education sciences

MDPI

Systematic Review

A Systematic Review of the Benefits and Challenges of Mobile Learning during the COVID-19 Pandemic

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Abstract: Following the COVID-19 outbreak, teaching and learning have been forced to move fully to the Internet rather than the conventional offline medium. As a result, the use of M-learning has risen dramatically, which was neither expected or anticipated. The challenges and benefits of such widespread usage are beginning to emerge in front of us. Thus, in this paper, we systematically review the benefits and challenges of leveraging M-learning for Science and Technology courses during the COVID-19 pandemic by educators and learners. Related articles were obtained from various databases, namely, IEEE, ACM Digital Library, ScienceDirect, and Springer. In total, 4210 related articles were initially found. Upon executing careful selection criteria, 22 articles were selected for review. After that, the advantages and threats were identified and discussed. As per our findings, it was determined that M-learning has excellent potential to be an effective platform for education provided that the identified shortcomings are resolved. This review will be helpful for education stakeholders and institutions to gauge the impact of leveraging M-learning as the only means for education to proceed. Moreover, it reveals the strengths and shortcomings that would aid in adjusting the relevant policies administered by the institutions. Furthermore, application developers will be able to comprehend the expected features that should be included in novel M-learning platforms.

Keywords: M-learning; systematic literature review; COVID-19 pandemic

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1. Introduction

Online learning, i.e., learning conducted through the Internet, has grown in popularity to the point where it is now offered in brick-and-mortar institutions that formerly solely offered face-to-face learning. Mobile learning (also known as M-learning) can be considered a subdivision of online learning, which refers to the process of learning across various settings through social and content exchanges through mobile devices such laptops, smartphones, and wearable technology [1,2]. It is a kind of remote education where learners use instructional technologies on mobile devices at their convenience [3]. The use of M-learning to promote teaching and learning among learners at the tertiary level has continued to be of interest. While M-learning is quickly seen as an efficient means of improving education, it must continue to evolve to meet today's learners' changing needs and learning demands [4]. Conventional ways of teaching and learning are no longer applicable and practical. Remote learning, flexibility, a user-friendly learning path, cost-effectiveness, and preparation for the digital future are some of the characteristics that distinguish mobile learning from traditional educational and training models [5].

Coronavirus disease 2019 (COVID-19), which was first reported in the Hubei Province of the People's Republic of China, has easily spread across the world [6,7], infecting a large

number of countries. This has led the WHO Emergency Committee to declare a global health emergency in late January 2020, citing an increase in COVID-19 confirmed cases all over the world [8]. COVID-19 has expanded across all continents, and the latest COVID-19 news overwhelmed the global media every day in 2020 and even in 2021 [9].

Before the pandemic, educational institutions were mainly conducting courses face-to-face. However, few courses were already being taught online and offline (face-to-face) [10]. Conventionally, academic teaching is primarily offline, and everyone was used to that [11]. Due to technological advancements, most professional courses were offered online, but most academic courses continued to be provided in the conventional face-to-face manner [12]. As the mobile user base grows daily and mobile devices become more affordable and popular among learners, M-learning became popular throughout the world [13].

After the outbreak of COVID-19, the entire existing teaching and learning approach from elementary schools to tertiary institutions was challenged [14]. The handling and control of the impact of the COVID-19 pandemic is entirely dependent on the policies established and executed by the government to prevent and control the virus's spread and its consequences. As a result, governments of the majority of the world's countries have imposed social distancing and advised citizens to conduct all activities (except those deemed essential) from home [15]. This has repercussions throughout a range of sectors, especially the education sector. Due to the COVID-19 pandemic, the educational landscape has flipped, with a massive shift toward online learning occurring literally everywhere on the planet [16]. These forced the whole world to rely on M-learning to continue teaching and learning activities [17]. Stay-at-home orders and in-office and in-school environment closures brought an unprecedented number of learners and educators into the virtual room [18]. Moreover, M-learning became even more popular due to the emergency arisen around the world. The flare-up of COVID-19 has changed the entire education system globally. Numerous institutions, universities, and institutions have discontinued face-to-face instruction. They are now forced to go online to proceed with their teaching pursuits [19]. This will have a detrimental influence on educational activities, as observing social distancing is crucial at this period [20]. This crisis has forced organizations that were previously reluctant to change to leverage M-learning. It was and is still a challenging period for educational institutions to deal with the current scenario, especially in Science and Technology education [21]. Nevertheless, this scenario demonstrated the potential of M-learning as a medium to pursue education despite the challenges experienced by both learners and educators. There are more than 4.8 billion mobile users worldwide, with approximately 3.8 billons of smartphone users [22].

Approximately 1.6 billion learners could not have physical classes due to temporarily closed schools; this has resulted in more than 91% of all learners enrolling online due to the COVID-19 pandemic [23]. Although some institutions are returning to the face-to-face medium of teaching with caution [24], in many parts of the world, the COVID-19 pandemic persists. It may take a while for the whole world to go back to normal, similar to what it was before the pandemic emerged [25].

The online learning platforms did not expect or anticipate the rise in the number of online learners, making them not ready to serve the spike of users. There are known advantages and disadvantages of leveraging M-learning for education. However, the COVID-19 pandemic brings a different perspective toward online education globally due to the large-scale use of online platforms by learners and educators [26]. This paper reviewed the strengths and shortcomings of leveraging M-learning for Science and Technology education during the COVID-19 pandemic. The aim is to form a solid understanding of the needs and expectations of learners and instructors toward novel M-learning platforms. The findings may also contribute to the development of policies related to educational technology at learning institutions.

This paper adopts the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach in conducting the review and analysis while minimizing

inconsistencies and biases. The structure of this paper is as follows: Section 2 presents the method used in conducting the review. Section 3 presents the results of the findings. Meanwhile, Section 4 discusses the findings, Section 5 presents the recommendations, and Section 6 concludes the paper.

2. Methods

The PRISMA methodology is one of the recommended procedures for systematic reviews [27]. This technique enables the development of a systematic strategy for locating relevant research [28]. The detailed procedure followed in conducting the review is illustrated in Figure 1.

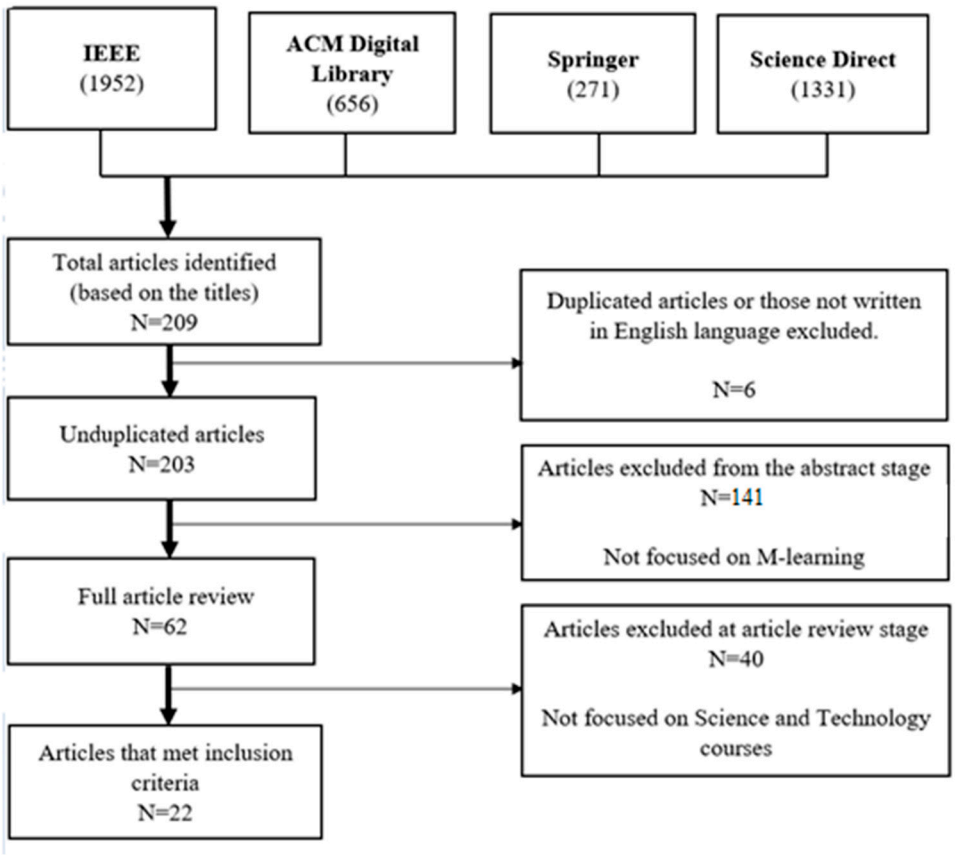

Figure 1. PRISMA flow diagram.

For this study, the articles were obtained from four different databases: IEEE, ACM Digital Library, ScienceDirect, and Springer. The search string was the same for the four databases: {M-learning} OR {Mobile Learning} AND filter year within 2020 to 2021. Mainly, the search was carried out during the COVID-19 outbreak, which was from 2020 to 2021.

The inclusion criteria for this review were articles (i) involving M-learning for education and (ii) focused on Science and Technology courses. The exclusion criteria were articles that (i) concentrated on learners or educators below higher school, (ii) mainly emphasized the technical implementation of M-learning, and (iii) that were not published in English.

In total, 4210 were found across four databases. Specifically, 1952, 656, 271, and 1331 articles were retrieved from the IEEE, ACM Digital Library, Springer, and ScienceDirect, respectively. The titles of the articles were then skimmed through, and 209 articles were selected based on relevance, with 107 from IEEE, 28 from ACM Digital Library, 59 from Springer, and 12 from ScienceDirect. Subsequently, reading through the abstract, 62 articles were selected for further analysis. Only articles that were examined during the pandemic period with a focus on Science and Technology were chosen from the M-learning articles.

Finally, after reading the whole article and focusing on the inclusion criteria, a subset of articles was chosen, and the others were eliminated. To proceed, a total of 22 articles were included in the review.

3. Review of the Benefits and Challenges of M-Learning during COVID-19 Pandemic

The 22 selected articles that met the inclusion criteria were reviewed individually, and the results are presented in Table 1. In addition, the reference number with title, the methodology used by the researchers, the benefits and challenges of M-learning, the platform used, and the targeted audience, including significant findings of the respective research, were also provided in the same table.

Table 1. Benefits and challenges of M-learning.

Title	Method	Benefits and Challenges	Platform	Target Population	Findings
Effectiveness of Mobile Learning Implementation in Increasing Student Competence and Preventing the Spread and Impact of COVID-19 [29]	Quantitative	**Benefits:** Students were not affected by COVID-19 since their education proceeded with M-learning.	Google Meet, Zoom, emails	University learners	M-learning allowed students to continue their education while avoiding the spread of COVID-19. Furthermore, the learning materials presented via M-learning were well-organized and useful to the students.
ControlDroid: A M-learning platform to learn and teach control systems in technology and engineering [30]	Qualitative	**Benefits:** Home-based laboratory experiments are both cost-effective and convenient.	Google visual tool Blockly	Engineering and Technology learners	Conducting practical lab work is one of the most challenging aspects of online education, although it is partly mitigated by the availability of a home laboratory.
Teaching-learning practices and methods for the elderly: support for pedagogical and accessibility guidelines [31]	Quantitative	**Challenges:** Language barriers, cognitive difficulties, and lack of patience.	Not mentioned	Senior citizen	Because of the nature of simulated teaching, maintaining composure is often difficult, and evaluations are tough to carry out.
Mobile Learning Adoption: An Empirical Study [32]	Quantitative	**Benefits:** Ease of use, regardless of gender, age, or educational institution. **Challenges:** Security and privacy concerns, the danger of diversions, mobile device screen size, data security, content concerns, financial limitations, and certain technological difficulties.	BYJU'S, SWA YAM, and NPTEL (Learning Management System available in India)	University learners	M-learning adoption is limited in developing countries such as India due to the lack of Internet access and power supply.
Adaptive Virtual Learning System Using Raspberry-Pi [33]	Qualitative	**Benefits:** Flexibility, offline version of the content, and practical assessment, which develops the student's skills. **Challenges:** Offline access to material and assessment is cumbersome for widespread usage.	Moodle	Remote village learners	Learners have the choice of progressing through the course according to their level of comprehension. On the other hand, owing to the large volume of learners on the online platform at the same time, there is a possibility of platform inaccessibility due to network or server failures.

Table 1. *Cont.*

Title	Method	Benefits and Challenges	Platform	Target Population	Findings
Engineering Students' Virtual Learning Challenges during COVID-19 Pandemic Lockdown: A Case Study [34]	Qualitative	**Challenges:** Availability of the content and ystem	Not mentioned	Nigerian engineering learners	It is a challenge to implement M-learning in areas where electricity and Internet access are unreliable.
Problems and Opportunities of Using LMS Moodle before and during COVID-19 Quarantine: Opinion of Teachers and Students [35]	Qualitative	**Benefits:** The content is organized **Challenges:** Instability, lack of active communication, and comprehension of the goal.	Moodle (Learning Management System)	University learners and educators	Students and teachers are more comfortable using social media over Moodle for active communication, and a deadline reminder plugin is expected.
Mobile Learning in Higher Education: Structural Equation Model for Good Teaching Practices [36]	Qualitative	**Benefits:** Mobility	Not mentioned	Spanish university educators	Students recognized the need for mobile learning and adapted appropriately since it was their only choice to continue their studies throughout the pandemic.
An empirical examination of continuous intention to use M-learning: An integrated model [37]	Quantitative	**Benefits:** Improves learner satisfaction and performance.	Not mentioned	Postgraduate learners	M-learning is more beneficial for postgraduate students since their maturity, flexibility in critical thinking, communication, and analytical skills are better compared to younger learners.
My CS1 class flipped over COVID-19 [38]	Qualitative	**Challenges:** Content problem	YouTube (PowerPoint slides and Google Meet video)	Programming learners	The content was supposed to be given in a conventional face-to-face session, but COVID-19 forced it to be offered online, which presented difficulties for the students.
Teacher's Readiness to Adopt Mobile Learning in Classrooms: A Study in Greece [39]	Qualitative	**Benefits:** Mobility **Challenges:** Non-ICT and aged educators	Not mentioned	Educators	Both technical and non-technical educators should embrace emerging M-learning trends.
COVID-19 impact on undergraduate teaching: Medical radiation science teaching team experience [40]	Qualitative	**Challenges:** Conducting experiments without a laboratory	Zoom	Mainly undergraduate learners	It is a challenge to set up laboratory services for the medical sector using M-learning.
Mobile learning in chemical engineering: An outlook based on case studies [41]	Qualitative	**Benefits:** Active participation attracts and maintains students' attention. **Challenges:** Issues with connectivity and a lack of attention on the lecturer	Platforms used for testing learners (Kahoot, Socrative, and Mentimeter), platforms used for improving the quality of classroom learning (Mindomo, Genially, social networks, and Quizlet), platforms used for sharing content (Padlet, Google Classroom, Moodle, and Concept Warehouse)	Chemical Engineering learners	Although the tools are all open source and inexpensive and help in directing learners' focus to the course, the connection issue detracts from students' interests.

Table 1. *Cont.*

Title	Method	Benefits and Challenges	Platform	Target Population	Findings
A Conceptual Framework for Mobile Learning Development in Higher Education [42]	Qualitative	**Challenges:** Lack of information, opportunity, and practice in Bulgaria	Not mentioned	Bulgarian learners	There is no practice or platform for online learning in Bulgaria.
A Sprint-Based Approach to Teaching Computer Science [43]	Quantitative	**Benefits:** Own tasks, minimize chances for cheating, maximize educator–learner interaction time, and allow one to work remotely.	Google Classroom	Computer science learners	The platform will increase students' capacity for creativity, while the soft copy of the code will reduce their tendency for cheating.
Investigation and Analysis of Learning Anxiety for Online Teaching in Universities and Colleges under the Epidemic Situation [44]	Mixed methods	**Challenges:** Inability to respond in real time, a lack of communication, and anxiousness.	MOOC, Rain Classroom, Tencent Classroom, WeChat, icourses, and some Chinese application	Chinese learners	Inadequate communication and the response of the student. Communication mainly takes place electronically.
New challenges for teacher education introduced by the use of ICT in the classrooms [45]	Qualitative	**Challenges:** Educators lack skills on the online platform as well as in assessment strategies.	Not mentioned	Educators	Educators should be provided with guidance and training on preparing online courses and exams.
Teachers' adaptation to technologies during the pandemic by COVID-19 [46]	Qualitative	**Challenges:** Lack of adaptation and interaction between learners and educators.	Google Forms, PowerPoint, Prezi, Zoom	High school learners and educators of Portugal	As a consequence of the online platform, there is a lack of interaction and connection between learners and learners.
Impact of COVID-19 and "Emergency Remote Teaching" on the UK Computer Science Education Community [47]	Mixed methods	**Challenges:** Issues with assessment and examination.	Not mentioned	Computer science learners	Due to the evaluation problem, and a dearth of practicum opportunities, the quality of online instruction is compromised as compared to face-to-face instruction.
The Application of IoT layer one Based Mobile Labs in Engineering, Science and Technology Education [48]	Quantitative	**Benefits:** Cost-effective and easily accommodates a large numberof learners.	Tinkercad	Engineering and Technology learners	The IoT-based labs were very beneficial since they accommodated a large number of learners with little resources and could be performed remotely. Additionally, they have an assessment function for grading the students.
Nursing Faculty Experience with Online Distance Education During COVID-19 Crisis: A Qualitative Study [49]	Qualitative	**Challenges:** Practical work and Assessment problem	Zoom	Medical Nurse learners	Medical practical lab work and assessment is very different to provide through online education.

As shown in Table 1, it is noted that 11 articles discussed the benefits of M-learning, 15 articles focused on the challenges of using M-learning, and only 5 of them covered both aspects. Eighteen articles targeted learners, five targeted educators, and two articles targeted both groups. Engineering learners are the most popular group covered. Among these learners, computer science engineering learners were the highest. Several articles focused on the geographical location, the challenges, and benefits depending on the

location, culture, and economy. Furthermore, 12 articles followed a qualitative method, 7 articles used a quantitative method, and 2 articles used a mixed-methods approach.

As per the objective of this review, we aim to assess the advantages and disadvantages of M-learning. The evident pros and difficulties were identified. The most significant benefits of M-learning, as stated in Table 1, are its mobility and flexibility. Aside from that, organized content is another significant benefit of M-learning. The most prevalent drawbacks are content issues, lacking connection, and lacking laboratory facilities. Moreover, several different platforms were mentioned, with Moodle, Zoom, Google Meet, and YouTube being the most common platforms. Figure 2 illustrates the proportion of evaluated papers classified according to their advantages, difficulties, and both.

Figure 2. Percentage of the articles reviewed based on categories: benefits, challenges, and both.

4. Discussion

This section discusses the benefits and challenges of adopting M-learning in Science and Technology courses.

4.1. Benefits

To avoid contracting COVID-19, the first and most important precaution is to keep a safe distance [50]. Globally, most educational institutions have embraced distant learning education through M-learning. Learners are not required to attend face-to-face lectures, but rather attend courses online. M-learning aids in the prevention of the further spread of COVID-19 in schools, colleges, and institutions [29]. Stability and adaptability were the most often cited characteristics in the examined publications [36]. M-learning allows learners and educators to continue their education from any location. They save a lot of time because they do not need to commute to campus for lectures [39]. Furthermore, it allowed learners to study on their own time. Learners and educators can complete their teaching and learning tasks at any time from any location. M-learning makes lessons and class materials available online and offline, too, via a variety of platforms, including Padlet, Google Classroom, Google Meet, Moodle, Concept Warehouse, and YouTube videos [21,39]. A large number of people can take the same course at the same time through online education, whereas offline courses are confined to a fixed number [36]. When comparing the two methods of learning, online is preferable for dealing with a large number of students, provided the course is well-designed [24,36]. The most significant feature of M-learning is its mobility and flexibility, which contributed to its popularity in the world.

The content of education is crucial. Lectures, class materials, sample questions, and other educational resources should all be available through the online education system. Conducting the course is impractical without the appropriate resources. Before the epidemic, online education was not extensively utilized [51]. Now, it is a prevalent and widely

used platform. To organize learning materials, it is suggested to use a learning management system. Educators can easily import all materials into the system according to courses and monitor the usage by learners easily [35].

Inventory costs, such as electricity bills and transportation, have dropped significantly since the schools closed and online education took over. The maximum number of students per class was also noted to increase. Simulated labs enable many learners to engage concurrently in a session [48]. Furthermore, learners are more likely to attempt a task many times if they fail the first time, allowing them to expand their horizons. Transitioning from conventional to completely mobile learning is a cost-effective strategy for institutions. When built properly, particularly for Science and Technology courses, online lab facilities would enable learners to do practical work at their own pace from any location [30].

Educators can engage students' attention via the use of a variety of online tools and apps, including Kahoot, Socrative, and Mentimeter. These often encourage learners to pay attention during the lesson [41]. In contrast to in-person assessments, which make it harder to identify cheating, online exams enable instructors to detect plagiarism via the use of applications such as Turnitin, Unicheck, and PlagScan. These practices assist learners in retaining their uniqueness and developing their intellect, innovation, and dynamism, while also benefitting the institution's budget due to the absence of paperwork in the assessment [43]. Figure 3 outlines all of the benefits of M-learning.

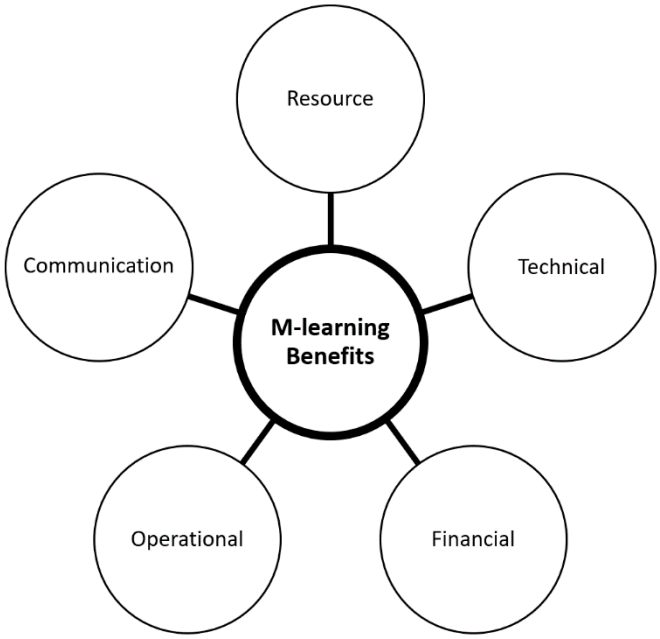

Figure 3. Benefits of M-learning.

4.2. Challenges

Resource problems include content issues, offline versions of content and appraisal used for online modes, and a lack of knowledge in using the system. The resources required for online learning should be available. If the required resources, content, or material are available, M-learning would deemed be successful. These resources are dependent on the medium of instruction, whether online or offline (traditional) [33]. Therefore, they should be altered based on the medium of instruction. For example, due to COVID-19, learning institutions abruptly had to go online, with content prepared for traditional face-to-face classes [38]. Moreover, some of the existing content is not suitable for conducting online education. It can be challenging to develop content for online teaching mode due to lacking knowledge, structure, skills, and location as the opportunities are not the same in different parts of the world [42]. Furthermore, the platform used for M-learning should be

designed to support a large number of users. Increased user traffic may affect the delivery of online education.

Life has improved drastically due to recent technological advancements [52], but people may find it hard to deal with age. Aged educators and learners do experience challenges in adapting to M-learning technology [31]. Non-ICT educators and learners find it harder to adjust to the latest online learning without proper hands-on training [39]. Furthermore, many educators find it challenging to teach entirely online. Preparing materials for M-learning is time-consuming and complicated [45].

Communication plays a vital role in the education system. It is challenging to execute teaching and learning activities without face-to-face contact between learners and educators [53]. Moreover, the platforms used for online education are not always effective in maintaining contact between them [44]. All are expected to conform to this new mode of communication and deal with machines rather than humans. Traditional teaching and learning was conducted through human-to-human contact before COVID-19, but now it is human to computer to human transmission. As a consequence, a substantial communication gap exists between learners and educators [46]. Online classes are commonly held using platforms such as Zoom, Teams, Tencent Classroom, and Google Meet. However, connectivity problems, massive usage, hardware issues, and the noisy environment of the user affect the quality of communication between learners and educators. People are more comfortable communicating using social platforms instead of educational platforms [35,44]. Non-ICT learners find it hard to keep in touch with their educators and to resume their studies online. They were not accustomed to using computers and were hesitant to follow directions, making it impossible for them to appreciate online education [31].

One of the most critical aspects of education is evaluation. Any educational institution is expected to ensure that assessment proposals are transparent and safe. Due to the pandemic, institutions have moved online to educate learners without a suitable evaluation mechanism [54]. Most institutions are unable to guarantee the appropriateness of the evaluation techniques employed for assessments. There is a significant disparity between offline and online assessments [49]. The Internet possesses many benefits for facilitating online education but presents major obstacles when it comes to assessments, as it is an open platform that can assist learners, and during an assessment, learners can request help from others [47]. Educators are in need of a solution to address the challenge they are facing to assess learners online [54].

When it comes to adopting M-learning for educational reasons, connectivity is a major stumbling block. It is mostly caused by power failures [34]. It may affect the learners, and instructors may have difficulties interacting with them, running courses, obtaining resources, and evaluating learners. This Internet and electricity issue is location dependent. It may vary from 0% in affluent nations and other regions to 90% in third-world countries [42]. According to the World Bank, 84% of European Union member states had access to the Internet in 2018, compared to 66% in Latin America and 18% in the least developed nations (LDC) [55]. Due to their scarcity, measurement and inspection have become exceedingly challenging. M-learning was not widespread in certain regions, and as a result of this pandemic, the education system was compelled to move online. Consequently, there were no established practices or sufficient potential, which contributed to high operational expenses and difficulty in resolving issues [34,41].

Online education requires a high level of data protection and privacy. Confidentiality, integrity, and availability of data may all be classified as technological difficulties encountered while implementing M-learning [32]. When doing laboratory work, Science and Technology students confront considerable obstacles. Providing laboratory facilities in the virtual world is challenging. Medical, engineering, and technology students need a hands-on laboratory environment. This is one of the most pressing problems confronting M-learning. Courses that need hands-on lab work are often hampered by online education because instructors are unable to provide the necessary lab training. As a consequence, learners passed an online course without gaining any hands-on experience [40,49].

Furthermore, the reviewed articles highlight motivational, problem-solving, psychological, and economical issues. The resources required for online education, content preparation, and training are costly and time-consuming [32]. The COVID-19 pandemic struck suddenly, and no one anticipated the ramifications. Moving online to continue teaching and learning occurred unexpectedly. Learners and educators have been forced to confront the issue and adapt to the new norm. Numerous individuals suffer from anxiety and other psychological problems that make it difficult to match with the current practice. The learning environment is different today than it was before since everyone takes courses and exams online. As a result, neither peers nor the institutional environment motivates learners [29,46]. System problems are also listed as a barrier to M-learning.

In addition, learners lack passion and are easily overwhelmed when it comes to formal education through the Internet [56]. Both educators and learners are unable to maintain sustained attention for a prolonged length of time. Concentrating on the lecture is a challenge for learners if the lecture was not interactive and the lecturer lacked the necessary skills to attract learners' attention [32,41]. Figure 4 summarizes all of the identified M-learning issues.

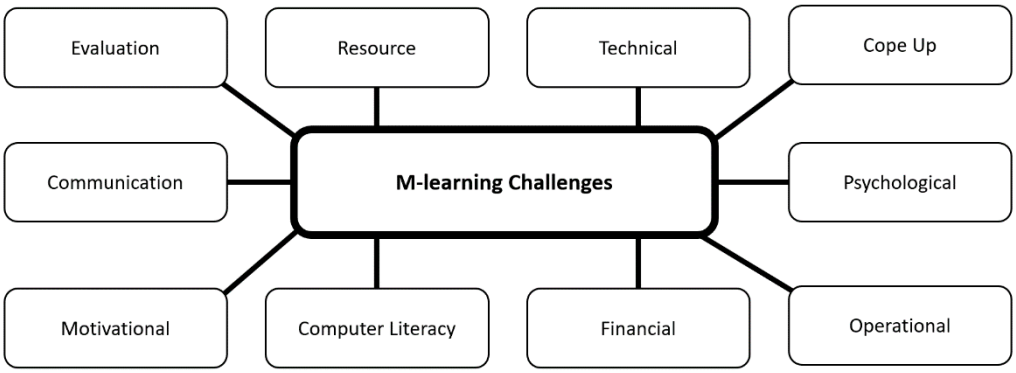

Figure 4. Challenges of M-learning.

5. Summary and Recommendations

To summarize, before COVID-19, most academic institutions were hesitant to employ M-learning for education, resulting in a lack of experience among learners and educators at those institutions in pursuing education online. The pandemic prompted a major shift, leading institutions to leverage online education via M-learning. A huge number of learners and educators went online during this period to proceed with education-related activities. The pressing use of M-learning during this period revealed many insightful experiences, both positive and negative, adding a new perspective toward the use of M-learning for education for now and the future. Even though face-to-face learning may soon take place for all, there is a high possibility that learners and educators worldwide may continue to leverage M-learning for education. We have analyzed feedback gathered from learners and educators. It is noted that several M-Leaning platforms became popular during the pandemic, and academic institutions were experimenting and leveraging them to pursue with their teaching and learning activities. Many institutions offered their services through these platforms. Although there are other issues such as security and privacy associated with such platforms [57], institutions were compelled to use a third-party platform instead of developing their own due to a lack of time. This review of the pros and cons of leveraging M-learning for education would enable institutions to understand the needs and expectations of learners and educators toward M-learning platforms. It would also aid them in building their own platforms or customizing existing ones to address the shortcomings identified.

The benefits and limitations of using M-learning for Science and Technology courses are discussed above. Here are some suggestions to improve the teaching and learning experience with M-learning. Learners and educators can be given a handbook or demon-

stration video on operating and using the system. It will be useful to assist both groups in making effective use of M-learning for education. For learners, and even educators, an educational institution may follow different guidelines for different courses. Hence, if the educators use the guidelines, the learning materials will be more resourceful. In class, quizzes can be arranged to engage learners' attention to the lectures. Learners need to be more focused than in the traditional classroom to achieve this. Furthermore, learners should be encouraged to participate in other group discussions to stay motivated.

Evaluations are necessary for learners, and these must be implemented flawlessly. To prevent cheating, M-learning can include features such as freezing the program so that nothing can be done at that time of assessment and the continuous recording of the participant's video is suggested. Even if the connection is lost, the procedure will remain the same. The answer sheet and the lost session will be instantly uploaded. Finally, the program must be light in weight so that users with low data rates can access it. Implementing any casting can be a useful way to avoid the issue of connectivity.

6. Conclusions

Education is the backbone of a nation [58]. Therefore, no matter what happens, education should proceed as it was before as much as possible [7]. The COVID-19 pandemic has significantly impacted the education sector. However, learning institutions need to continue devising suitable ways to ensure teaching and learning activities to proceed without much hindrance. It is established from the reviewed articles that education cannot proceed using the traditional way—it needs to change! A new form of delivery is expected, which is possible through the potential of M-learning. The widespread use of mobile learning applications has allowed learners and educators to stay at home and safe during this COVID-19 pandemic; furthermore, this has reduced the spread of the virus through face-to-face classrooms in learning institutions by enabling education to continue online. The challenges and benefits of the current use of M-learning are reviewed following the PRISMA method. This study would aid application developers in improving M-learning platforms for Science and Technology courses, wherein they can identify the present strengths and weaknesses of M-learning implementations and modify them accordingly. Finally, the recommendations included would be helpful to learning institutions in amending their policies to proceed with online education successfully.

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