of the network. For example, educators were unable to read the face and moods of students and thus found it difficult to change the teaching pattern. They were also not sure whether the students switched on the mobile device for the sake of it, were actively learning, or not doing anything at all. 22% indicated that educators are not aware of the existing solutions; therefore, they are not able to choose a suitable solution according to their needs or to find solutions that encourage participation in the live classroom that works with the educators teaching ability and style.

4.8 Challenges Facing Students

The descriptions below show the challenges facing students (Fig. 8).

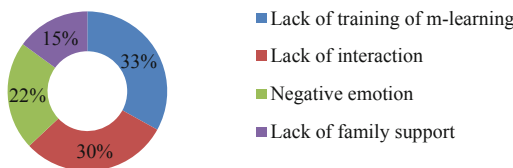


Fig. 8. Challenges Facing Students

The key challenges related to the students included a lack of training in m-learning (33%), a lack of social interaction between students, and a lack of direct contact between students and educators, especially in practical training (30%). 22% represent students with negative emotions as the result of sudden life changes, financial hardships, stress balancing life, and lack of motivation.

4.9 Learning Content Challenges

The descriptions below indicate the challenges facing the content of m-learning (Fig. 9).

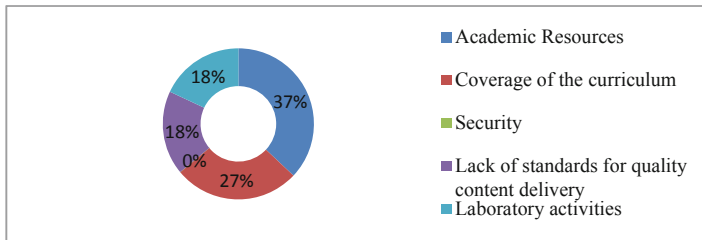


Fig. 9. Challenges Facing Content

Most of The challenges facing the content of m-learning are related to the lack of Supporting Academic Resources, no research papers mentioned unauthorized access to the personal information of the students in the m-learning system (Security). It is likely that security from mobile devices poses less of a threat to institutional infrastructure.

4.10 Origin

The descriptions below show the region where research paper done (Fig. 10).



Fig. 10. Origin

Most research was from the context of developing countries. Developed countries had only five research papers. The phenomenon could be a result of the m-learning maturity in many developed countries or even the infrastructural maturity in developed countries being prepared for disruptive phenomenon.

5 Research Agenda

The above findings lead to further research required in terms of learning during the time of crisis.

5.1 Context

There were gaps in understanding m-learning at primary and secondary levels of education. The following are some research questions that need to be answered, therefore:

- What has been the impact of m-learning at primary and secondary levels of education post-COVID?
- What are the challenges facing m-learning implementation at primary and secondary levels of education post-COVID?
- What are the critical success factors (CSFs) for m-Learning in higher education?

5.2 Opportunities

Although m-learning provided many opportunities for both students and educators in times of crisis, such as accessibility and flexibility of m-learning resources, the current study indicates a gap in the opportunities to own new technology for mobile education, and this is because of the accessibility to the technology for both students and educators. Also, only two papers mentioned that mobile learning provides opportunities for students to work remotely because the number of students who combine study and work is low. M-learning also provided opportunities for educators to practice technology and acquire skills, but the current study indicates a lack of opportunity to broadcast educational lessons on TV and radio platforms. The following are some research question that needs to be answered, therefore:

- What are the student and educator's experiences and attitudes toward m-learning in times of crisis?

5.3 Student Challenges

The result of the current study suggests that accessibility is still the major challenge facing the success implement m-learning during the time of crisis most students have limited internet access, slower internet speeds at home, heavy internet bills, and students do have not good internet data at home, especially who live in which are in rural areas. Additionally, lack of training in m-learning is another challenge facing student. However in the current study there is a gap in the lack of family supports for students, especially students who belong to under privileged families and where the responsibility lies on family members to assist in routine tasks. For example, if parents are not educated enough, how will m-learning be possible for younger learners? Most research papers indicated that m-learning is one of the solutions to ensure the continuity of education during times of crisis, despite the presence of many challenges that can face its implementation. An most important question for further research is therefore:

- What are the government policies that must be implemented to overcome the challenges of accessibility and lack of training in m-learning ?

5.4 Educator Readiness

For the educator to become an electronic educator, an intellectual reformulation is needed where the educator is convinced that traditional teaching methods must change to match

the amount of knowledge that exists. The education also need to learn modern methods of teaching and effective strategies. The results of the current study indicate there is a gap in educator readiness is lacking, and educators lack training in teaching. Including training in interactive online teaching methods, the formation of an individual learning trajectory, and online multidisciplinary course development. The training for educators can improve student learning in educational programming for the instructors to facilitate the goals aligned with the learning goals of higher education institutions. The following are some research questions that need to be answered, therefore:

- What is the readiness of educators for m-learning post-COVID?
- How does m-learning influence the role of the educator post-COVID??

5.5 Learning Content

There is a gap in security and privacy around m-learning, there was no research about secure access to the personal information of students in m-learning. The following are questions that can be investigated:

- How can data privacy and data security be maintained in m-learning spaces?
- How can m-learning data be shared without compromising security and privacy?

5.6 Origin

Developed countries had only five research papers likely because of the infrastructural maturity that was prepared for the disruptive phenomenon. In contrast, a mobile device has spread rapidly in both developed and developing countries, so the number of mobile phones in some developing countries exceeds the number of individuals. The following questions can therefore be investigated:

- How can m-learning act as a facilitator beyond the digital divide in developing countries?

6 Conclusions and Implications of the Study

Higher education was affected by the COVID-19 pandemic with thousands of school closures in a very limited period to enforce social distancing measures. However, the global pandemic also opened opportunities for other countries to reconsider their educational mode of delivery and include emerging technologies.

M-learning which allows distributed flexible access to educational content is required at all educational levels, yet there was limited research at the primary and secondary levels. Even though the mobile device was found as the most favorable tool for m-learning, especially for its ubiquity and interactivity, it also presents distractions as the mobile is also used for non-educational purposes. Most mobile devices also have limited capacity and must be forced to either stream content or access previously streamed content. This also has implications in terms of data costs, infrastructure, and physical devices for both the educator and the student.

M-learning also brought parents and guardians closer to their children's education as they were required to assist. Parents, therefore, needed to suddenly learn critical teaching

skills, many of whom struggled to adjust, while others found it helpful. The impact of this parent involvement with their children's education through m-learning would also need to be established.

The unreadiness of educators to adapt to m-learning coupled with the inability to read the student's moods was a stressor. There was also stress among students with some going into depression. Educators play a strong role in recommending alternatives for students and were therefore not able to adequately assist in this regard.

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