

# Learning with technology during emergencies: A systematic review of K-12 education

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## Abstract

Emergency situations that cause damage to educational buildings or require the closure of schools due to unsafe health, environmental, or political conditions can be an unwelcomed interruption to education. Indeed, the recent COVID-19 pandemic created the largest disruption of education in history, affecting 94% of the world's student population. In emergencies, technology is often utilised as part of a crisis response protocol by continuing education using emergency remote education (ERE). The purpose of this study is to determine how technology has been used to continue K-12 learning remotely during an emergency. This systematic review included an aggregated and configurative synthesis to examine extant empirical work over eleven years, from January 2010 to December 2020. Following a rigorous, PRISMA selection process, 60 articles were included in the final analysis from 48 countries. Grounded coding of the strategies used for learning revealed the following categories: communication, delivery systems, student ERE readiness, partnerships, promoting student learning and engagement, and resources. Grounded coding of the technologies revealed that types of technologies used were

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divided into two major categories: Internet-based and non-Internet based, with the majority using Internet-based technologies.

#### KEYWORDS

COVID-19, disasters, emergencies, emergency remote education, pandemic

### Practitioner notes

What is already known about this topic

- The COVID-19 pandemic has caused school closures across the globe and prevented in-person school teaching.
- The rapid shift to distance education in schools can be conceptualised as 'emergency remote education' (ERE).
- Prior ERE research focused on bounded geographic locations where localised emergencies occurred.

What this paper adds

- This provides the scholarly community with a unique systematic review of existing academic research on K-12 ERE implementation in emergencies.
- This provides aggregated data and analysis on the past 11 years of the types of emergencies, participants, subject domain, technologies used, and location information.
- This provides findings of the types of remote teaching strategies involving technology used to continue K-12 learning in emergency situations.
- This provides a set of recommendations on ERE for teachers, school leaders, policy makers, and funders.
- This provides researchers with a review of the field with identification of gaps and future research opportunities.

Implications for practice and/or policy

- Recommendations regarding ERE are provided in this paper that will be of benefit to K-12 teachers, school leaders policymakers, and funders in the continuing COVID-19 pandemic and future emergencies.
- The research gaps highlighted in this paper, such as the lack of studies conducted in low and low middle-income countries, are presented with suggestions for much needed future research. This can lead to changes in practice and policy.

## INTRODUCTION

The past decade has seen a variety of emergency situations including earthquakes, tsunamis, nuclear disasters, hurricanes, typhoons, Ebola outbreaks, cyclones, the recent COVID-19 pandemic, and other accidents and conflicts. Many of these emergency situations cause disruption to learning, as educational buildings are damaged, and/or schools are forced to closed due to emergency conditions. The most recent emergency situation,

the COVID-19 pandemic, created the largest disruption of education in history (United Nations, 2020), affecting 94% of the world's student population and 99% of those in low and lower-middle income countries (UNESCO, 2020). Schools closed as social distancing measures were put in place to slow the spread of the pandemic. With the absence of the physical learning environment, teachers turned to remote instruction with technology as part of a crisis response protocol to remotely continue education (Bozkurt & Sharma, 2020; Rapanta et al., 2020; Thompson & Copeland, 2020).

Online learning, remote learning, and electronic distance education are terms that describe education which takes place using technologies with students geographically separated from an educational building, peers, and teachers. These planned, educational methods are different from forced, unplanned, remote learning with technology during an emergency situation. The term used to describe this unplanned remote teaching and learning in emergencies is *emergency remote education* (ERE: Bozkurt et al., 2020).

While ERE allows disrupted learning to continue, scholars and teachers have questions regarding ERE for K-12 learners. These include questions about pedagogical strategies (Zhu et al., 2020), specific technologies (Kabaka & Stoltenkamp, 2013), access to technology/programmes/Wi-Fi infrastructure (Bozkurt et al., 2020; Fujita, 2020), digital skills, and inclusivity (Thompson & Copeland, 2020). While isolated studies provide a snapshot of ERE related to a specific context, little is known of the collective findings of empirical research to answer these key questions put forward by scholars that will help to support the implementation of ERE in the future. The purpose of this study is to conduct a rigorous systematic review to uncover how ERE has been used in emergency situations.

## BACKGROUND

### Emergency remote education

Scholars believe there has been an increase in emergencies since the turn of the century, necessitating an urgent need for strategies to mitigate the negative effects caused by these emergencies, such as disruption in schools (Kabaka & Stoltenkamp, 2013). During emergency situations when students are unable to attend school in person, ERE has been used to continue teaching and learning. ERE can involve the use of technological resources, such as group and individual online conferencing, electronic platforms to store, access, and edit information and resources, and non-Internet based technologies, such as radio and television. Scholars (viz., Bozkurt et al., 2020; Rapanta et al., 2020) posit that the use of technology provides the most efficient and cost-effective method to continue learning. Indeed, some scholars report that technology is the only option for continuing instruction during emergency situations where face-to-face is not possible (Butcher, 2020). During emergencies it is important to gather empirical findings to add to the scholarly understanding of what strategies have been used during these rapid shifts to ERE. In addition, resources needed for conducting ERE should be considered when examining global findings.

With the large reliance on technologies in ERE, broadband infrastructure, hardware, and software should be considered. Some local and national broadband infrastructures are not necessarily available, with students in low income countries less likely to have Internet access as those in high income countries (Blaskó & Schnepf, 2020). Students and teachers may also need access to hardware, such as laptops and mobile devices. Emergency situations across the globe often come hand-in-hand with other financial hardships and ensuring both students and teachers have the technological tools to continue education is important (Fujita, 2020). Software, such as programme availability and applicability to language and

other contextualised needs of an area need to be addressed (Shraim & Crompton, 2020), while meeting the needs of all learners (Thompson & Copeland, 2020).

Teachers in emergency situations need support in teaching with ERE (Hartshorne et al., 2020). Teachers working within an emergency situation may have their personal lives impacted; nonetheless, they need to quickly adapt to new pedagogical approaches, routines, technologies, and support students in using these new systems, while physically isolated from the school peer and administrative network (Espino-Díaz et al., 2020). There has been a push in recent years for K-12 teachers to become familiar with remote learning with technology techniques and pedagogies for general nonemergency online teaching. However, a large number of teachers have not had professional development in teaching online (Kennedy & Ferdig, 2018) and many feel unprepared to implement ERE (Hodges et al., 2020). Lack of teacher technology skills and knowledge are especially prevalent in low and low-middle income countries, such as sub-Saharan Africa, with only 64% of primary and 50% of secondary teachers receiving even minimum training (ITTE, 2020).

## Extant systematic reviews

Scholars have conducted systematic reviews to better understand the collective scholarly information on education during emergencies. In a review of empirical literature, there appears to be a paucity of systematic reviews on K-12 education during emergency situations. Two recent systematic reviews focused on refugees. Sullivan and Simonson (2016) conducted a study on school-based emotional interventions for refugee and war-traumatised youth. Horswood et al. (2019) developed a systematic review protocol for examining school factors related to emotional wellbeing and resettlement backgrounds. These studies serve an important purpose in supporting this population during this emergency situation. However, these studies described learning within a specific physical academic environment, that is, a refugee camp and not emergencies in which learning had to be remote.

A systematic review of Zhu et al. (2020) did focus on remote online learning in K-12 and higher education. The authors also described the relevance of the study to students going online during the pandemic. However, the 39 articles reviewed were not related to teaching or learning during the pandemic. Rather, the studies were all from planned online learning. Furthermore, the research centered around the use of technology for learning, specifically the use of social annotation tools in online classes (Zhu et al., 2020). Similar to Zhu et al. (2020), Greenhow and Chapman (2020) also focused on the use of a specific technology. These scholars conducted a literature review that provided a summary of insights from the literature to examine the use of digital tools for connecting students, teachers, and citizens in an emergency. This work focused on K-12 and used four specific articles for their reference (viz., Chapman, 2019; Greenhow & Askari, 2017; Greenhow & Chapman, 2020; Manca et al., 2019) that include insights from a decade of research and case studies that focus on the use of social media in K-12 education. The authors use this work to highlight the affordances of how this technology can be used for teaching during an emergency.

Each of these extant studies provide a valuable contribution to the field. Nonetheless, other than the studies on refugees, they do not examine learning during an emergency. The refugee studies are helpful in providing specific answers to the ongoing emergency of the refugees in the camp, but there are no systematic reviews across emergencies. The technology focused studies are also helpful in providing an in-depth examination of a tool, but other technologies are not examined. Scholars call for more studies that focus on emergency situations to examine pedagogical strategies (Crompton et al., 2021; Zhu et al., 2020), technologies (Kabaka & Stoltenkamp, 2013), access to technology/programmes/Wi-Fi infrastructure

(Bozkurt et al., 2020; Fujita, 2020), and digital skills, and inclusivity (Crompton et al., in press; Thompson & Copeland, 2020).

## Purpose

The purpose of this study is to respond to the call by scholars (viz., Bozkurt & Sharma, 2020; Fujita, 2020; Kabaka & Stoltenkamp, 2013; Thompson & Copeland, 2020; Zhu et al., 2020) and address the lack of scholarly understanding of how technology is used to continue formal, K-12 learning remotely during emergency situations. Hence, the overarching question driving this study is: How has technology been used to continue K-12 learning remotely during an emergency situation?

Three subquestions further refine this examination. It is important to note that the first two questions provide context as to the type of emergency, student participants, subject domain, technologies, countries of study and the country economic classification. This context will help the reader to better understand the research and the strategies used during ERE within the formal educational system. The three sub questions are:

1. What was the emergency situation that disrupted face to face learning, who were the student participants, what was the subject domain, and what technologies were used?
2. In what countries did the studies take place and what were the economic classifications of those geographic locations?
3. What remote teaching strategies, involving technology, were used to continue K-12 learning in that emergency situation?

## METHOD

A systematic review method is used to answer the research questions guiding this study. Systematic reviews are an empirical method to minimise bias, while identifying, selecting and synthesising a summary of studies (Moher et al., 2015). In this study, *Preferred Reporting Items for Systematic Reviews and Meta-Analysis* (PRISMA principles) (Liberati et al., 2009) and the PRISMA extension *Preferred Reporting Items for Systematic Reviews and Meta-Analysis for Protocols* (PRISMA-P) (Moher et al., 2015) were used as a protocol-driven system to document the a-priori road map.

This systematic review methodology involves an aggregated and a configurative synthesis. The aggregated data approach provides answers to specific questions through deductive reasoning. The configurative approach is used to look at the qualitative data with iterative methods to answer questions about experiences and meaning which leads to generating and exploring new theories through inductive reasoning (Gough et al., 2017).

## Search strategy

PRISMA principles (Liberati et al., 2009) directed this search strategy. To ensure the level of quality of the research included in this study, only peer-reviewed journal articles and conference proceedings were included. Conference proceedings were included to allow for the most up-to-date research during this current pandemic emergency of 2020. The data parameters were set to include studies from January 2010 to December 2020, to gather past emergency data, while remaining as current as possible with changes in technology.

TABLE 1 Boolean search terms

Search section	Search terms
Part 1	"distance education" OR "distance learning" OR "online education" OR "online learning" OR "remote teaching" OR "remote learning", OR "mobile learning" OR "virtual learning"
Part 2	"k-12" OR "elementary school" OR "middle school" OR "high school" OR "secondary school" OR "school level" OR "primary" "grade 1" OR "grade 2" OR "grade 3" OR "grade 4" OR "grade 5" OR "grade 6" OR "grade 7" OR "grade 8" OR "grade 9" OR "grade 10" OR "grade 11" OR "grade 12" OR "1st grade" OR "2nd grade" OR "3rd grade" OR "4th grade" OR "5th grade" OR "6th grade" OR "7th grade" OR "8th grade" OR "9th grade" OR "10th grade" OR "11th grade" OR "12th grade"
Part 3	"covid-19" OR coronavirus OR "2019-ncov" OR pandemic OR epidemic OR outbreak OR emergency OR disaster

An extensive electronic and hand search was conducted. The electronic search included the following educational databases: EBSCOHOST, ProQuest Central, Wiley International, Science Direct, Elsevier Direct, Sage Journals Online, JSTOR, and LearnTechLib. A Boolean search was utilised which focused on the three primary aspects of the systematic review topic: (1) remote technology-based education, (2) K-12, and (3) emergency situations. This ensured the more relevant articles were gathered during the search process. Table 1 presents the Boolean search terms that were selected to represent the different nomenclature for those three topics, while also recognising differences in culture, context, and synonyms.

The electronic Boolean search used AND to connect the three parts of the search string:

Search Terms Part 1 **AND** Search Terms Part 2 **AND** Search Terms Part 3

A hand search was also conducted of additional databases, journals, and conferences that were relevant to the study topic. This included a search of *Emerald Insight*, *Journal of Educational Technology Systems*, *Asian Journal of Distance Education*, *Journal of Pedagogical research*, *Inter-Agency for Education in Emergencies*, *Journal of Education for Teaching*, *Journal of Mobile and Blended Learning*, *IEEE*, and *Journal of Technology and Teacher Education*. This hand search was specifically conducted in consideration of teleological ethics. In other words, the researchers were cognizant that the "representation of experiences and perceptions of diverse groups, especially those viewpoints that tend to be less represented in the literature, [were included] to the extent this is permissible from the published literature" (Suri, 2020, p. 44). This provided the inclusion of journals that may not be widely recognised or are journals that are not included in mainstream databases. Specific journals were selected that included studies from developing as well as developed countries. The electronic and hand search resulted in a total of 1428 studies.

Inclusion and exclusion criteria

Following the compilation of the 1428 articles from the electronic and hand search, 481 duplicates were removed. Next, the 947 studies were reviewed against the set of inclusion and exclusion criteria (see Table 2). For an article to be included, it had to align with all the inclusion or exclusion criteria. Four researchers were involved in independently reviewing the articles, with two researchers reviewing each article. The researchers came to an inter-rater



**TABLE 2** Inclusion and exclusion criteria

Inclusion	Exclusion
<ul style="list-style-type: none"> <li>• Primary research</li> <li>• Peer review journal articles, and conference proceedings</li> <li>• Topic must include K-12 students</li> <li>• Involve emergency remote education</li> <li>• Include the use of technology</li> <li>• Include an emergency situation—health, natural disaster, man-made (&gt;10 people)</li> <li>• Studies published in English</li> </ul>	<ul style="list-style-type: none"> <li>• Higher education, adult learning</li> <li>• Emergency situations with minimal numbers involved (&lt;10 people)</li> <li>• Health issues that do not directly connect with teaching and learning (eg, handwashing)</li> </ul>

agreement for 97.5% for the coding. After discussing the misaligned articles, a 100% agreement was achieved.

From the examination of the inclusion and exclusion criteria, a further 887 were removed. A diagram of the PRISMA article selection process is presented in Figure 1 showing the numbers with the reasons for exclusion from Table 2.

### Data extraction

Following the PRISMA selection protocol, a final total of 60 articles were selected for review. Next, a database was developed to extract and aggregate information to then conduct an in-depth review via coding. The focus of extraction was to examine eight elements from the research questions: (1) Emergencies, (2) Participants, (3) Subject Domains, (4) Strategies for Learning, (5) Technologies Used, (6) Country, and (7) Country Economic Classification.

### Coding

The coding of data within systematic reviews is different than coding primary research, as participant data and author analysis are interpreted to provide third-order constructs (Britten et al., 2002). Two types of coding were used in this study, a priori coding and grounded coding. A priori coding was used for Emergencies, Participants, Learning Topics, Country, and Country Economic Classifications. Emergencies were coded using the emergency categories adapted from the International Disaster Database (EM-DAT, 2009), with the three overarching categories of (1) biological (eg, pandemic, epidemic), (2) natural disaster (eg, hurricane, earthquake), and (3) human caused (conflict, accidental explosions). The student participants in the studies were coded using school level categories of (elementary, 5–12 years; and secondary, 13–18 years). Subject matter domains were coded into academic areas. For Country Economic Classification, the World Bank Atlas Calculation (World Bank, 2020) was used. This specified the country/location income level.

Both Technologies Used and Learning Strategies were coded using a grounded theory design using a constant comparative method (Strauss & Corbin, 1995). Coding identified important text from the data. Through this iterative, inductive coding process, the initial codes led to axial codes with a constant comparison of strategies with strategies, of strategies with codes, and codes with codes. Once all the strategies fit with one of the codes, they were deemed theoretically saturated. In vivo (Saldana, 2015) coding was used, keeping the researcher's language where possible to keep it consistent with the original research. During the coding process, the researchers remained reflective of bias to ensure the context and original authors meaning of the data were preserved while conducting the secondary

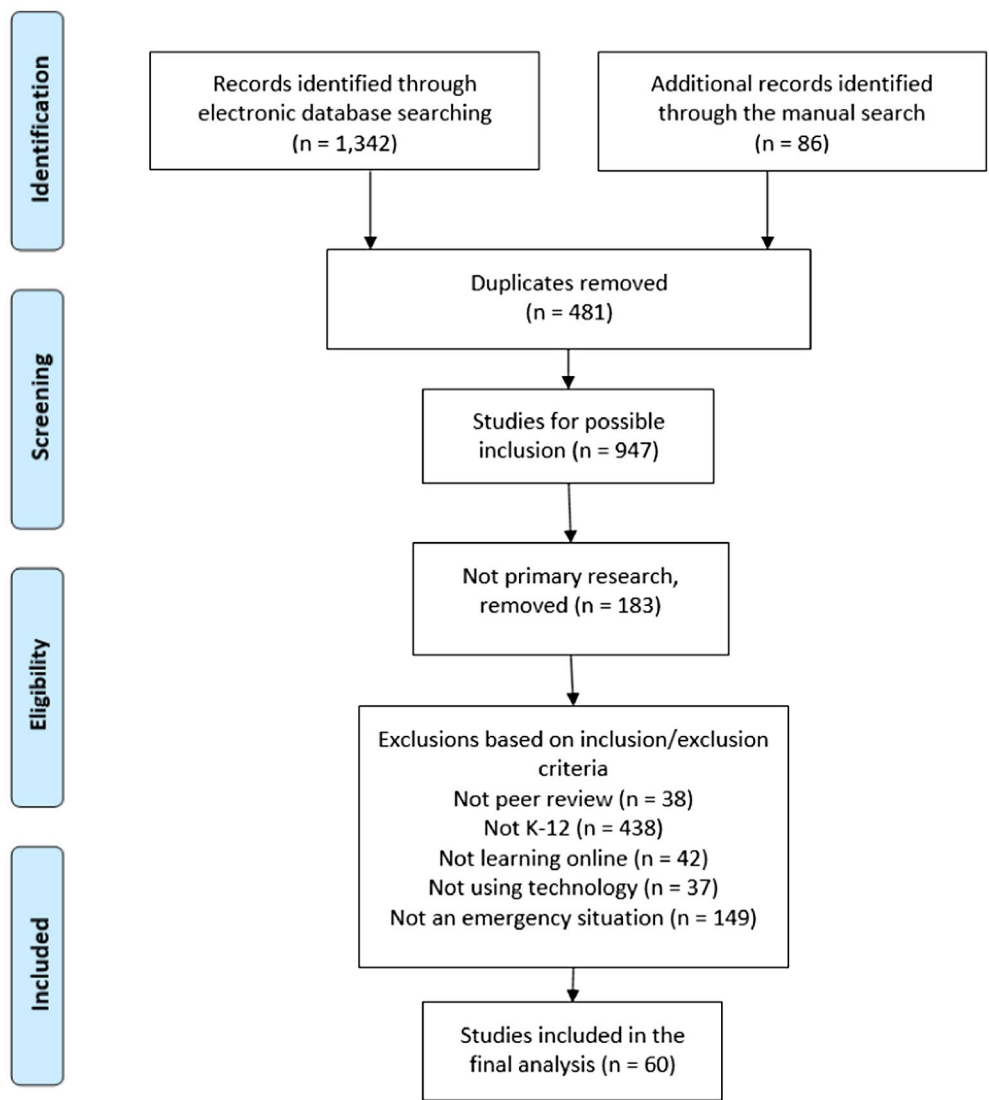


FIGURE 1 PRISMA article selection process

analysis (Sandelowski et al., 2012). Each of the data were coded by two researchers to reach interrater agreement of 98%. After discussing the misaligned articles, a 100% agreement was achieved.

## FINDINGS AND DISCUSSION

The findings and discussion are organised by the three research questions guiding this systematic review. As a reminder to the reader, the first two questions provide important information about the contextual aspects that surround the studies, specifically, the type of emergency, student participants, subject domain, countries of study, country economic classification, and technology used. The third larger question answers what teaching strategies were used to continue K-12 learning during the emergency.



Question 1. What was the emergency situation that disrupted face to face learning, who were the student participants, what was the subject domain, and what technologies were used?

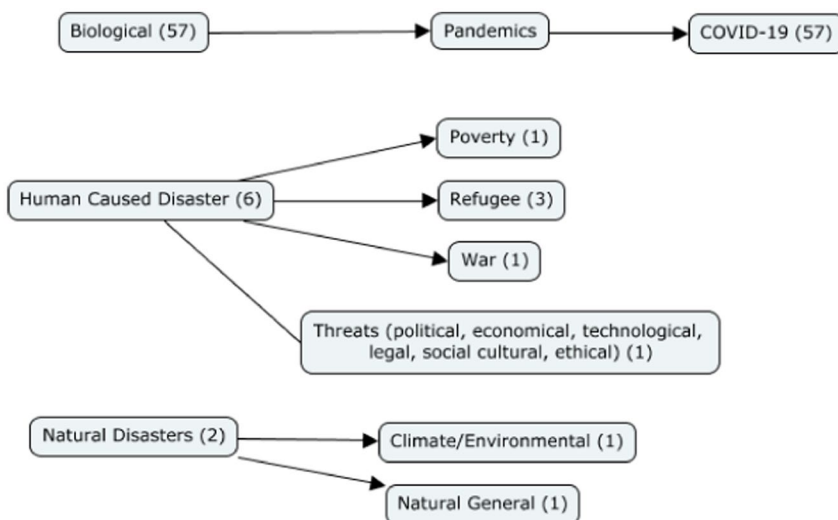
## Emergency situations

Of the 60 studies, 57 involved biological disasters, with all 57 studies specific to COVID-19 (see Figure 2).

This disproportionate number of COVID-19 cases could be connected to three reasons: (1) world-wide geographical spread, (2) the duration of the emergency, and (3) direct impact on funded researchers. First, emergencies, such as poverty and political turmoil, are more common to low-income countries than high income countries typically due to the higher financial and democratic infrastructure (Kelley et al., 2020). However, the emergency of the COVID-19 pandemic has been rampant across all economic and national boundaries. Indeed, COVID-19 has disrupted learning of 94%–99% of K-12 students worldwide (UNESCO, 2020).

Secondly, the duration of the COVID-19 pandemic has been long-running with the current year possibly extending to multiple years. Other emergencies may be short term, from a week to a month, and ERE may not be required as school leaders may have chosen to close the school during that time. This long-term disruption of learning from COVID-19 has required alternative forms of remote education for sustained periods of time. Various strategies and solutions have been highly sought; hence the abundance of scholarly work in this area.

Nonetheless, in examination of the data, studies do report on other emergencies that could be described as global and longitudinal, such as refugee emergencies (Moghli & Shuayb, 2020; Sirin et al., 2018). The refugee studies included in this systematic review investigated ERE in Syria, Jordan, Lebanon and Palestine, all lower middle-income countries. Further examination in the use of educational strategies for refugees could be highly valuable for supporting displaced populations, with scholars lament entire generations of children being “lost” to education (viz., de Hoop et al., 2019; Smith, 2018).



**FIGURE 2** Types of disasters. Numbers exceed 100% as studies may have more than one type of disaster focus for the study

Finally, the large focus on COVID-19 studies could be due to the direct impact of COVID-19 on researchers' immediate lives and families. This may have prompted researchers worldwide to conduct research on COVID-19. This will have been exacerbated further with the spread of this emergency in wealthy countries that provide funding for researchers to conduct these studies. Localised emergencies may only draw attention to researchers local or those connected in some way to the emergency.

Student participants

In the examination of the K-12 student academic level, there was a mix of grade levels represented in the studies (see Figure 3). While emergency situations are typically not linked to a particular age, over 50% of the studies examined specific ages, with the majority of those focused on secondary students. Age specific research can be helpful as interventions, strategies, and experiences can be congruous with a set age group. For examples of studies focused on an age group, Maulucci and Guffey (2020) investigated ERE in a high school biology class and Anderson and Hira (2020) researched the use of technology to create meaningful, socially distant learning experiences for elementary students. These findings will be particularly helpful for researchers and educators looking at these grade levels.

There were a significant number of studies that included all K-12 grades. Some pedagogies and technologies can be implemented across grades. These studies can provide valuable data for teachers at all levels. While there is a relative paucity of work investigating ERE, these generalisable strategies can be helpful to inform teachers until the body of empirical work on ERE grows and more can be found for specific grade levels to best tailor ERE to students.

Subject domains

Of the 60 studies examined, only 13 focused on a specific discipline (see Figure 4). As emergencies impact all learners, it appears scholars may have wanted to focus across disciplines to again make the results as generalisable as possible. However, similar to research in specific grade levels, the information gained from discipline focused studies may also help educators examine pedagogies and technologies that would best support student learning in those disciplines.

As Figure 4 shows, there were a number of studies that did focus on a specific discipline. For example, Sintema (2020) investigated potential effects of COVID-19 on STEM education

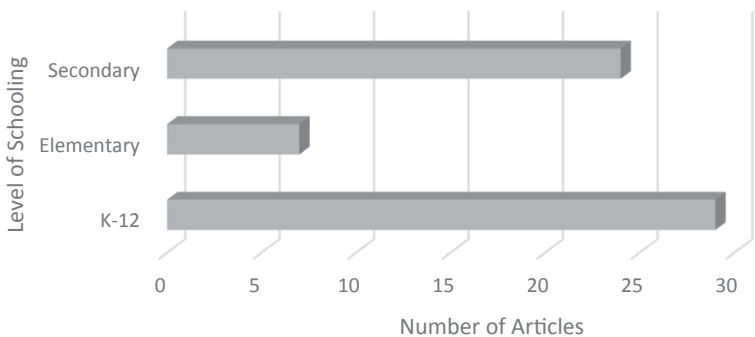


FIGURE 3 K-12 student grade focus



FIGURE 4 Topics of study

in Zambia, and Masterson (2020) researched the role of digital technologies in foreign language instruction in Ireland during the pandemic. Meeting the needs of both subject matter specific and more general curricular areas during ERE needs to be researched to inform scholars and teachers alike.

Types of technology

Grounded coding of the technology data revealed two major categories: non-Internet based and Internet-based. Although only two studies reported the use of non-Internet based technologies, it is important to remember that ERE can be delivered without the use of the Internet. This is of particular importance in countries, such as Syria, Lebanon, Palestine, and Jordan which have limited and uncertain Internet access (Moghli & Shuayb, 2020). In the studies that reported Internet-based technologies, six final codes emerged from the data. These can be found in Table 3 with examples of the specific technologies used.

Within the six Internet-based categories, there appear to be a large range of technologies used. There are a number of possible reasons why such a wide variety of technologies were chosen. The use of technology should be chosen to best suit the educational need, and the range of technologies reflects a wide range of affordances. Teacher to teacher communication, for example, required a technology that facilitated regular and informal communication and therefore social media may be the most appropriate. Similarly, for the delivery of educational content, teachers generally preferred to use specifically designed apps such as Nearpod and software such as Google Classroom. Such technologies may have been ‘trusted’ to enable learning while considering safeguarding issues. The availability and familiarity with technology may have played a significant part in its use, particularly given the rapid onset of the school closures and the requirements on teachers to rapidly transition to ERE. For instance, the ready availability of free content on a familiar platform such as YouTube, and the use of familiar providers such as Google and Microsoft would have made content available and easy to deploy for teachers. Different geographic locations may also explain different preferences for certain technologies. For example, WeChat and DingTalk are popular in China whereas Facebook in the United States, and WhatsApp in Europe are popular.

TABLE 3 Types of technology

<b>Non-Internet-based technologies</b>		
Radio		
Telephone		
Television		
<b>Internet-based technologies</b>		
<i>Communication/conferencing tools</i>	<i>Free distance learning resources</i>	<i>Learning management systems</i>
Zoom	Youtube	Canvas
Tencent Meeting	Khan academy	Schoology
Email	Moocs	Power School
SMS		Skyward
Skype		
<i>Online workspace/management tools</i>	<i>Social media</i>	<i>Specific applications</i>
Microsoft 365	Facebook	Nearpod
Google G Suite	WhatsApp	Zaptoons
Twinspace/etwinning	Twitter	Wescratch
Classin	Tik Tok	SWYG
	WeChat	Flipgrid
	GroupMe Chat	SeeSaw
	Instagram	Kahoot
	Ding Talk	RoomBox
		EdPuzzle
		Gportfolios
		Chaoxing
		Freckle Math
		Myon Reader

Question 2. In what countries did the studies take place and what were the economic classifications of those geographic locations?

Countries and economic classifications

The studies gathered in this systematic review took place in 48 specified countries. The majority of the studies focused on individual locations and these countries are displayed visually in Figure 5.

The data gathered in this systematic review include low, lower middle, upper middle, and high-income populations. Nonetheless, data show a greater representation of countries of higher income, as shown in Figure 6.

These data are partly skewed in this systematic review from the inclusion of a set of proceedings from a US-based conference that focused completely on COVID-19. This is exacerbated further with the desire of journal editors to often highlight studies more generalisable to as many readers as possible. This generally involves those larger countries with a

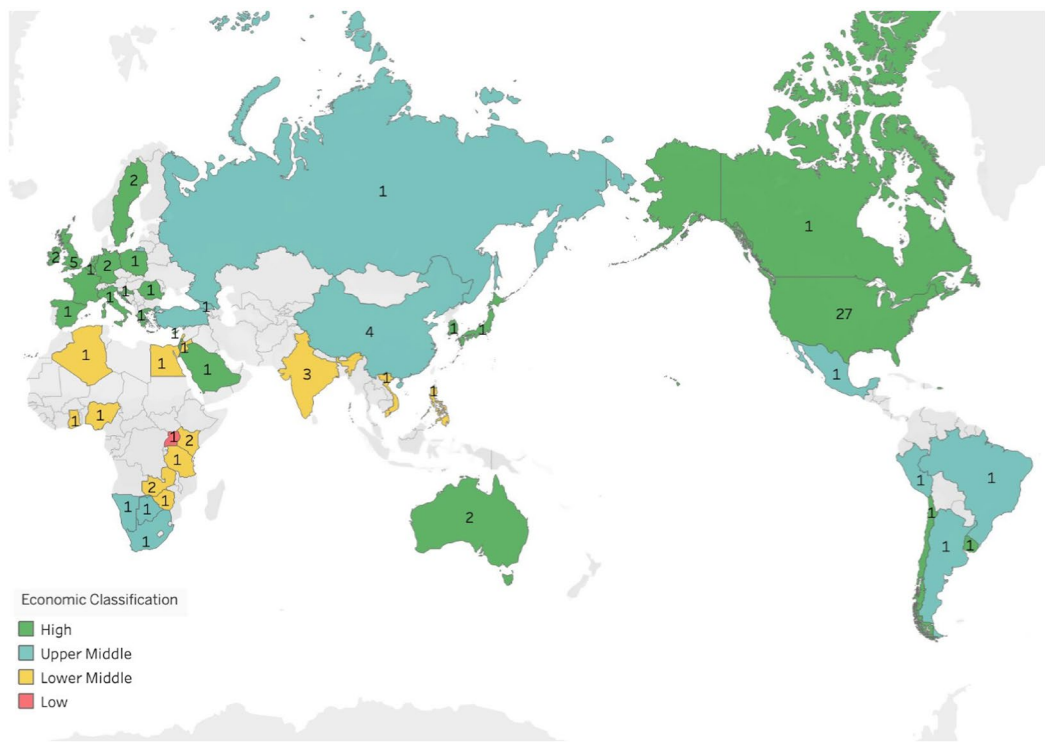


FIGURE 5 Countries included in studies

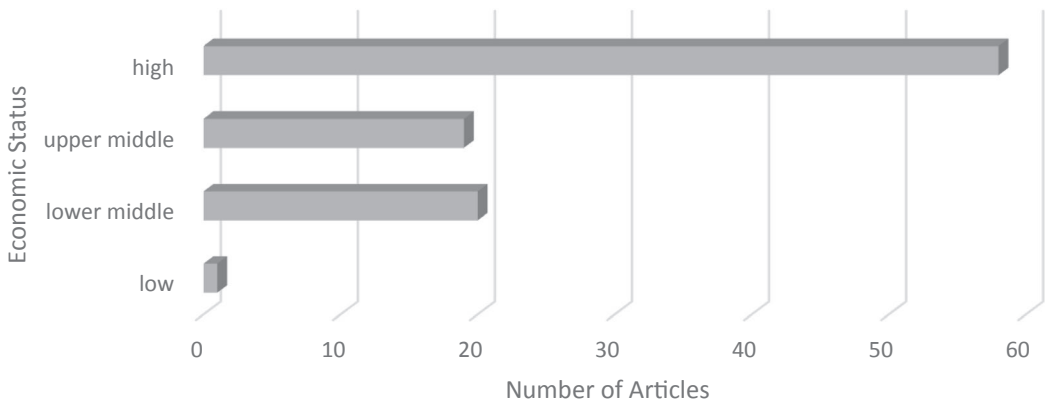


FIGURE 6 Economic status of countries. Country numbers of articles is above the 60 total articles. This is due to multiple countries represented within a single study

high income who publish research in English. Furthermore, high income countries typically fund researchers which may not be afforded to those in low-income locations. It would be important for future research to be more representative of these countries in order to better understand the global situation in ERE.

Question 3. What remote teaching strategies, involving technology, were used to continue K-12 learning in that emergency situation?

Strategies

The 60 studies were analysed to determine the teaching strategies and technologies that were used to continue K-12 learning in emergency situations. With regard to the strategies used, grounded coding revealed six final codes. These can be found in Table 4 with a description of each code.

Communication

From the studies that were coded *communication*, the data revealed how teachers were rising to the challenge by finding multiple ways to communicate with all of their constituencies. One study (Anderson & Hira, 2020) found teachers had used email, personal phone numbers, Facetime, and text messages to maintain consistent contact with their students. Another study (Burgess & Anderson, 2020) created a digital blog for middle school students to create a culturally relevant, social, and informative space with which they could interact. A third study (Garbe et al., 2020) employed an online survey sent to parents to investigate parents' experiences and struggles during school closures. The findings of this study indicate that communication was critical to insure that learning continued and the research indicated that teachers used a wide variety of ways to communicate.

It is interesting that these data show that conventional communication strategies, such as blogs, are being utilised (eg, Burgess & Anderson, 2020), while also other strategies are emerging such as personal phone numbers and Facetime (eg, Anderson & Hira, 2020) that step into the teacher's private life. These forms of communication may often be deemed inappropriate in many countries, especially those in the West. This can be due to the lack of transparency and accountability as those modes of conversation are in the purview of the individual rather than the school. Teachers may have chosen to provide these personal lines

TABLE 4 Teaching strategies used during ERE

Final codes	Description of codes
Communication	Studies focused on the use of multiple modalities in order to communicate with multiple audiences: students, parents, teachers
Delivery systems	Studies examined different delivery systems for learning, online and systems that would not necessarily be online, for example, radio and television
Student ERE readiness	Studies uncovered what support was needed to successfully engage in ERE
Partnerships	Studies examined different types of school partnerships developed during ER, for example, with technology companies, digital media organisations, with families and teachers
Promoting student learning and engagement	Studies explored specific ways to promote student engagement and learning
Resources	Studies that identified resources that were available during ERE

of communication as students may have been struggling to use conventional methods, and the teacher not want to delay learning that had already been disrupted. Families may also not have a computer at home or are sharing a computer with multiple others. In this case, a telephone may be a way to allow two-way communication with teacher and student.

The findings of this study also revealed that there were many audiences that teachers needed to communicate with, including parents, community partners, businesses, and government officials. Outside of ERE, communication may typically be less as parents and other groups are familiar with the blend of strategies, procedures, and teaching traditions that have been built over many years. Emergencies often disrupt or halt these familiar practices that have to be replaced with new strategies that may be constantly revised while educators and school leaders strive to find the best way of communicating during emergencies.

## Delivery systems

Studies within the *delivery systems* code involved research that analysed how ERE was delivered to students. From this global systematic review, the findings show the use of a variety of online delivery methods, such as Zoom, Skype, and Google suite, etc and a few researchers had used methods not reliant on the Internet, for example, radio (Schwartz et al., 2020), and television (Moghli & Shuayb, 2020). It is positive to see different technologies used to deliver instruction. It is interesting to see this “delivery systems” code emerge. Although technology systems are crucial to remote learning, this focus on how to deliver instruction may have been at the expense of teachers investigating how to use technology as a means to effectively teach using the affordances of the technology (Crompton, 2014). For example, the work of Basilaia and Kvavadze (2020) reviewed the different available platforms that can be used for online education, but does not investigate the best practices in using these platforms.

While scholars (viz., Bozkurt et al., 2020; Rapanta et al., 2020) posited that the use of technology provides the most efficient method to continue learning when face-to-face is not possible, the infrastructure for advanced technologies are not always available. It is interesting to see that Schwartz et al. (2020) found that while both radio and television may be easier to access than online teaching, there were also barriers to these basic technologies in keeping students engaged, in addition to the lack of instructional diversity, and the limited capacity of radio and television to cover the extensive curriculum. Teachers need to be aware of the different ways in which students can receive non-face-to-face instruction. While access to digital communication tools may appear to be almost universal, teachers needed to adapt their delivery systems based on student accessibility while considering the educational value.

## Student ERE readiness

The *student ERE readiness* code included studies in which the researchers analysed data to determine the amount and type of support that learners needed to be successful. To learn successfully in ERE there are a variety of physical, cognitive, and spatial resources needed. Bhaumik and Priyadarshini (2020) conducted a study in Delhi that analysed students' access to resources (personal e-devices, Internet connection, personal study space, hardware facility, and e-storage), and the level of digital literacy and e-readiness of learners to study remotely with technology. The findings show that students prioritised the need to have an undisturbed online space to work. Students often lacked hardware, although learners deemed this as an essential service both during and outside of emergencies. One of the



important findings of this study was the lack of student digital skills, with 40% of students having difficulty in performing basic Internet searches.

Studies, such as Bhaumik and Priyadarshini (2020) are important in highlighting the many different needs that students have participating in ERE. It may be easy to consider the hardware resources, but the skills and knowledge are also very important. Ownership of the hardware may be irrelevant if students cannot use it. Understanding the support students need to be successful can be a difficult task to accomplish while students were learning remotely, however, understanding these needed supports are critical to student success. Without this knowledge teachers would not be able to meet the needs of ERE learners.

## Partnerships

The data from the *partnership* code uncovered how individuals or groups could partner with educators during ERE. The earlier *Communication* code focused on communication with teachers, students, parents, and the wider community. However, this code targets specific partnerships with organisations, companies and individuals to better meet the needs of learners during ERE by providing resources currently lacking. For example, researchers (viz., Burgess & Anderson, 2020) approached philanthropic partners such as Spectrum Internet to provide Wi-Fi hotspots for students who did not have access to the Internet. These same researchers also connected with the organisation, *Donors Choose*, to allow members of the community to purchase devices or mobile hotspots with Internet service for students. The earlier *Student ERE Readiness* code can be beneficial in identifying the gaps in student's needs. If students lacked Internet access, partnerships with Internet providers may ameliorate or even fill that need. Other partnerships may fill other needs, such as student tutoring in how to use the technologies. One example in this case would perhaps be those partners that offer prerecorded video tutorials that can be reviewed in advance by school leaders and educators to ensure ethical compliance and then shared with students.

Reaching out to others in the community is important as ERE creates a significant burden on both teachers and students. Having other constituents in the community support learning makes the emergency a shared responsibility within the larger community.

## Promoting student learning and engagement

From the findings of this systematic review, this code had the largest number of studies. It is not surprising that promoting student learning and engagement was the area most often researched, as this is the utmost priority in learning. There were a variety of strategies to promote student learning and engagement, such as incorporating physical activity (Yarımkaya & Esentürk, 2020), virtual nagging (Semington et al., 2020), providing intervention sessions for behavioural goals of special education students (Frederick et al., 2020), providing phone-based assessments (Angrist et al., 2020), cultivating and maintaining relationships with students (Combs, 2020), creating new or modified learning activities using materials students had at home (Anderson & Hira, 2020), and using eye-tracking software with special education students (Iannizzotto et al., 2020).

Within ERE, student learning and engagement is arguably one aspect of learning that changes the most. However, promoting student learning and engagement during ERE can be the most difficult task for teachers. Many teachers may use technology within the classroom environment, yet it is typically a blend of technology and traditional teaching. Other teachers may even use minimal or no technology. However, within ERE, technology is often the only way to interact and teach students. Educators need to consider many new strategies

for teaching and learning as well as keeping students engaged. This can be particularly difficult when working with young learners (Szente, 2020).

## Resources

The final code emerging from the data was *resources*. During ERE, textbooks, physical manipulatives, and other educational resources in school buildings are inaccessible to students and teachers. Digital resources need to be explored to fill that need. In one study, Huang et al. (2020) investigated possible use of open educational resources (OER) and open educational practices (OEP) during ERE. OER allows teachers to revise, reuse, retain, remix and redistribute educational content marked as an OER resource (Read et al., 2020). A study conducted by Tang (2020) just prior to the start of the COVID-19 found that teachers needed more professional development opportunities to understand how to efficiently search for OER resources and how to adapt them for use with their students. During emergency situations, teachers are forced to explore these options. It would be interesting to see in future studies if teachers' use of OEP and OER remains high when teachers return to face-to-face teaching.

It is important to note that considerations need to be made regarding digital citizenship and the appropriate selection and use of resources. (Kimmons, 2015). Teachers need to be aware that in their attempt to quickly provide ERE they also need to be aware of challenges of selecting and vetting digital resources and making sure that their students understand the qualities of good digital citizenship. Finally, it is important to acknowledge that both digital and non-digital resources were important during ERE (Schwartz et al., 2020). The availability of digital, Internet-based resources is not ubiquitous, and educators need to be aware that providing non-digital learning resources is an important element of ERE.

## RECOMMENDATIONS

Within the findings, various recommendations are made regarding the trends that emerged from this systematic review. Here are highlights of some of those recommendations for those conducting ERE in K-12.

- There are a variety of physical (hardware/software), cognitive (skills and knowledge), spatial, and infrastructure resources needed by both the teachers and students when using ERE. It would be pertinent to consider all these aspects and identify gaps.
- The exploration of partnerships with organisations, companies, and individuals to provide resources needed (eg, Internet connectivity) by students and teachers is necessary. Local groups may be more willing to support local schools in the community.
- Open lines of communication need to be established between teachers, students, parents, and the wider community. Nontraditional methods, for example, personal phone numbers, may be considered but this should be first discussed with school leaders and to ensure ethical practices for all parties involved.
- Educators should be given support in the investigation of strategies to support student learning and engagement. Examples, such as those provided in this systematic review, can be a springboard for ideas.

## LIMITATIONS AND FUTURE RESEARCH

The findings reveal a limitation in the number of countries represented in this study. This may be due to searching only in English language databases. Multiple language options were selected, but this still drew articles from journals prioritising the English language. This is a common limitation for systematic reviews, which can appear to give greater weight to Western countries and researchers who can publish in English (Alexander, 2020). It would be valuable if future studies examined various databases across languages. Data also show a limitation in the inclusion of low and lower middle-income countries. Future researchers should explore processes to further include studies from these countries that may not use a typical research format. Scholars should also examine ERE for other ongoing emergencies, such as K-12 refugees who may not be connected to local educational entities.

## CONCLUSION

Drawing from collective findings, systematic reviews play a powerful role in informing policy, practice, further research and public perception (Suri, 2020). This study provides a unique systematic review of ERE within the past eleven years to determine how technology has been used to continue K-12 learning remotely during an emergency situation. This research revealed that the vast majority of the studies were conducted since the beginning of the COVID-19 pandemic in 2020. The world-wide pandemic increased the attention of researchers leading to studies being conducted in 48 countries across the globe with 79% of the studies being from upper-middle and high-income countries, and the remaining 21% from low- and lower middle-income countries, with only one study carried out in a low-income country.

Findings show that studies looking at technology use included two main categories: Internet-based technologies, and non-Internet broadcast technology, such as radio and television. Through coding, six categories emerged to identify how teaching strategies and technologies were used to continue K-12 learning in emergency situations: communication, delivery systems, student ERE readiness, partnerships, promoting student learning and engagement, and resources. The types of digital technologies used which emerged from the coding were communicating/conferencing tools, free distance learning resources, social media, online workspace/management tools and specific applications. The large majority of studies focused on the COVID-19 pandemic, with the remainder addressing human caused and natural disasters. In the K-12 student contexts, there was a mix of grade levels represented with secondary students being the most prevalent level. Only 13 of the 60 studies focused on a specific discipline. This review will be of benefit to researchers, policymakers, and educational practitioners in the continuing COVID-19 pandemic and future emergencies necessitating ERE.

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## CONFLICT OF INTEREST

There is no conflict of interest.

## DATA AVAILABILITY STATEMENT

The data are gathered from Open Access Databases that can be accessed through university subscription or from access through local libraries.

## ETHICS STATEMENT

Institutional Review Board approval not needed for this systematic review.

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