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Mobile Learning for COVID-19 Prevention

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Abstract

In recent years, due to the explosion of COVID-19, people's expectation for accessing personalized learning resources anytime and anywhere has become stronger. The features of m-learning such as accessibility and personalization greatly satisfy people's needs and are therefore widely used. In this paper, a study was conducted to investigate and analyze how m-learning can help prevent COVID-19. The study shows that m-learning can help disseminate outbreak-related messages and provide people with personalized knowledge, so that it can enhance public health and community safety. While there are still many challenges, m-learning remains a valuable tool for preventing and mitigating the spread of COVID-19 globally, and provides a solid reference for deepening m-learning development in the future.

Keywords: Mobile Learning, COVID-19 Prevention, Public Health, Personalized Learning Materials

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1. Background of Mobile Learning

Mobile learning, often referred to as m-learning, is a pedagogical approach that meets the learning expectations of learners by integrating new technologies into the learning environment [1]. Due to the progress of science and the proliferation of mobile devices, m-learning makes access to learning resources and opportunities easier through the use of interactive devices such as smartphones and tablets [2] . Therefore, m-learning is seen as an effective method of optimizing the allocation of educational resources and expanding education equity [3] .

During the early days, scholars defined mobile learning as, "learning with handheld devices as tools" [4] . Mobile learning initially originated from the research program of "WirelessAndrew" at Carnegie Mellon University in the United States, and then developed rapidly in Europe, America and other developed countries. At present, the software and hardware equipment for mobile learning has been developed quite maturely in Europe and the United States. In China, mobile learning started late, but in 2007, Shanghai Television University carried out "mobile interactive teaching", realizing the first step of China's mobile learning.

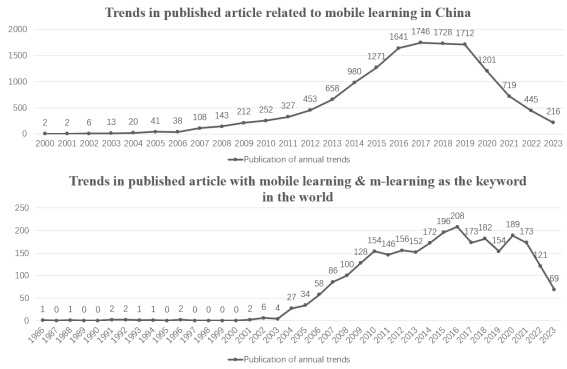

Figure 1. Schematic diagram of the trend of the number of Chinese and foreign article with mobile learning

Figure 1 illustrates the trend of published related literature over the years searched using m-learning as a keyword. With the continuous development of mobile technology and the deepening of mobile teaching applications, we summarise the advantages of m-learning in the following five main points [5]:

Accessibility: Extensive learning materials can be freely accessed by students anytime, anywhere [6] . Simultaneously, informative and intelligent learning materials give mobile

learning spaces both virtual and real features and functions, making learners' learning spaces include not only physical experiences and subject interactions in physical places, but also media support and information interactions in virtual environments [7] .

Personalization: Mobile apps and learning platforms can meet the personalized needs of learners in terms of content and learning paths according to their different characteristics [8] . Information can be filtered systematically to recommend content and paths that meet the learner's needs, and the presentation can be changed according to the learner's learning style [9] .

Interactivity: The incorporation of multimedia elements, gamification, and real-time feedback can help students improve their learning concentration and really connect with knowledge [10] . At the same time, it can also help teachers understand the learning situation of learners in real time and make timely teaching adjustments [11] .

Collaboration: Students can easily connect with peers and educators through discussion forums, messaging, and video conferencing [12] .From the perspective of collaborative learning, learning itself is the process of engaging in a community of practice [13] .This type of learning can create group cohesion and help students to improve their learning effectively [14] .

Flexibility: The flexibility of m-learning is reflected in the modularity of the learning content and the fragmentation of knowledge, allowing learners to take advantage of fragments for informal learning at any time.

The remaining paper is organized as follows: Section 2 describes several tools commonly used in mobile learning. Section 3 gives some measures which can effectively prevent COVID-19. Section 4 details how mobile learning can help prevent the spread of COVID-19 in the era of outbreaks. In Section 5, we analyze the difficulties and challenges that exist in mobile learning today. Section 6 proposes some methods and criteria for evaluating m-learning for preventing COVID-19. Finally, we conclude that m-learning as a pedagogical approach is a valuable resource for preventing and mitigating the spread of COVID-19 globally.

2. Tools of Mobile Learning

The portability and affordability of mobile devices have made them widely accepted and utilized by the masses in the digital age [15] . Mobile learning relies on a variety of tools and technologies to facilitate effective and engaging educational experiences for learners [16] . These tools and technologies encompass both hardware and software components [17] . Here are some key categories of tools and technologies commonly used in mobile learning:

Mobile Devices: The foundation of mobile learning is the hardware itself, which includes smartphones, tablets, and even laptops [18] . These devices provide learners with the flexibility to access educational content, apps, and resources anytime, anywhere. Their portability, touch interfaces, and internet connectivity make them ideal for on-the-go learning.

Mobile Apps: Mobile applications are specialized software designed for mobile devices [19] . Educational apps can cover a wide range of subjects and learning styles, from language learning apps to interactive math games [20] . Learning management system (LMS) apps allow students to access course materials, participate in discussions, and submit assignments on their mobile devices. Popular examples include Duolingo for language learning and Khan Academy for mathematics [21] .

Learning Management Systems (LMS): LMS platforms such as Moodle, Canvas, or Blackboard, often have mobile versions or apps [22] . They provide a centralized location for instructors to upload course materials, manage assignments, and track student progress. Students can access course content, interact with peers, and receive feedback via the LMS, making it a critical component of mobile learning [23] . Table 1 shows the more widely used learning management systems today, with a list of when they were created and descriptions.

Table 1. Summary of some common Learning Management Systems

LMS	Time	Description
TalentLMS	2012	A flexible and scalable cloud-based LMS solution for enterprise and corporate training programs. It simplifies the entire e-learning process from authoring to evaluation and also provides great gamification tools to better engage trainees.
SAP Litmos	2019	An award-winning LMS that enables companies to quickly create, manage, deliver, and track self-paced, instructor-led, or blended training across every department through any platform, anytime, anywhere. Companies realize greater productivity, employee engagement, and reduced training costs with Litmos solutions.
Docebo	2005	Docebo sells its LMS solutions in 35 languages to more than 80 countries. Designed to improve learning engagement and performance, the Docebo is known for its ease of use, allowing customers to combine tutoring with social and formal learning, and the 70/10/10 model has been validated through extensive research.
iSpring Learn LMS	2001	It can be used to develop e-learning courses and create specific learning paths. Simultaneously, it can manage online seminars and trainings

		from a single screen, add game elements to training, perform online assessments, and generate advanced reports.
LearnUpon	2013	A one-stop solution for your organization's learning needs. It has all the tools and features you need to manage and create content, build and deliver courses, analyze and report on student progress, and more.
eFront	2012	It provides you with an adaptable and scalable LMS solution that gives you complete control over your training materials, modules, and other related documentation.
SkyPrep	2016	A simple, intuitive, and advanced LMS tool that simplifies training and onboarding. It offers powerful tools and features that make the company a strong contender for top LMS software companies.
eCoach	2023	An online LMS and authoring platform that offers dozens of free training modules that you can edit and customize to r your training program and br d.
Moodle	2013	It provides learners, educato and administrators with powerful, secur tegrated system to eate cu omized learning environm s. It combines fferent meth logie is ideally s d to learning irements of ools and colle as well as t training needs f businesses and corporatio
Schoology	2010	It provides earning modules for K-12 schools, higher education institutions and com rcial enterprises. It allows y to easily manage, share and eate training and educational content and resources online.

ugmented Reality (AR) and Virtual Reality (VR): AR a VR technologies have been increasingly integrated into mo learning [24] .AR apps can overlay educational inform n in the real world, creating interactive and immersive experiences [25] .VR applications offer 360-degree, three-dimensional environments for educational simulations. These technologies can enhance learning in subjects like science, history, or even medical training.

Additionally, cloud-based services, e-books, video conferencing tools, and social media platforms are also integral to the mobile learning ecosystem. It's essential for educators and institutions to select and integrate the appropriate tools and technologies that align with their pedagogical goals and the needs of their learners [26] . When used effectively, these tools can foster engagement, interactivity, and accessibility, thereby enhancing the overall mobile learning experience.

3. COVID-19 Prevention

The spread of an infectious dis e requires the si ltane s presence of three basic com ents: the urce of i ion, the means of transmission, d the sceptible population [27] . The receptor fo OVI 9 angiotensi onverting enzyme2 which ha very high a ity with OVID-19. At the same time, mber of ACE2 nta ng cells in the body are exp d to . Once expose e envelope of the COVID-19 virus fuses th the cell membrane, releasing viral genetic material and enerating more viral protein struc es. It is the unique stru e of COVID-19 that causes it remely transmissible and makes it difficult to control. Pr enting the sp ad of COVID-19 [28] involves a co bination of ind dual and community-level efforts to red the transmis n of the virus [29] . Here are some key measu to prev COVID-19:

Vacci n: Widespread vaccination is one of the most e tive ways to prevent COVID-19 [30, 31]. Getting vacci not only reduces your risk of severe illness but also contributes to community immunity, which helps protect those who are unable to get vaccinated due to medical reasons. It is essential to follow national and local vaccination guidelines and schedules.

Hygiene Practices: Practicing good hand hygiene is crucial. Regularly wash your hands with soap and water for at least 20 seconds, especially after being in public spaces or touching surfaces [32] . If soap and water are unavailable, use hand sanitizer with at least 60% alcohol. Avoid touching your face, particularly your eyes, nose, and mouth, as this can introduce the virus to your respiratory system.

Face Masks: Wearing face masks, especially in indoor or crowded settings, can help prevent the spread of respiratory droplets that may contain the virus [33] . Masks are particularly important in areas with high transmission rates or when it is difficult to maintain physical distance from others. Follow local guidelines on mask-wearing, and use masks that provide adequate protection.

Physical Distancing: Maintain physical distance from others, particularly in crowded or indoor environments [34] .This reduces the risk of close contact with infected individuals and the transmission of respiratory droplets. Follow local recommendations regarding the specific distance to maintain from others.

Good Respiratory Hygiene: Cover your mouth and nose with a tissue or your elbow when you cough or sneeze [35] . Dispose of tissues in a closed trash container and wash your hands immediately. This prevents the spread of respiratory droplets that may contain the virus.

Regular Cleaning and Ventilation: Regularly clean and disinfect frequently touched surfaces in your home and workplace [36] . Adequate ventilation can help dilute and remove viral particles from indoor spaces.

Stay Informed: Keep up to date with the latest information and guidelines from reputable sources such as the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and your local health authorities. Follow the guidance provided to stay safe and adapt to changing circumstances.

Quarantine and Isolation: If you have symptoms of COVID-19, have tested positive, or have been in close contact with someone who has COVID-19, it's essential to follow quarantine and isolation guidelines provided by health authorities [37] . This helps prevent the further spread of the virus.

Travel Safely: If you need to travel, follow guidelines for safe travel, such as wearing masks, practicing physical distancing, and adhering to quarantine or testing requirements as necessary [38] .

Table 2. How Measures Stop the Spread of COVID-19

Measures	Isolating the source of infection	Blocking the path of transmission	Focusing on susceptible populations
Vaccination	√		√
Hygiene Practices		√	√
Face Masks		√	
Physical Distancing		√	
Good Respiratory Hygiene			√
Regular Cleaning and Ventilation		√	
Stay Informed			√
Quarantine and Isolation	√	√	
Travel Safely		√	

Prevention of COVID-19 is a collective effort that requires individuals, communities, and governments to work together [39] . Table 2 analyses how measures control the spread of new crowns in three basic segments. Adhering to public health measures, getting vaccinated, and staying informed are key steps in mitigating the spread of the virus and protecting public health [40] .

4. Mobile Learning helps COVID-19 Prevention

Mobile learning can play a significant role in COVID-19 [41, 42] prevention by facilitating the dissemination of vital information, promoting health awareness, and offering remote educational opportunities [43] . Here's how mobile learning can assist in COVID-19 prevention:

Dissemination of Information: Mobile learning platforms, including educational apps, websites, and messaging services, can be used to deliver accurate and up-to-date information about COVID-19 [44] . This includes information on symptoms, prevention measures, vaccination schedules, testing locations, and quarantine guidelines. Users can access this information at their convenience, helping to dispel myths and provide trustworthy sources of information.

Health Education and Awareness: Mobile learning can be utilized to create and distribute educational content about COVID-19 and public health practices [45] . This content can include video tutorials, interactive simulations, and infographics to help individuals understand the virus and learn proper hygiene, mask-wearing, and social distancing techniques. Gamification and quizzes can make learning engaging and fun, reinforcing the importance of these practices.

Remote Learning for Healthcare Professionals: Mobile learning can support the training and education of healthcare professionals who are at the forefront of combating COVID-19 [46] . Online courses, webinars, and mobile apps can provide access to training on topics such as infection control, telemedicine, and contact tracing, ensuring that healthcare workers are equipped with the latest knowledge and skills.

Promotion of Telehealth Services: Mobile apps and platforms can connect users with telehealth services, allowing them to consult with healthcare providers remotely [47] . This reduces the need for in-person medical visits, helping to mitigate the spread of the virus. Telehealth can be used for initial COVID-19 assessments, monitoring symptoms, and providing medical advice, contributing to early detection and intervention.

In summary, mobile learning is a versatile tool in the fight against COVID-19. It empowers individuals with knowledge, encourages health-conscious behaviors, supports healthcare professionals, and promotes access to telehealth services [48] .As Figure 1 shown, by leveraging mobile learning technologies, we can use mobile learning to provide personalized learning materials to users, enhance public health efforts, and reduce the spread of the virus, ultimately contributing to the prevention and control of COVID-19.

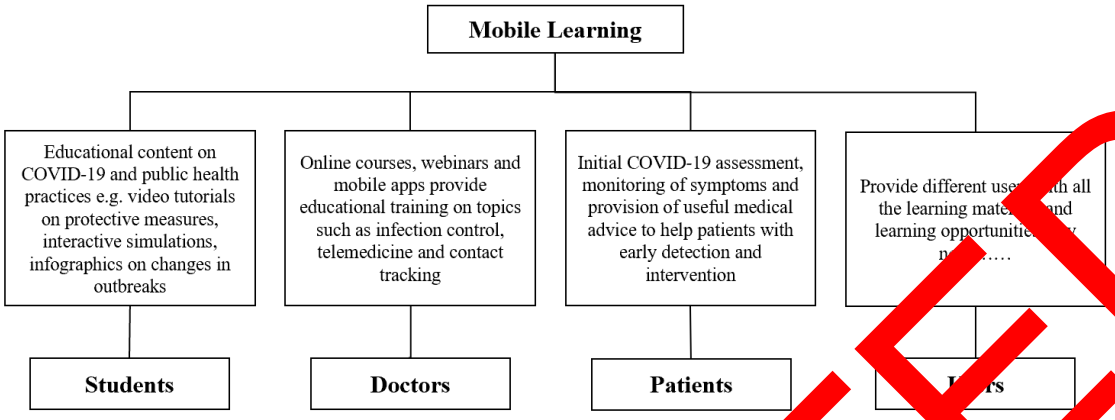

Figure 2. Schematic diagram of personalized learning materials provided by m-learning for different users

5. Challenges of Mobile Learning

However, due to the drawbacks of mobile devices and human misuse, mobile learning comes with several challenges that need to be addressed for successful implementation [49] . Here are some of the key challenges of mobile learning:

Device and Connectivity Disparities: One of the most significant challenges in mobile learning is the unequal access to devices and reliable internet connectivity [50] . Not all students have access to smartphones, laptops, and variations in device capabilities can lead to disparities in the learning experience. Additionally, the availability and quality of internet connections can be inconsistent, hindering access to online resources [51] .To overcome this challenge, institutions and educators must consider alternative delivery methods and ensure equity in access to technology.

Digital Literacy: Not all learners, especially older adults and individuals from disadvantaged backgrounds, are equally familiar with digital technology and mobile applications [52] . Mobile learning assumes a certain level of digital literacy, and some students may struggle to navigate apps, platforms, or troubleshooting technical issues. Educators must provide support and resources for learners to develop digital literacy skills and troubleshoot common technical problems [53] .

Distraction and Lack of Focus: Mobile devices are versatile and offer numerous distractions, including social media, games, and messaging apps [54] . These distractions can interfere with a student's ability to focus on educational content. Maintaining student engagement and minimizing distractions is a continuous challenge for educators in the mobile learning environment. It requires effective instructional design and the use of engaging and interactive content to keep learners motivated.

Security and Privacy: Mobile devices can pose security and privacy risks. Educational institutions must handle sensitive student data responsibly and protect it from unauthorized access [55] . Moreover, mobile apps and platforms may collect and transmit user data, potentially raising concerns about privacy. Ensuring the security of both the technology and the personal information of learners is an ongoing challenge that requires robust policies and practices.

Pedagogical Adaptation: Traditional teaching methods may not seamlessly translate to mobile learning. Educators need to adapt their pedagogical approaches to make the most of mobile learning's capabilities, such as interactivity, multimedia, and personalization. This adaptation often necessitates professional development and training for instructors.

Assessment and Evaluation: Traditional methods of assessment may not be suitable for mobile learning environments. Ensuring the validity and integrity of assessments while preventing cheating can be more challenging in online and mobile settings. Educators must develop appropriate assessment methods and utilize technologies that can help monitor and authenticate student work.

Content Adaptation: Creating and adapting content for mobile learning can be time-consuming and resource-intensive [56] . Content must be responsive to different screen sizes and device types. Additionally, not all educational materials are readily available in mobile-friendly formats. Institutions may need to invest in content development or utilize content authoring tools to ensure accessibility.

Technical Issues and Support: Mobile devices can encounter technical issues, such as app crashes,

connectivity problems, or compatibility issues. Students and instructors may require technical support to address these issues promptly. Providing accessible and responsive technical support is essential for a smooth mobile learning experience.

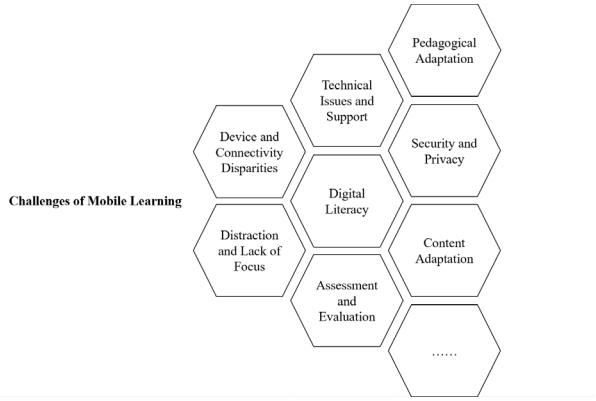

Figure 3. A graphic representation of the current challenges of mobile learning

Addressing these challenges requires a collaborative effort involving educators, institutions, technology providers, and policymakers. As shown in Figure 2, there are still many issues facing mobile learning. Through careful planning, the appropriate resources, and a focus on inclusivity and student success, these challenges [illegible] needed to be mitigated that make M-Learning a m[illegible] effective and accessible educational option.

6. Evaluation of Mobile L[illegible]arning on COVID-19 Preventi[illegible]n

Evaluating the effectiveness [illegible] mobile [illegible]rning in the context of COVID-19 [57[illegible]8] prevention [illegible] critical to assess its impact on dis[illegible]n[illegible]g information, [illegible]omoting healthy behaviors, and [illegible]upporti[illegible]ublic health e[illegible]orts [59] . Common evaluat[illegible]n methods and [illegible]teria include:

Knowledg[illegible]nd Awareness Ass[illegible]ment: One of the primary obj[illegible]ves of mobile learning i[illegible] COVID-19 [60, 61] preve[illegible]on is to i[illegible]rease knowledge and awareness among use[illegible] [62] . Evaluation involves pre-and post-assessments t[illegible]asure the c[illegible]nge in knowledge levels r[illegible] COVI[illegible]9, its s[illegible]ptoms, prevention measures, [illegible]nd the i[illegible]portance [illegible]cination. Surveys, quizzes, and knowled[illegible] tests within mobile apps or platforms can be used t[illegible] [illegible]ffectiveness of educational content. An [illegible]se in correct responses in post-assessments indicates t[illegible] success of the mobile learning intervention.

[illegible]havioral Change and Adherence: Effective COVID[illegible]9 [63, 64] prevention goes beyond knowledge to actual behavioral change [65] . Evaluations should measure whether users have adopted recommended health behaviors, such as mask-wearing, hand hygiene, physical distancing, and vaccination. This can be assessed through self-reporting, observation, or tracking mechanisms integrated into mobile apps. For example, users can self-report their adherence to health practices or use mobile apps to track their compliance with recommended measures.

Engagement and Interaction: The level of engagement with mobile learning materials is an essential factor in evaluation. Metrics such as the number of logins, the time spent on the app, the completion of module[illegible]nd the frequency of interactions with educatio[illegible] conte[illegible]an indicate user engagement. High leve[illegible] of engagem[illegible] suggest that the content is engagi[illegible]nd effective i[illegible] holding the user's attention, which [illegible] essential fo[illegible] knowledge retention [66] .

User Feedback and S[illegible]eys: Collecti[illegible] feedb[illegible] from mobile learning use[illegible] through s[illegible]eys, rati[illegible] and reviews provides valuab[illegible] insights [illegible]to user satisfaction and the perceived i[illegible]pact [illegible]h[illegible] intervention[illegible] Users can share their thoug[illegible]on the cla[illegible] of inform[illegible]on, the user-friendliness [illegible] app or pla[illegible]m, [illegible]d the overall effectiven[illegible] of t[illegible] learning experi[illegible]. Their feedback can inform iterative i[illegible]rovements and refinements to the mobile learning program[illegible]

Table 3. Assessment methods and assessment cr[illegible]ria for mobile learning

[illegible]sessment crit[illegible]a	Content elements of measurement
Knowl[illegible] and [illegible]wareness Assessment	pre-and post-assessments to measure the change in knowledge levels regarding COVID-19, its symptoms, prevention measures, and the importance of vaccination
Behavioural Change and Adherence	use self-reporting, observation, or tracking mechanisms to assess human health behaviours
Engagement and Interaction	the number of logins, the time spent on the app, the completion of modules, and the frequency of interactions with educational content
User Feedback and Surveys	feedbacks from mobile learning users through surveys, ratings, and reviews

In addition to these common evaluation methods shown in Table 3, it's essential to consider the specific goals and objectives of the mobile learning initiative for COVID-19 prevention [67] . The effectiveness of the intervention may be assessed by the reduction in COVID-19 cases within a target population, the increase in vaccination rates, or other public health outcomes.

Ultimately, evaluating mobile learning in COVID-19 prevention requires a combination of quantitative and qualitative data to assess the impact on knowledge,

behavior, engagement, and user satisfaction [68] . Regular monitoring and assessment of the mobile learning program can help adapt and refine the content and delivery methods to better serve the needs of users and support effective COVID-19 prevention efforts.

7. Conclusion

In conclusion, mobile learning has proven to be a valuable tool in the global effort to prevent and mitigate the spread of COVID-19. This versatile educational approach leverages the widespread use of smartphones and tablets to disseminate vital information, promote health awareness, and provide remote educational opportunities. By harnessing the power of mobile technology, governments, healthcare organizations, educational institutions, and individuals have found innovative ways to contribute to COVID-19 prevention in various ways [69] .

Mobile learning has played a pivotal role in increasing knowledge and awareness about COVID-19, ensuring that individuals are well-informed about the virus, its symptoms, and prevention measures [70] . It has enabled the dissemination of accurate and up-to-date information, helping to combat misinformation and myths that can exacerbate the crisis. In future information dissemination, it is effective in increasing the percentage of true and reliable information to avoid more serious diseases [illegible] tragedies due to misinformation.

Moreover, mobile learning has not only educated but also encouraged behavioral change. It facilita[illegible] and encourages people to adopt more effective means of protection, such as wearing masks, hand hygiene, physical distance and vaccinations. Through engaging content and interactive features, mobile learning has motivated individuals to embrace these measures, thus contributing to public health and community safety [71].

In a world where the spread of information is as crucial as the prevention of the virus itself, mobile learning has emerged as a potent ally. Its ability to reach individuals at their convenience, deliver personalized content, and promote safe practices has made it an integral part of the broader strategy to combat COVID-19. At the same time, m-learning provides for the future of infectious disease prevention and control by being able to effectively maintain organized classroom activities in schools. As we continue to navigate the challenges of the pandemic, mobile learning remains a valuable resource in our collective efforts to stay informed, stay safe, and prevent the spread of COVID-19.

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