Journal of Information Technology Education: Innovations in Practice

An Official Publication of the Informing Science Institute
InformingScience.org

JITEiip.org

Volume 23, 2024

EDUCATIONAL CONTINUITY IN EMERGENCIES: THE ROLE OF OFFLINE DIGITAL LIBRARIES IN UNDER-CONNECTED COMMUNITIES

Libbie Farrell	Arizona State University, Tempe, AZ, USA	libbie.farrell1@gmail.com
Laura Hosman*	Arizona State University, Tempe, AZ, USA	laura.hosman@asu.edu
Cassandra Barrett	Arizona State University, Tempe, AZ, USA	cbarre38@asu.edu
Rachel Nova	Arizona State University, Tempe, AZ, USA	rnova@asu.edu

* Corresponding author

ABSTRACT

Aim/Purpose	This article explores the critical need for adaptable educational models in times of crisis, focusing on strategies to overcome infrastructural and digital inequalities exacerbated by the COVID-19 pandemic.
Background	By examining a case study of an offline digital library project implemented in South Sudan, this paper seeks to examine the impact of an offline digital educational solution for low-resource and crisis situations.
Methodology	The authors utilize a mixed-methods approach, integrating both qualitative interviews and quantitative data analysis, to evaluate the use and impact of the SolarSPELL Initiative's offline digital libraries in South Sudan.
Contribution	This study contributes to our understanding of digital and information literacy within crisis contexts, highlighting the vital role of localized, offline content.
Findings	The findings demonstrate that offline digital solutions can effectively mitigate educational disruptions by providing an accessible means to continue education during emergencies.
Recommendations for Practitioners	Recommendations for practitioners include the adoption of robust offline digital learning solutions to promote educational continuity.

Accepting Editor Martin D Beer | Received: July 12, 2024 | Revised: September 25, October 3, 2024 | Accepted: October 15, 2024.
Cite as: Farrell, L., Hosman, L., Barrett, C. B., & Nova, R. (2024). Educational continuity in emergencies: The role of offline digital libraries in under-connected communities. *Journal of Information Technology Education: Innovations in Practice, 23,* Article 14. https://doi.org/10.28945/5385

Recommendations for Researchers	The authors recommend that researchers continue investigating the potential of offline digital educational solutions for low-resource and crisis situations.
Impact on Society	Ultimately, this article finds that offline digital libraries, when paired with skill-building, are a viable means to lessen digital disparities and promote educational continuity in times of crisis and beyond.
Future Research	The study suggests further exploration into the long-term impacts of such interventions on learning outcomes.
Keywords	digital literacy, information literacy, COVID-19, digital inequality, education in emergencies, capacity building, ICT4D, libraries

INTRODUCTION

Educational disruptions have long posed challenges to the global education system. Some interruptions, like annual summer holidays, are routine; however, many disruptions are unforeseen and prolonged, arising from civil unrest, displacement, and natural disasters (Dryden-Peterson, 2011; Engzell et al., 2020). Education in emergencies (EiE) refers to the critical need for education during times of crisis, which can halt educational routines and stop traditional, in-person schooling. EiE is seen as both humanitarian aid and a fundamental human right (Taka, 2023). During armed conflicts and natural disasters such as earthquakes and floods, school buildings often sustain damage or are repurposed as temporary shelters for displaced or homeless populations (Sinclair, 2007). These circumstances can force students, teachers, and their families to become refugees, seeking safety in other countries. Alarmingly, 48% of refugee children are not in school, and in 2022, refugee learners lost an average of 142 days due to school closures (USA for UNHCR, 2024). This highlights the need for alternative education models that can be accessed remotely without requiring internet connectivity.

Though educational disruptions are not new, in early 2020, the world was struck by the most widespread and devastating global disruption to date: the COVID-19 pandemic. Due to the high transmission rate of the virus, nearly every country enacted mandatory social distancing and quarantine measures that forced citizens to stay home and keep small social circles (Pokhrel & Chhetri, 2021). As a result, traditional academic instruction was suspended, requiring education systems to pivot toward various forms of remote teaching and learning programs, and, by nearly all accounts, these distance program solutions resulted in significant learning losses for students (Azevedo et al., 2020; Harmey & Moss, 2023). With more than 1.6 billion learners affected and a general sense of uncertainty shrouding prospective educational developments, the need for academic institutions to become better equipped to support student learning in all circumstances became incredibly apparent (Pokhrel & Chhetri, 2021). Though virtually all countries have been affected by the COVID-19 pandemic, educational outcomes in low-income, marginalized communities have sustained considerably greater adverse effects. In addition to emergency reconfiguration, these school systems are also confronted with (1) infrastructural deficits, (2) insufficient educational resources, and (3) inadequate training in digital and information literacy (Foster et al., 2022; UNESCO, 2020). The compounding challenges in marginalized communities expose gross inequalities between advantaged and disadvantaged members of society (Segbenya et al., 2022; Yunusa et al., 2021).

This article analyzes the infrastructural and digital inequalities that have posed challenges for under-connected communities and led to extreme educational losses during times of emergency, especially during the COVID-19 pandemic. From there, distance learning solutions implemented during the COVID-19 pandemic will be considered. Through this analysis, it will become increasingly clear that the mounting inequalities in under-connected communities must be addressed in order to affirm quality education in times of emergency. If these inequalities are not addressed, then the much-

needed educational developments will only continue growing further out of reach, resulting in growing inequalities in all other developmental sectors as well. Therefore, this article proposes that during times of emergency, education systems must adopt more sustainable and inclusive learning solutions to address infrastructural deficits and digital inequalities. Additionally, the findings demonstrate that offline approaches can effectively and efficiently provide education in emergencies and may be more appropriate for building information literacy and internet-ready skills, particularly in infrastructurally challenged settings.

One such approach, and the focus of this article, is the SolarSPELL Initiative at Arizona State University. SolarSPELL is a global educational initiative that combines curated offline digital libraries, solar-powered, simple-to-use technology, train-the-trainer training, and impact evaluation. To date, the initiative has seen partnerships and implementations in 15 countries across Sub-Saharan Africa, the Middle East, and the Pacific Islands. This article will explore SolarSPELL's work in South Sudan during the COVID-19 pandemic. While SolarSPELL digital libraries were being used in seven schools and a community center in Juba, South Sudan, since 2018, the onset of the pandemic in 2020 presented the opportunity for these libraries to have an even greater reach beyond the schools. A distance learning program, via the offline SolarSPELL digital libraries, was launched to equip as many teachers, parents, and students as possible with digital textbooks and other supplementary learning resources so that learning could continue remotely, in conjunction with radio lessons broadcasted by the South Sudanese Ministry of General Education and Instruction (MOGEI).

With both quantitative data and qualitative interviews from library users in Juba, the SolarSPELL team tracked the impact of the SolarSPELL offline digital libraries in low-resource schools. We argue that offline digital educational approaches can be more effective than online approaches at providing education in emergencies, like the recent COVID-19 pandemic, as students and teachers are able to advance toward educational goals despite infrastructural deficits, school disruptions, and displacement. The final section of this article provides concluding remarks and proposes further research vis-a-vis offline digital learning solutions.

LITERATURE REVIEW

INFRASTRUCTURAL DEFICITS, DIGITAL INEQUALITIES, AND INFORMATION LITERACY IN GLOBAL EDUCATION

In 2021, the World Bank reported that nearly 260 million school-aged youth were out of school (World Bank Group, 2021). These numbers have been increasing over time and can be attributed, in part, to governments and education systems not adapting to the needs of financially insecure, marginalized communities (Graeff-Martins et al., 2006). Many countries around the world do not have the infrastructure to provide universal access to quality education. In other words, infrastructure is the invisible, yet necessary, building block that allows for the effective operation of a society. Infrastructure tends to be taken for granted when present and operational, yet infrastructural systems become highly visible when they break down and pose enormous challenges when not present in a community (Star, 1999).

Infrastructural deficits tend to be present within marginalized communities, making these communities more vulnerable to emergencies, including climate change, economic upheaval, and social stratification. A 2022 policy report chronicling public investment in infrastructure shows that these deficits do not seem to be improving (Foster et al., 2022). Rather, across low-income countries, public expenditure investments have been dropping since 2010. In 2018, infrastructural investments reached an all-time low, with just below 1% of GDP being invested in infrastructure upkeep and development (Foster et al., 2022). In the context of this article, decreasing levels of infrastructural investment acts as a critical barrier for individuals and communities pursuing a quality education due to strong evidence that links high-quality infrastructure with high-quality educational instruction, improved student outcomes, and reduced dropout rates (Teixeira et al., 2017).

Although adaptable physical structures, reliable energy systems, and resilient communities are all factors that must be accounted for in the pursuit of quality education, the main focus of this article will be on digital infrastructure and the reverberating effects on communities and education systems that do not have access to reliable information and communication technologies (ICTs) and broadband/Internet (Verdecchia et al., 2022). Inadequate digital infrastructure is not exclusive to any region or population. Even in countries where physical infrastructure gaps have been closing, governments overlook populations that continue to lack reliable access to internet and broadband connectivity (Vassilakopoulou & Hustad, 2023). Furthermore, research shows that even in communities with reliable broadband access, there have been increases in internet misuse, including online gaming, gambling, and pornography (Gjoneska et al., 2022). Problematic use of the internet serves as a clear reminder that mere connectivity does not automatically lead to meaningful, empowered connections and brings to the forefront the issue of information literacy and digital literacy.

Information literacy is the "set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information" (Association of College & Research Libraries, 1989). These skills help to facilitate individual and community empowerment by developing critical thinking skills and self-efficacy, or agency, amongst individuals to build upon other valuable knowledge and capabilities. Though information literacy can be learned on non-digital platforms, digital platforms are becoming more ubiquitously used within global governments, education systems, and in all sectors of the economy, particularly following the COVID-19 pandemic, making it crucial to pair information literacy skills with those of digital literacy (Hosman & Pérez Comisso, 2020; van Laar et al., 2020).

Digital literacy skills are developed by taking information literacy abilities and relaying them onto a digital platform (Walton, 2016). In other words, digital literacy is using ICTs and the Internet to find, evaluate, and effectively use the information to accomplish an identified goal (Gurstein, 2003; Hosman et al., 2020). However, when the digital and physical infrastructure is not able to support the development of these skills, it results in digital inequalities in which growing disparities arise between individuals who do and do not have access to ICTs and the internet (Hosman et al., 2020; Tinmaz et al., 2022).

With digital connectivity at the crux of the modern information society, the need to address infrastructural deficits and digital inequalities is of utmost importance (Bebell & Pedulla, 2015; Fu & Pow, 2011). Additionally, training and skills development are critical so that digital and information literacy skills can be established even before the internet reaches the billions of people who have yet to connect. In this way, as physical infrastructure develops, so can the individual's capacity to engage with the influx of information available once connected, ultimately establishing a solid foundation for the provision and attainment of quality education globally.

The COVID-19 Pandemic, Education in Emergencies, and Global Learning Losses

In 2020, education in emergencies expanded beyond war-torn countries and refugee populations and became necessary on a global scale when the COVID-19 pandemic halted traditional societal operations. Besides the already significant infrastructural and digital inequalities that may impede a nation's ability to achieve the goal of quality education, the COVID-19 pandemic put the global education system under significantly greater pressure. Due to the high transmissibility and mortality of coronavirus, education systems and academic institutions around the world were forced to temporarily shut down schools in order to adhere to quarantine and social distancing protocols, affecting more than one billion learners (Angrist et al., 2021; Moodley et al., 2022; UNESCO, 2020). This was the largest global educational disruption in recorded history (Reshi et al., 2023). Consequently, very few school systems were prepared for the emergency transition from in-person instruction to distance learning. Even so, many school systems rallied with innovative approaches to support the continuation of student learning through emergency distance learning strategies in which students were able to connect

to classroom environments through various channels, including television and radio programs, online education platforms, and take-home article learning packets (Foster et al., 2022; Reimers, 2022). Nonetheless, these innovative approaches proved insufficient around the world in addressing students' learning and socio-psychological needs, particularly for those in marginalized, unconnected communities (Gaydelis et al., 2023).

Research from The Netherlands demonstrated how extensive student learning losses may have been during the COVID-19 pandemic (Engzell et al., 2020). Learning losses are defined as the measured cumulative deterioration of (1) previous learning, also known as knowledge forgotten over time, and (2) the opportunity cost of lost learning, which can be understood as the learning that students would have gained in a typical school year without closures (Azevedo et al., 2020). Thus, even in a 'best-case' scenario where schools are adequately funded, have reliable broadband access, and experienced short lockdown periods, students made little to no progress in attaining educational outcomes while learning from home due, in part, to the difficulty of keeping students cognitively engaged with all the distractions in the household (Angrist et al., 2021; Azevedo et al., 2020; Engzell et al., 2020). Other studies found that students in grades one through twelve who were affected by school closures could have lost anywhere between 0.3 to 0.9 years of schooling, resulting in diminished educational outcomes and anticipated long-term economic losses throughout their lifetimes (Azevedo et al., 2020; Hanushek & Woessmann, 2020). Though these disruptions may seem brief, learning gaps of this length have substantial implications for students and communities. Furthermore, a majority of the research done thus far has relied on information and data accumulated from high-income countries.

Unfortunately, it is challenging to know the scope of loss of education in under-connected communities, particularly because, according to the United Nations Educational, Scientific, and Cultural Organization (UNESCO, 2020), nearly a quarter (25%) of low- and lower-middle-income countries are not tracking student progress, compared with 3% of high-income countries. With minimal tracking underway in low-income countries, it is difficult to quantify the scope and intensity of learning loss over time and, by extension, the long-term consequences. However, distance learning programs are generally less effective when communities are under- or unconnected, even when communities are receptive to them (CEPAL & UNESCO, 2020; Engzell et al., 2020).

With the growing infrastructural and digital inequalities around the world, not all countries and communities have the infrastructure to support online learning. Multi-modular programs that utilize a combination of television and radio programs, take-home article learning packets, and, when applicable, online education platforms may then be employed rather than relying exclusively on online digital approaches (Foster et al., 2022; Reimers, 2022).

However, there is growing evidence that governments have not been able to sufficiently respond to the infrastructural circumstances and digital realities of the general population, a phenomenon known as the 'remote learning paradox' (Aedo et al., 2020; Topuz et al., 2022). When distance learning programs are implemented that are not tailored to a community's ability to adopt the program, for example, by addressing lack of connectivity, then the very programs that are meant to help abate learning losses quickly become exacerbators of loss (CEPAL & UNESCO, 2020). For example, a ministry of education might invest its resources in developing a fully online educational solution even though the majority of people in the country do not have access to reliable electricity or the internet. Once released, this online distance learning response will make little to no impact, regardless of content, because of students' inability to access the materials. Therefore, governments' responses to the COVID-19 pandemic played a critical role in determining whether inequalities within and between countries would widen or lessen (Topuz et al., 2022; UNESCO, 2022).

Regardless of governments' well-intentioned efforts to roll out emergency educational responses, students in marginalized communities experienced higher rates of learning loss because of weak infrastructure and low internet connectivity (Yunusa et al., 2021). It can thus be argued that more inclu-

sive distance learning solutions in times of educational disruptions support the goal of providing education during emergency disruptions. On the other hand, policies and practices that do not meet the needs – infrastructurally or otherwise – of marginalized communities will further disadvantage them, regardless of how well-intentioned these policies might be.

For example, the Kenyan government has committed to achieving quality education by 2030 and, consequently, has been reforming primary and secondary curricula so that information and communication technologies (ICTs) are integrated into learning, teaching, and research practices (Uwezo Kenya, 2020). However, schools have had difficulties integrating ICTs due to a variety of factors, including inadequacies of (1) internet connectivity, (2) regular electricity, (3) available digital content, and (4) standards for effective content delivery (Uwezo Kenya, 2020). Due to these compounding challenges, it is suggested that in Kenya, cumulative losses could equate to anywhere between six months and one year of lost learning during the pandemic (Angrist et al., 2021). However, it is important to note that these losses are primarily concentrated in the more impoverished regions because, when disaggregated based on socioeconomic status, only 1% of impoverished learners globally have access to distance learning solutions (Edwards, 2020). Thus, the discrepancy between intended results versus actual learner outcomes has resulted in specific groups – low-income, under- or unconnected communities – being disproportionately negatively impacted.

The COVID-19 pandemic is not the only cause of educational disruptions. Wars, natural disasters, and displacement also interrupt education, may decrease available educational expenditures, cause student enrolment numbers to fluctuate, and ultimately require alternative means to provide schooling (Lai & Thyne, 2007). In rural areas, shifting from in-person to online learning during emergencies is unrealistic, highlighting resource inequality and lack of digital literacy (Landa et al., 2021). The COVID-19 pandemic served as a painful global example of the importance of being prepared for education in emergencies.

Up to this point, the literature referenced has considered the implications of disrupted distance learning and its effects on students' learning outcomes during education in an emergency, specifically the COVID-19 pandemic. Thus far, there has been a lack of research done on how to prevent learning losses of this magnitude from recurring in the future, particularly given the meager rates of internet connectivity among rural learners in the lowest-income countries. This article addresses the gap in the literature regarding offline approaches to digital distance learning and how these approaches can support education in emergencies and be leveraged to provide educational resources to unconnected communities and populations during crisis situations.

CASE STUDY: SOLARSPELL INITIATIVE IN SOUTH SUDAN

SOUTH SUDAN

South Sudan is a landlocked country in Eastern Africa bordered by Ethiopia, Sudan, the Central African Republic, the Democratic Republic of the Congo, Uganda, and Kenya. It is the world's newest nation, having only recently gained independence from Sudan in 2011 after decades of conflict. In 2005, a Comprehensive Peace Agreement (CPA) was signed in Kenya between the Sudan People Liberation Movement (SPLM) of South Sudan and the Khartoum Government, which gave the Southern region a six-year transitional period to decide via referendum whether to remain as one united Sudan or to separate into sovereign South Sudan. In January 2011, 99% of citizens living in Southern Sudan voted in favor of creating an independent South Sudan. Therefore, South Sudan declared independence on July 9, 2011. Unfortunately, the pre-independence violence did not subside when South Sudan became a sovereign nation. Political quarrels, food shortages, and civil war afflict the Sudanese region to this day (Sahu, 2023; Varma, 2011).

With civil conflict and violence continuing to wreak havoc in the young country, South Sudan has a low human development score, resulting in being categorized as a least-developed country (LDC) as

defined by the United Nations Human Development Index (HDI). The most recent UN HDI measurement captures data until 2022, which accounts for the disturbances caused by the COVID-19 pandemic. At the time of measurement, citizens in South Sudan averaged a life expectancy of 55.6 years. South Sudanese citizens are also reported to have an average of 5.7 years of education over their lifetime (United Nations Development Programme (UNDP), 2024). The gross national income (GNI) is also quite low by global standards, at approximately $1,155 (based on 2017 USD), meaning that South Sudanese citizens, in general, do not have a decent standard of living (UNDP, 2024). In fact, the UNDP ranks South Sudan at 192 out of 193 for the recorded countries and territories in terms of overall human development (UNDP, 2024). Given South Sudan's low quality of life, ongoing military skirmishes across the country that continually threaten to escalate into civil war, and famines and droughts that plague the country on a yearly basis, the case can be made that South Sudan is in a perpetual state of crisis. For this reason, although the data in this article come from both pandemic and non-pandemic time periods, we assert that both timeframes represent education in emergency, or EiE, in South Sudan.

In terms of infrastructure, only an estimated 7% of the South Sudanese population has access to the internet, and a mere 8.4% of the population has access to electricity, according to the most recent data (World Bank Group, 2024). The vast majority of electricity and internet use occurs in more urban areas, leaving rural areas almost entirely unconnected and without electricity. Further, UNESCO (2022) reports that literacy rates are approximately 48% for young people aged 15-24 and as low as 29% among the South Sudanese adult population aged 25-64.

Literacy has been defined by UNESCO (2024a, 2024c) as the continuum of learning that facilitates individuals' ability to develop knowledge, achieve goals, and participate in the wider community. However, the UNESCO definition does not align with the actual reporting methods used by the organization. In fact, the current collection method for literacy data entails asking the head of the household to declare whether or not they can read and understand a simple short story, written in any language, about one's everyday life (UNESCO, 2024b). The discrepancy between a philosophical understanding of the concept and its actual measurement leads to a tremendously misleading depiction of the global state of literacy. Further, such misaligned philosophical vs. practical understandings of literacy have compounding effects as literacy gains a highly relevant digital dimension.

Since digital literacy requires access to electricity, content, a device, digital resources, and some form of training to adapt traditional literacy skills to the digital realm, nearly by definition, the digital literacy rates will be significantly lower in areas lacking this infrastructure and skills. Without developing basic literacy and internet-ready skills, the progression toward digital literacy is not a simple transition (Hosman & Pérez Comisso, 2020).

Like most other ministries of education around the world, during the COVID-19 pandemic, South Sudan's MOGEI was responsible for implementing emergency educational solutions that relied upon distance learning to allow students to continue their schooling. With such low rates of accessible electricity and even lower rates of internet connectivity, the pursuit of implementing a remote learning program was no small feat. However, together with the United States Agency for International Development (USAID) and the United Nations International Children's Emergency Fund (UNICEF), MOGEI distributed 32,000 solar-powered radios to students around the country, with a particular focus on ensuring that children from marginalized households had access to radio sets (UNICEF, 2020). Once distributed, the South Sudan Broadcasting Corporation and Radio Miraya were able to broadcast lessons to students, allowing instruction to resume at some level (UNICEF, 2020).

Although connecting students to educational material via the radio-based learning program was unquestionably an achievement, the widespread lack of access to textbooks or other supplementary learning materials made it challenging for students to follow along with the lessons and to continue their studies after the radio lessons finished. Thus, combined with the evidence that shows radio-

based learning solutions as being far less effective in reaching desired educational outcomes than implementing blended learning models (Prahmana et al., 2021), a partnered initiative with both local and international partners proposed a blended distance learning program to take place in Juba, South Sudan's capital city. In this blended model, the radio-based lessons were supplemented with digital textbooks that were distributed via the SolarSPELL offline digital library.

The SolarSPELL Initiative

SolarSPELL is an offline digital library and information literacy initiative at SolarSPELL University that provides curated, localized information in rural regions facing pervasive infrastructural barriers, such as lack of internet and electricity. SolarSPELL's field-tested, holistic approach to building information literacy in offline environments engages four key components: curated digital libraries; solar-powered, offline technology; training of in-field partners; and ongoing monitoring and evaluation. The SolarSPELL digital library utilizes an offline-first approach while mimicking an online experience so that internet-ready skills can be taught even in the absence of internet connectivity (Hosman et al., 2020). The library's offline technology allows learners and teachers to access the content without relying on internet connectivity, and the ability to download any of the resources from the library enables users to take the content with them to access it anytime, anywhere.

Although the term "offline learning" is sometimes used to describe traditional, in-person modes of education (Faidal et al., 2020; Wadhwa et al., 2020), it can also refer to learning outside of the classroom using digital devices offline, as is the case with the SolarSPELL Initiative. In this article, offline learning refers to digital modes of learning that happen to take place without (the need for) internet connectivity. An offline library can provide access to educational resources in emergencies, meaning that resources from the offline library remain available and accessible even if power is out, individuals are displaced, or in-person schooling is disrupted.

The SolarSPELL offline digital library was first created in 2015 and is characterized by (1) participatory, action-based research, (2) in-field lessons gained by working with on-the-ground partners, and (3) multidisciplinary teamwork (for a more detailed description of the SolarSPELL Initiative's background and history see Hosman (2018) and Hosman et al. (2020)). As opposed to a model in which users are left on their own to figure out how to use the technology and how to incorporate it into their lives or build skills surrounding its use, it is critical to the SolarSPELL mission that in-field partners and library users are supported throughout the implementation and use of the digital library. To date, SolarSPELL digital libraries have been implemented with local partners in 15 countries globally.

The SolarSPELL Initiative curates specific library collections for each region in which it works. These libraries contain resources that are localized and relevant to the users within each partner country. For example, the East Africa Education library collection contains resources for students and teachers in South Sudan, Rwanda, and Ethiopia and has all the content areas that can be found in a primary or secondary school. Per the request of local partners, the majority of resources are in English; however, there are resources available in local languages, including Amharic, Kinyarwanda, and Kiswahili. Each library has audio, video, PDF, and interactive HTML resources and also includes curricula, syllabi, local school textbooks, and storybooks.

In South Sudan, the Ministry of Education (MOGEI) provided the SolarSPELL Initiative with local textbooks to add to the library. Although not within the scope of this paper, access to textbooks in low-income countries is limited due to the high cost of creating, publishing, printing, and distributing them (Fredriksen et al., 2015) and also by the for-profit nature of many textbook distributors (Mbengei & Galloway, 2009). This creates a challenge for teachers and students to receive physical copies of textbooks and demonstrates the importance of offline access provided by the partnership of the SolarSPELL Initiative and the Ministry of Education.

The SolarSPELL Initiative follows a train-the-trainer model to ensure library users have the confidence and knowledge to access library information and to train others on how to do the same, which

are key components of successful ICT integration and digital literacy (Bingimlas, 2009). The SolarSPELL Initiative creates in-country partnerships and, in non-emergency situations, travels to the country to conduct a multi-day in-person train-the-trainer training. Once the in-country training is completed, there is consistent communication with partners before (ideally) returning to the country for a 6-month follow-up monitoring and evaluation visit. However, the COVID-19 pandemic shifted SolarSPELL's approach to training and impact evaluation globally, as well as in South Sudan.

South Sudan - SolarSPELL Partnership

In 2019, the SolarSPELL Initiative, in partnership with Empower Kids South Sudan (EKSS), a Juba-based NGO, launched a Teacher Training Center at the Juba Girls Secondary School in Juba, South Sudan. This center established a regional hub for Juba-area teachers to receive training on how to effectively use SolarSPELL digital libraries to support their in-person teaching. To indicate support for the Teacher Training Center's establishment, the Minister of Education was present for its launch and approved and supplied digital copies of the then-newly written South Sudanese digital textbooks to be added to the SolarSPELL digital library.

The SolarSPELL Initiative, in collaboration with EKSS and MOGEI, was able to expand the implementation of SolarSPELL libraries to an additional seven Juba-area schools. Teachers from each participating school received training at the Juba Girls School Teacher Training Center. Having access to the offline digital library proved to be a significant shift for the Juba-area schools because, according to teachers and administrators from the participating schools, before this point, there were few textbooks to share amongst teachers or students, making it difficult for teachers to prepare their lessons or for students to engage fully with class information. With access to the SolarSPELL digital library, textbooks could be accessed and downloaded by any individual associated with the pilot schools.

In 2020, when the COVID-19 pandemic struck, and the MOGEI began broadcasting lessons over the radio, the director of EKSS realized that his own children did not have textbooks to follow along with on-air lessons. He proposed a Distance Learning Program that would allow textbooks and supplementary learning resources to be downloaded from the SolarSPELL offline digital library. This proposal was approved by MOGEI and received funding from the US Embassy in Juba for a 2-week initiative.

The Distance Learning Program engaged and trained eight facilitators who delivered SolarSPELL digital libraries to designated schools throughout the Juba area at scheduled times announced by the MOGEI over the radio. This allowed parents and teachers to go to schools safely (following social distancing protocols) and download digital textbooks and supplementary educational materials to their smartphones or other devices, which they then brought home for their children to use. By gaining access to these resources, students were able to follow along with the digital textbook while listening to MOGEI's radio broadcasts.

METHODS AND DATA COLLECTION:

This paper follows a case study approach. A case study is "an intensive study of a single unit for the purpose of understanding a larger class of similar units" (Gerring, 2004, p. 342). Case studies allow for an in-depth understanding of phenomena by concentrating on a specific situation or context (Lijphart, 1971). The case study process has received criticism due to the lack of requirements and rigor guiding case research (Meyer, 2001); however, the case study approach allows for a multi-perspective analysis of what is being studied (Tellis, 1997). Furthermore, the triangulation of data from various sources within case studies contributes to the validity and accuracy of case studies (Tellis, 1997; Yin, 2003). While it was not possible to collect in-depth qualitative data from each of the participating schools, quantitative data was collected from each school. Combining the self-reported (qualitative) and actual (quantitative) data enhanced the reliability and validity of the study and helped to address biases inherent in qualitative data.

When implementing case study research, it is important to test the replicability of findings across similar cases. Although this may pose a challenge, it is the authors' intention to apply the findings of this study across future cases in South Sudan and in other countries where the SolarSPELL Initiative works. As the schools in this case study are still participating in the SolarSPELL Initiative, the present research is ongoing.

Research/Study Design

The SolarSPELL team research strategy consisted of a mixed methods approach, using both qualitative and quantitative data. A mixed-methods approach is critical to the holistic evaluation of the SolarSPELL Initiative because it allows for a more comprehensive understanding of the impact of the digital libraries and provides a more complete understanding than a single-method approach (Migiro & Magangi, 2011). Qualitative data analysis was conducted in the form of structured interviews with library-using teachers and administrators, following a uniform set of questions to ensure consistency among those who were interviewed (Mueller & Segal, 2015). Quantitative data analysis was conducted by collecting data from the SD (Secure Digital, or tiny memory) cards from each library in the field.

Seven schools are included in this article's analysis, which corresponds with the seven schools participating in the SolarSPELL Initiative in South Sudan. All of these schools are located in the capital city of Juba, which was a necessity due to South Sudan's volatile political situation and the effects of the COVID-19 pandemic. This is a potential limitation of the study, as it may limit the representativeness of the broader population in South Sudan.

Due to strict pandemic-related restrictions, the SolarSPELL team was unable to travel to South Sudan to conduct the interviews, necessitating that they be conducted by our in-country partner. The team thus remotely trained the director of EKSS on qualitative methods of data collection and provided the interview tools.

Qualitative Data Analysis

Before conducting the interviews, the SolarSPELL Initiative received approval from the Anonymous State University Institutional Review Board Committee. Verbal informed consent was obtained by interview participants prior to data collection. In order to obtain a representative sample, the director of EKSS conducted structured interviews at three out of seven schools that received the SolarSPELL digital libraries from December 2021 to January 2022. Primary and secondary schools in Juba were on staggered breaks as they recovered from the COVID-19 pandemic. The three schools participating in monitoring and evaluation activities were in session, and their administrators made the teachers available. Thus, while in-depth interviews took place at three schools, library usage data was collected from all seven participating schools.

The interview questions were developed by the SolarSPELL research team and consisted of 41 structured questions and follow-up questions. Seven interviews were conducted with teachers and school administrators from the three schools. The administrators at each school selected two teachers who were familiar with and/or were using the SolarSPELL digital library. In one case, the administrators themselves agreed to be interviewed, as well, as they were using the SolarSPELL library. The qualitative questions covered topics including demographic information, resource availability, library content and implementation, and out-of-school use. Audio recordings of each interview were taken. These recordings were subsequently shared with the SolarSPELL research team, who transcribed and coded them. The coding process is described below.

Designing a qualitative data analysis strategy requires thoughtful consideration to accommodate contextual differences between individual projects (Elliott, 2018). The coding process for the qualitative data interviews was designed to ensure reliability and validity. Initially, two researchers independently reviewed the transcripts to familiarize themselves with the content and identify preliminary themes.

Following this, the researchers developed a comprehensive coding framework collaboratively, drawing on relevant literature and the specific research objectives of this study. This framework provided a structured approach to categorizing the data, ensuring consistency in the coding process.

Once the initial framework was established, the two researchers independently thematically analyzed the interviews. This step was crucial in identifying any discrepancies or differences in interpretation. After thematic analysis, the researchers met to discuss their findings, reconcile differences, and refine the analysis framework. Throughout the study, the analysis framework was updated to accommodate new themes and patterns that emerged from the data, allowing for a more nuanced and comprehensive analysis of the interviews. This process was used to identify overarching themes and draw meaningful conclusions about the participants' experiences. This qualitative approach provided valuable information about the overall impact of the SolarSPELL digital library, as well as a more nuanced understanding of how educational and teaching outcomes were impacted.

Quantitative Data Analysis

Each SolarSPELL digital library is equipped with an SD card containing the library's content, software code that enables the broadcasting of an offline WiFi hotspot, and a usage tracking script. This script logs each instance in which a resource is accessed, capturing details such as the resource title, type, subject, and whether it was downloaded. The SolarSPELL team developed a Usage Data Analysis Tool to aggregate this usage data. This tool categorizes the information, filters the data, and creates visual representations of the usage patterns. These visualizations provide valuable quantitative insights and support qualitative findings regarding the usage of SolarSPELL libraries in individual schools and across the entire program.

The director of EKSS collected a total of thirteen library SD cards from the field, from both participating schools and the Distance Learning Program. The SolarSPELL team downloaded the usage data from each SD card as CSV files and uploaded these files to the Usage Data Analysis Tool for detailed analysis. The aggregated data and visualizations were analyzed inductively by the authors for patterns of usage across and within schools, including most-accessed files, subjects, and types of resources.

Findings

The findings of this case study reveal the efficacy of offline digital approaches to provide educational materials in areas with limited infrastructure and mitigate learning disruptions during emergencies. Findings are presented in descriptive statistical charts created from usage data files, combined with supporting qualitative data from interviews with teachers and administrators at participating schools.

The figures below are first separated by learning modality and then combined to provide an overview. Figure 1 illustrates library usage that took place within the schools (an in-person learning modality). This usage took place from 2019 to January 2022 and includes the months (approximately April 2020-October 2021) when the pandemic forced school closures but does not include the 2-week Distance Learning Program. Figure 2 shows usage solely during the 2-week Distance Learning Program during the pandemic (August 2020), and Figure 3 combines all data, both from in-school use and from the Distance Learning Program.

In total, more than 40,000 digital resources were accessed across all schools from the beginning of library implementation in schools in South Sudan in 2019. As illustrated in Figure 1, textbooks and local resources were the most popular content in the SolarSPELL libraries, comprising 54.5% of all resources accessed. Local resources in the SolarSPELL digital library primarily include local textbooks and teacher guides, curricula, syllabi, and other related content provided by MOGEI. Of the 40,000 resources accessed across all schools, the South Sudanese textbooks and local resources were accessed more than 21,000 times.

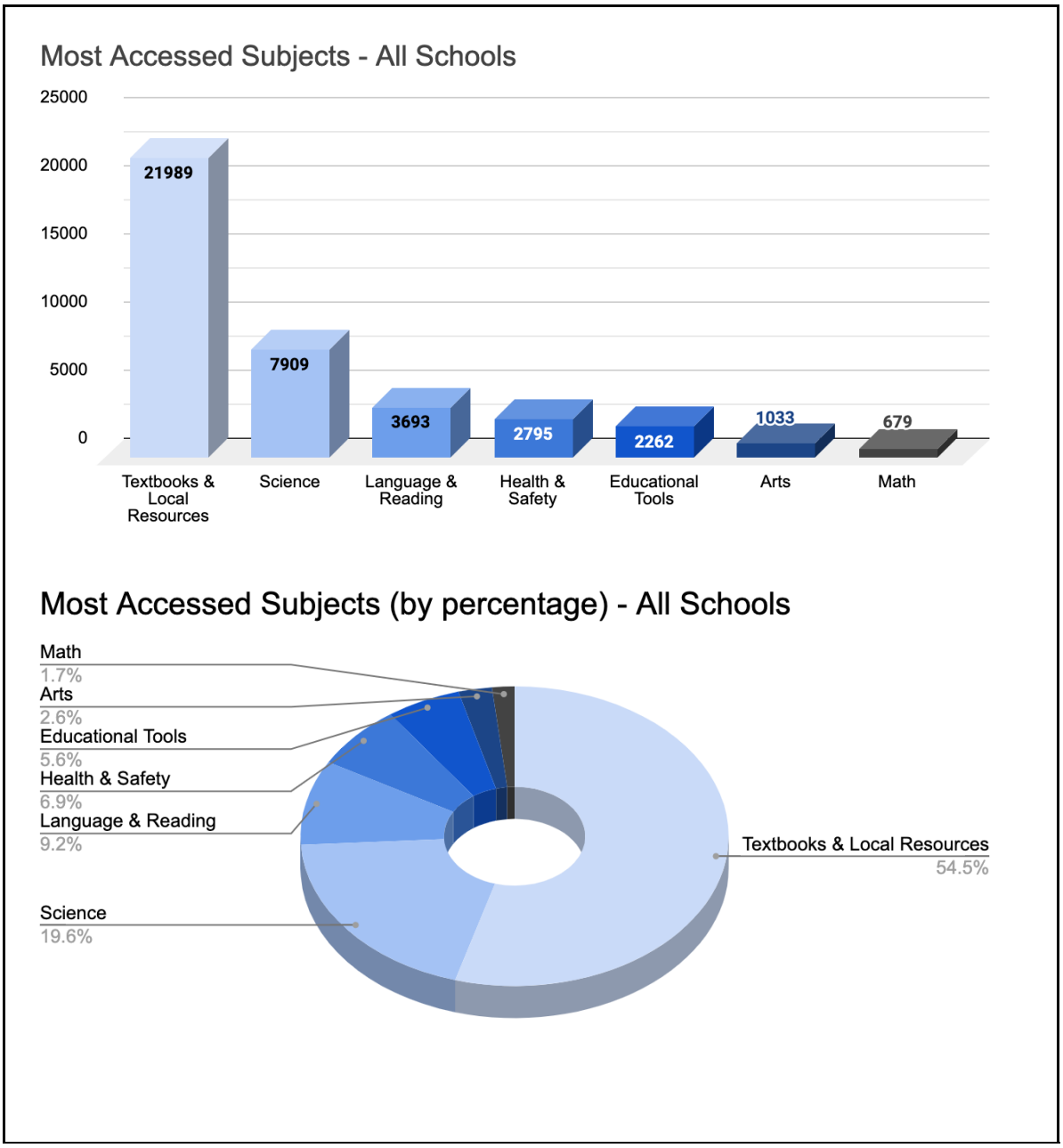

Figure 1. Library resources that have been accessed since the SolarSPELL digital library usage began in South Sudan in 2019

The data usage report shows that science is the second most accessed subject, constituting nearly 20% of resources accessed. The data corroborate the claims made by administrators and teachers across all schools in the interviews that science resources were highly sought after and widely used. Other supplementary learning resources for language and reading, arts, health and safety, and math have also been accessed from the SolarSPELL libraries to support classroom and home learning. Supplementary resources have a less frequent access rate because the critical subject material is also relayed to learners and teachers through the localized textbooks in the SolarSPELL digital library.

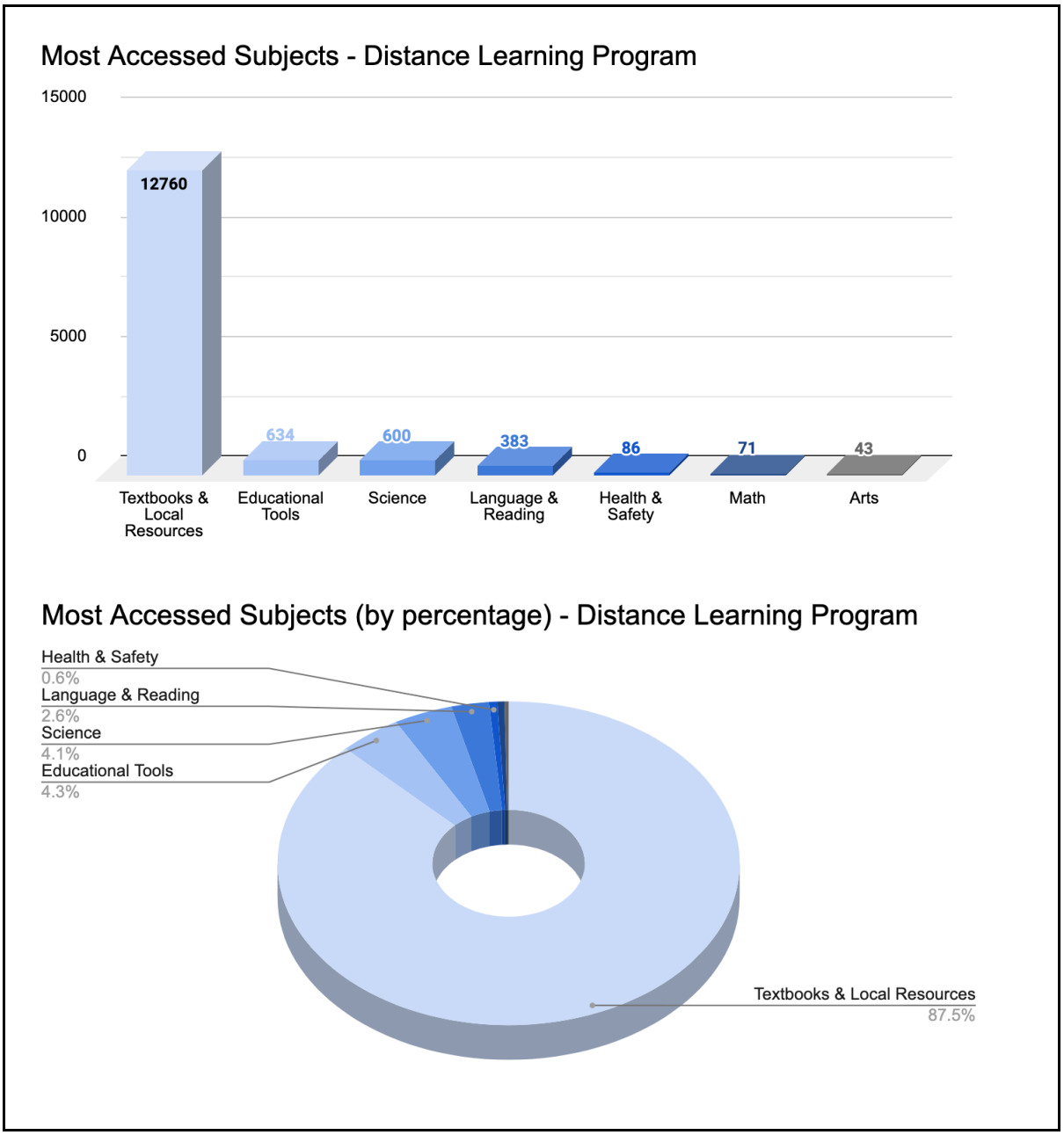

Figure 2. Resources most frequently accessed over the two-week Distance Learning Program in South Sudan

Figure 2 shows the resources accessed during the two-week Distance Learning Program described above. In this short timeframe, 14,577 resources were accessed in the libraries. The vast majority of these resources (87.5%) were textbooks and the other learning resources made available by the Ministry of Education (teacher guides, syllabi, etc.). Since the stated intention of the program was to distribute textbooks so that students could follow along during radio lessons, this helps explain the high percentage of textbooks downloaded vis-a-vis the rest of the library's content. It likely also accounts for the significant difference in the proportion of textbooks accessed during the Distance Learning Program (87.5%) versus in-person learning (54.5%), when there was a greater possibility to utilize the library as a repository of supplementary materials over a broad range of educational subjects.

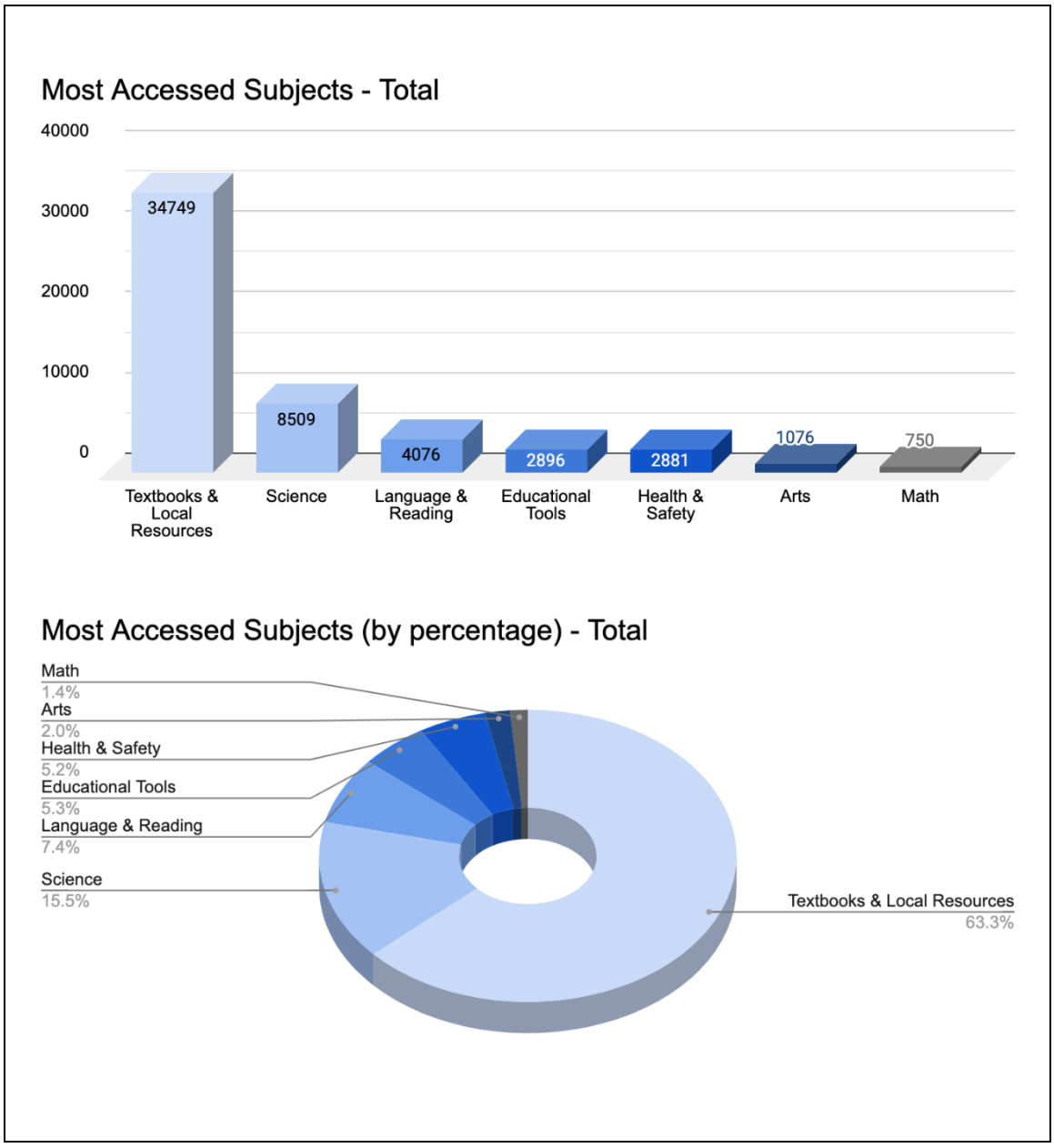

Figure 3. Total number of resources accessed from the SolarSPELL digital library in both in-school (in-person) and Distance Learning Program use

Figure 3 aggregates all resources accessed across all subjects, during both the Distance Learning Program and during in-person learning in the schools since 2019. In total, 54,937 resources were accessed between both initiatives from 2019-2022, with textbooks and local resources being the most accessed category and science being the second most accessed category (or the most-accessed individual subject).

Although the SolarSPELL SD card is able to track the number of times resources are accessed while they are in the library, it is important to note that once these open-access resources have been downloaded and have thus made their way into the community, they could be used and shared countless times – leaving no way for the SolarSPELL Initiative to track how extensively each resource is used or shared once it is downloaded. Because the goal of the Distance Learning Program was to enable

parents and teachers to download resources quickly, even while social distancing, no interviews were conducted during the 2-week program.

A few months after in-person instruction resumed, however, structured interviews were conducted with administrators and educators that allowed the SolarSPELL team to develop an understanding of how resources were used and what impact they had on academic pursuits. Perhaps the clearest indication of the positive impact that SolarSPELL digital libraries had on teachers and administrators was the unanimous response that each of them felt more prepared to effectively do their job by using the SolarSPELL digital library.

In terms of frequency of use, six out of seven of the teachers and administrators interviewed reported that the libraries were used on a daily basis at their school, particularly since in-person learning resumed. Every teacher and administrator also reported the positive aspect of the libraries providing soft copies of the textbooks that the students and teachers alike could download and use at school or at home.

> *It has relieved us from the issue of finding books. With the number of books in SolarSPELL, each and every person can get access. And there's no issue of copying the books. And the book is still in place after downloading. So, we have no problem of storage.*

Most teachers also noted that learners and educators now had access to textbooks, which had been a challenge before the arrival of the libraries.

> *It has helped the teachers in getting the content to teach, because the majority suffered when getting access to what to teach in class. But with SolarSPELL, they come and they ask for this library, then they write down notes. So they find what they want. It has been very good for them. It has also eased the issue of students always complaining about textbooks. When we got this SolarSPELL, the complaints reduced, because now they have the books with them.*

One teacher expressed excitement about the portability of the library resources since they can be downloaded onto personal devices.

> *You can go with it anywhere. You can even download the books on your phone. In your free time in your house, you can prepare for the lesson for tomorrow. You don't need to come to the library to access it. That is one of the most beautiful things in the SolarSPELL.*

Many of the teachers also expressed their excitement about how the digital library can help their students build important skills for continuing their education.

> *We give them assignments, and they go, and they can extract the assignments. And then tomorrow, when they are at the university, normally the professor doesn't give you 90% of the knowledge, they only give you 10%. The 90%, you need to go and look at it in the library. With the SolarSPELL, you are already training them on how to extract notes.*

Multiple teachers pointed out that SolarSPELL provides both learners and educators the opportunity to build skills for the 21st century and to modernize their educational experience.

> *We need teachers to not just be used to the traditional method of teaching, but they need to also be used to the modern way of teaching. This SolarSPELL is something that exposes us to that. The impact I would like to share is that it supports the learning and encourages the young generation to come. Because we are at the age of globalization, and it exposes one to technology.*

When asked about the other educational resources in the school, one teacher responded:

> *Well, we have a library there, which is lacking in books. But the ones which we have, they are helping it. Plus now we have the SolarSPELL. Because the SolarSPELL is now the mother of all. She has the new curriculum; she has the textbooks. So this is how we are getting our educational resources now.*

Some schools took the initiative to make libraries available to the community and/or to neighboring schools to allow the downloading of resources, both during and after the COVID-19 pandemic.

> *Teachers and students use the library. And then there are people coming from outside. The communities come from outside. Because there are some neighboring schools around here, they don't have access to these books or to the textbooks. They come to download these books from us here.*

Interviews also provided the opportunity for teachers and administrators to share examples of challenges that they experienced and make recommendations for additional content they would like to see added to future library versions. The most common challenge noted across all of the schools was the lack of digital devices (computers, tablets, smartphones) for all students to connect to the SolarSPELL digital library at one time. Similarly, the Distance Learning Program, though generally successful in terms of increasing access to learning resources, faced comparable challenges. For example, one school administrator reported that individual households often have only one smartphone. Therefore, even when parents successfully download digital materials for all the kids in their house, challenges still arise when large households with multiple school-aged children try to share a single smartphone.

Even with such challenges, the findings from South Sudan suggest that there has been a significant positive impact on student educational outcomes in schools and communities where SolarSPELL digital libraries are most utilized. Some of the most striking feedback received by the SolarSPELL team came from *School 1,* where the SolarSPELL library has been in use since November 2019. Teachers and administrators reported high usage levels of the SolarSPELL digital library even while the pandemic made in-person instruction impossible. Independently from the aforementioned Distance Learning Program, teachers and administrators from this school used the SolarSPELL library to support remote learning by disseminating lesson plans among students and encouraging them to download textbooks from the library onto their personal devices (or to family/household devices). This enabled students to reference course materials while at home and listen to the radio-based lessons. This school received the highest overall score, or ranking, in South Sudan for the 2020 National Exams. Furthermore, this school had two individual students who ranked in the top ten highest exam-scoring students in the country (ranking #2 and #6, respectively) for 2020. Both teachers and administrators at this school directly attributed these successes to the school's extensive (and often creative) use of the SolarSPELL digital library before, during, and after pandemic-related school closures.

Teachers and administrators from *School 2* reported that the frequency in which teachers used the SolarSPELL digital library ranged from daily to once per week, with reported usage rates decreasing as teachers downloaded resources to their mobile phones and were thus able to access and use those resources directly from their phones. According to teachers at the school, students were enthusiastic about their ability to access textbooks so that they could review material and read ahead to prepare for lessons. It was also reported that students who used the SolarSPELL digital library more frequently showed an increased motivation to learn and did better on the National Exams.

Schools that regularly used SolarSPELL digital libraries and invested time in sustaining the train-the-trainer model tended to see greater student success and more teachers reporting increased self-efficacy. However, in schools where the train-the-trainer model was not taken up, and general student engagement with the SolarSPELL library was lacking, positive changes in educational outcomes were also limited. For example, at three of the schools that received SolarSPELL digital libraries, the initial teachers trained to use the SolarSPELL digital library did not return to school when in-person instruction resumed.

Two further challenges faced by the research team came from the usage data collected from the libraries. At the point in time, the data was collected, it did not indicate whether a resource had been downloaded, nor did it provide a timestamp to indicate when resources were accessed. Both of these

features have since been incorporated into usage data that will be collected in the future. Additionally, all of the estimates of resources accessed represent underestimates since there are distinct, self-contained learning modules that are also available in the library that contain hundreds to thousands of resources per module. Because of how they are coded, the SolarSPELL usage data software has not been able to track module resource usage. This has been somewhat addressed since the data informing this article were collected from South Sudan, with module access but not overall use, and are now being tracked.

DISCUSSION

Given political instability, climate change, and the possibility of pandemics, educational disruptions will continue to emerge, necessitating a progressive approach to global infrastructure and educational challenges. For many people, access to quality education is directly inhibited by insufficient access to digital and technological infrastructure (Vassilakopoulou & Hustad, 2023; Verdecchia et al., 2022). Addressing these infrastructural challenges is crucial for improving educational outcomes, which in turn impacts economic prosperity, individual agency, and digital literacy.

The findings of this article demonstrate that programs like the SolarSPELL Initiative have shown positive impacts in both regular and disrupted educational settings in resource-constrained locations. Data collected from the SolarSPELL Initiative in South Sudan indicate that offline digital libraries provide critical access to educational resources and help develop essential digital and information literacy skills. When looking at the difference in the proportion of textbooks accessed during the Distance Learning Program (87.5%) versus during in-person learning (54.5%), it is clear that offline digital libraries serve a critical role in education during emergency situations. Although textbooks are necessary for all forms of schooling, during an emergency situation, such as the COVID-19 pandemic, textbooks become a main source of information for students and teachers. Having access to textbooks is monumentally important for students so they do not fall behind in their studies. Furthermore, the findings demonstrate the importance of having localized resources available in the digital library. For example, South Sudanese textbooks are specific to South Sudan, and educators and students in other countries require their own national textbooks. This highlights the importance, for international organizations working in the educational sector, of having strong in-country partnerships as well as partnerships with ministries of education to ensure the relevance and effectiveness of resources being provided (Hosman, 2014).

It is important to note that implementing alternative education modes during emergencies comes with challenges. For the SolarSPELL digital library in South Sudan, primary obstacles included a shortage of digital devices for accessing the library and a lack of ongoing training of trainers. Low teacher morale and economic challenges post-pandemic were common globally (Robinson et al., 2023). These challenges led many people to travel and seek new forms of employment. As a result, some of the trained teachers were often unavailable to facilitate the use of the SolarSPELL digital libraries, leading to limited use. To address this challenge, new teachers from the three aforementioned schools were identified and attended a train-the-trainer training at the Juba Girls School in order to promote increased library usage and further training of teachers and administrators at their schools.

Even without the added pressure of educational disturbances, it is clearly beneficial to create more adaptable education systems that allow for knowledge mobilization in a variety of infrastructural contexts, including learning opportunities that are outside the scope of traditional, formal education, and that foster lifelong learning opportunities (Damasceno, 2023). As the educational response to the COVID-19 pandemic suggests, there is a need to develop adaptable education pathways, particularly for under-connected, marginalized communities around the world.

However, our findings suggest that the mere presence of technology is insufficient to surmount educational disruptions, and training and local adoption are critical for the long-term impact and sustain-

ability of solutions. As mentioned above, for positive impacts to take root, knowledge of how to utilize and leverage SolarSPELL digital libraries must pass between teachers, students, and administrators - in this way, knowledge exchange becomes sustainable. The extent to which the SolarSPELL libraries are used and integrated into teaching and learning appears to be correlated to whether or not subsequent trainings are held after the initial train-the-trainer training to train additional teachers and administrators and increase uptake school-wide. When such training and local adoption occurred, the SolarSPELL digital library proved to be a valuable educational resource during the COVID-19 pandemic for students, teachers, and community members in South Sudan.

CONCLUSION

The impact of the SolarSPELL offline digital libraries in South Sudan during the COVID-19 pandemic underscores the potential of inclusive, offline learning solutions in addressing educational disruptions in under-connected communities. The findings from this case study highlight that such initiatives not only help maintain educational continuity during crises but also contribute to building digital and information literacy skills among teachers and students. The qualitative and quantitative data collected reveal that the SolarSPELL digital libraries were successful in increasing access to educational resources, particularly textbooks, during regular school openings and pandemic-induced school closures. The success of the Distance Learning Program, supported by the Ministry of General Education and Instruction, demonstrated that strategic partnerships and community engagement are critical for the effective implementation of such initiatives.

An important takeaway that warrants reiterating is that the mere presence of technology is not enough. The effectiveness of digital libraries is enhanced by comprehensive and continuous training and support for teachers and administrators. The train-the-trainer model used by the SolarSPELL Initiative proved essential in ensuring that educators could confidently utilize digital libraries and integrate them into their teaching practices. Challenges such as the limited availability of digital devices highlight the need for continued investment in infrastructure to best use digital educational tools.

Offline digital libraries, like those provided by the SolarSPELL Initiative, offer an adaptable approach to education in emergencies, especially in low-resource settings. These libraries support continuous learning, foster digital and information literacy, and help provide educational resources during times of crisis, such as environmental disasters, civil unrest, and global pandemics. Future action research should focus on expanding such initiatives, addressing infrastructural challenges, and exploring additional ways to enhance the scalability and sustainability of offline digital learning solutions in similar contexts. Furthermore, an in-depth analysis of the long-term impact on educational outcomes is recommended despite the inherent challenges involved in this undertaking. By undertaking such research, we can make significant strides toward ensuring quality education for all, even in times of crisis.

REFERENCES

Aedo, C., Nahata, V., & Sabarwal, S. (2020, November 10). The remote learning paradox: How governments can truly minimize COVID-related learning losses. *World Bank Blogs*. https://blogs.worldbank.org/en/education/remote-learning-paradox-how-governments-can-truly-minimize-covid-related-learning-losses

Angrist, N., de Barros, A., Bhula, R., Chakera, S., Cummiskey, C., DeStefano, J., Floretta, J., Kaffenberger, M., Piper, B., & Stern, J. (2021). Building back better to avert a learning catastrophe: Estimating learning loss from COVID-19 school shutdowns in Africa and facilitating short-term and long-term learning recovery. *International Journal of Educational Development*, *84*, 102397. https://doi.org/10.1016/j.ijedudev.2021.102397

Association of College & Research Libraries. (1989). *Presidential Committee on information literacy: Final report.* https://www.ala.org/acrl/publications/whitepapers/presidential

Azevedo, J. P., Hasan, A., Goldemberg, D., Iqbal, S. A., & Geven, K. (2020). *Simulating the potential impacts of COVID-19 school closures on schooling and learning outcomes: A set of global estimates*. World Bank Group. https://openknowledge.worldbank.org/server/api/core/bitstreams/2b6bde96-8b1c-5fde-91e9-256504fb7590/content

Bebell, D., & Pedulla, J. (2015). A quantitative investigation into the impacts of 1:1 iPads on early learner's ELA and Math achievement. *Journal of Information Technology Education: Innovations in Practice*, *14*, 191–215. https://doi.org/10.28945/2175

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics, Science and Technology Education*, *5*(3), 235–245. https://doi.org/10.12973/ejmste/75275

CEPAL & UNESCO. (2020). *Education in the time of COVID-19*. ECLAC. https://hdl.handle.net/11362/45905

Damasceno, C. (2023). MOOC appropriation and agency in face-to-face learning communities. *Journal of Information Technology Education: Innovations in Practice*, *22*, 49–65. https://doi.org/10.28945/5104

Dryden-Peterson, S. (2011). Conflict, education, and displacement. *Conflict & Education, 1*(1), 1–5.

Edwards, J. (2020). *Protect a generation: The impact of COVID-19 on children's lives*. Save the Children International. https://resourcecentre.savethechildren.net/document/protect-generation-impact-covid-19-childrens-lives/

Elliott, V. (2018). Thinking about the coding process in qualitative data analysis. *The Qualitative Report*, *23*(11), 2850–2861. https://doi.org/10.46743/2160-3715/2018.3560

Engzell, P., Frey, A., & Verhagen, M. D. (2020, October 29). *Learning loss due to school closures during the COVID-19 pandemic*. https://doi.org/10.31235/osf.io/ve4z7

Faidal, N. F., Nur, R., & Suriani, S. (2020). The teachers' pedagogic competence in teaching English through online and offline setting. *ELT Worldwide: Journal of English Language Teaching*, *7*(1), 42–53. https://doi.org/10.26858/eltww.v7i1.13294

Foster, V., Rana, A., & Gorgulu, N. (2022). *Understanding public spending trends for infrastructure in developing countries*. The World Bank. https://doi.org/10.1596/1813-9450-9903

Fredriksen, B., Brar, S., & Trucano, M. (2015). *Getting textbooks to every child in sub-Saharan Africa: Strategies for addressing the high cost and low availability problem*. World Bank Group. https://doi.org/10.1596/978-1-4648-0540-0

Fu, J., & Pow, J. (2011). Fostering digital literacy through web-based collaborative inquiry learning – A case study. *Journal of Information Technology Education: Innovations in Practice*, *10*, 57–71. https://doi.org/10.28945/1383

Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review*, *98*(2), 341–354. https://doi.org/10.1017/S0003055404001182

Gjoneska, B., Potenza, M. N., Jones, J., Corazza, O., Hall, N., Sales, C. M. D., Grünblatt, E., Martinotti, G., Burkauskas, J., Werling, A. M., Walitza, S., Zohar, J., Menchón, J. M., Király, O., Chamberlain, S. R., Fineberg, N. A., & Demetrovics, Z. (2022). Problematic use of the internet during the COVID-19 pandemic: Good practices and mental health recommendations. *Comprehensive Psychiatry*, *112*, 152279. https://doi.org/10.1016/j.comppsych.2021.152279

Graeff-Martins, A. S., Oswald, S., Obst Comassetto, J., Kieling, C., Rocha Gonçalves, R., & Rohde, L. A. (2006). A package of interventions to reduce school dropout in public schools in a developing country: A feasibility study. *European Child & Adolescent Psychiatry*, *15*, 442–449. https://doi.org/10.1007/s00787-006-0555-2

Gurstein, M. (2003). Effective use: A community informatics strategy beyond the Digital Divide. *First Monday*, *8*(12). https://doi.org/10.5210/fm.v8i12.1107

Hanushek, E., & Woessmann, L. (2020, September). *The economic impacts of learning losses* (OECD Education Working Papers No. 225). https://doi.org/10.1787/21908d74-en

Harmey, S., & Moss, G. (2023). Learning disruption or learning loss: Using evidence from unplanned closures to inform returning to school after COVID-19. *Educational Review*, *75*(4), 637–656. https://doi.org/10.1080/00131911.2021.1966389

Hosman, L. (2014). International service-learning partnerships: Lessons of successes and challenges that defy simple categorization. *Partnerships: A Journal of Service-Learning and Civic Engagement*, *5*(1), 24–50.

Hosman, L. (2018). Impatience as a virtue: Addressing persistent ICT-in-education challenges in small developing countries. In I. A. Lubin (Ed.), *ICT-supported innovations in small countries and developing regions* (pp. 169–193). Springer. https://doi.org/10.1007/978-3-319-67657-9_8

Hosman, L., & Pérez Comisso, M. A. (2020). How do we understand "meaningful use" of the internet? Of divides, skills and socio-technical awareness. *Journal of Information, Communication and Ethics in Society*, *18*(3), 461–479. https://doi.org/10.1108/JICES-05-2020-0055

Hosman, L., Walsh, C., Pérez Comisso, M., & Sidman, J. (2020). Building online skills in off-line realities. *First Monday, 25*(7). https://doi.org/10.5210/fm.v25i7.10839

Lai, B., & Thyne, C. (2007). The effect of civil war on education, 1980-97. *Journal of Peace Research*, *44*(3), 277–292. https://doi.org/10.1177/0022343307076631

Landa, N., Zhou, S., & Marongwe, N. (2021). Education in emergencies: Lessons from COVID-19 in South Africa. *International Review of Education*, *67*, 167–183. https://doi.org/10.1007/s11159-021-09903-z

Lijphart, A. (1971). Comparative politics and the comparative method. *The American Political Science Review*, *65*(3), 682–693. https://doi.org/10.2307/1955513

Mbengei, B. N., & Galloway, F. (2009). The impact of policy changes in the education sector on the development of the book publishing industry in Kenya. *Mousaion*, *27*(1), 159–174.

Meyer, C. B. (2001). A case in case study methodology. *Field Methods*, *13*(4), 329–352. https://doi.org/10.1177/1525822X0101300402

Migiro, S. O., & Magangi, B. A. (2011). Mixed methods: A review of literature and the future of the new research paradigm. *African Journal of Business Management*, *5*(10), 3757–3764.

Moodley, K., van Wyk, M., Robberts, A., & Wolff, E. (2022). Exploring the education experience in online learning. *International Journal of Education and Development Using Information and Communication Technology*, *18*(1), 146–163.

Mueller, A. E., & Segal, D. L. (2015). Structured versus semistructured versus unstructured interviews. In R. L. Cautin & S. O. Lilienfeld (Eds.), *The encyclopedia of clinical psychology* (1st ed., pp. 1–7). Wiley. https://doi.org/10.1002/9781118625392.wbecp069

Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, *8*(1), 133–141. https://doi.org/10.1177/2347631120983481

Prahmana, R. C. I., Hartanto, D., Kusumaningtyas, D. A., Ali, R. M., & Muchlas. (2021). Community radio-based blended learning model: A promising learning model in remote area during pandemic era. *Heliyon*, *7*(7), e07511. https://doi.org/10.1016/j.heliyon.2021.e07511

Reimers, F. M. (2022). Learning from a pandemic. The impact of COVID-19 on education around the world. In F. M. Reimers (Ed.), *Primary and secondary education during Covid-19* (pp. 1–37). Springer International Publishing. https://doi.org/10.1007/978-3-030-81500-4_1

Reshi, I. A., Khanrafiq, & Wanihaya. (2023). COVID-19 pandemic and teaching and learning: A literature review. *MORFAI Journal*, *2*(4), 820–826. https://doi.org/10.54443/morfai.v2i4.693

Robinson, L. E., Valido, A., Drescher, A., Woolweaver, A. B., Espelage, D. L., LoMurray, S., Long, A. C. J., Wright, A. A., & Dailey, M. M. (2023). Teachers, stress, and the COVID-19 pandemic: A qualitative analysis. *School Mental Health*, *15*, 78–89. https://doi.org/10.1007/s12310-022-09533-2

Sahu, S. (2023). *Food insecurity and malnutrition in South Sudan* (SSRN Scholarly Paper 4666620). https://papers.ssrn.com/abstract=4666620

Segbenya, M., Bervell, B., Minadzi, V. M., & Somuah, B. A. (2022). Modelling the perspectives of distance education students towards online learning during COVID-19 pandemic. *Smart Learning Environments*, *9*, Article 13. https://doi.org/10.1186/s40561-022-00193-y

Sinclair, M. (2007). Education in emergencies. In Commonwealth Secretariat, *Commonwealth Education Partnerships 2007* (pp. 52–56). Nexus Strategic Partnerships. https://www.cedol.org/wp-content/uploads/2012/02/52-56-2007.pdf

Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist*, *43*(3), 377–391. https://doi.org/10.1177/00027649921955326

Taka, M. (2023). When education in emergencies fails: Learners' motivations for a second chance education in post-conflict Rwanda. *Compare: A Journal of Comparative and International Education*, *53*(2), 217–234. https://doi.org/10.1080/03057925.2021.1886908

Teixeira, J., Amaroso, J., & Gresham, J. (2017, October 3). Why education infrastructure matters for learning. *World Bank Blogs*. https://blogs.worldbank.org/en/education/why-education-infrastructure-matters-learning

Tellis, W. (1997). Introduction to case study. *The Qualitative Report*, *3*(2), 1–14. https://doi.org/10.46743/2160-3715/1997.2024

Tinmaz, H., Lee, Y.-T., Fanea-Ivanovici, M., & Baber, H. (2022). A systematic review on digital literacy. *Smart Learning Environments*, *9*, Article 21. https://doi.org/10.1186/s40561-022-00204-y

Topuz, A. C., Saka, E., Fatsa, Ö. F., & Kurşun, E. (2022). Emerging trends of online assessment systems in the emergency remote teaching period. *Smart Learning Environments*, *9*, Article 17. https://doi.org/10.1186/s40561-022-00199-6

United Nations Development Programme. (2024). *Breaking the gridlock: Reimagining cooperation in a polarized world* (Human Development Report 2023/2024). UNDP. https://hdr.undp.org/system/files/documents/global-report-document/hdr2023-24reporten.pdf

UNESCO. (2020, July 30). *UNESCO COVID-19 education response: How many students are at risk of not returning to school?* https://unesdoc.unesco.org/ark:/48223/pf0000373992

UNESCO. (2022, October). *GAL country profile: South Sudan*. https://www.uil.unesco.org/sites/default/files/medias/files/2022/11/gal_country_profiles_southsudan.pdf

UNESCO. (2024a). *Literacy*. Glossary. https://uis.unesco.org/node/3079547

UNESCO. (2024b). *Literacy*. Education and Literacy. https://uis.unesco.org/en/topic/literacy

UNESCO. (2024c). *Literacy: What you need to know*. https://www.unesco.org/en/literacy/need-know

UNICEF. (2020, December 23). *32,000 USAID-funded solar-powered radios will enable distance learning for up to 160,000 children*. UNICEF Press Centre. https://www.unicef.org/southsudan/press-releases/solar-powered-radios-enable-distance-learning

USA for UNHCR. (2024). *Refugee statistics*. https://www.unrefugees.org/refugee-facts/statistics/

Uwezo Kenya. (2020). *Are our children learning? The status of remote-learning among school-going children in Kenya during the Covid-19 crisis*. https://docs.opendeved.net/lib/LRBK4LWS

van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2020). Determinants of 21st-century skills and 21st-century digital skills for workers: A systematic literature review. *SAGE Open*, *10*(1). https://doi.org/10.1177/2158244019900176

Varma, A. (2011, November). The creation of South Sudan: Prospects and challenges. *Observer Research Foundation*, *Occasional Paper* #27. https://www.orfonline.org/public/uploads/posts/pdf/20230723013739.pdf

Vassilakopoulou, P., & Hustad, E. (2023). Bridging digital divides: A literature review and research agenda for information systems research. *Information Systems Frontiers*, *25*, 955–969. https://doi.org/10.1007/s10796-020-10096-3

Verdecchia, R., Lago, P., & de Vries, C. (2022). The future of sustainable digital infrastructures: A landscape of solutions, adoption factors, impediments, open problems, and scenarios. *Sustainable Computing: Informatics and Systems*, *35*, 100767. https://doi.org/10.1016/j.suscom.2022.100767

Wadhwa, N., Khatak, S., & Poonam. (2020). Online versus offline mode of education – Is India ready to meet the challenges of online education in lockdown? *Journal of the Social Sciences*, *48*(3), 404–413.

Walton, G. (2016). "Digital Literacy" (DL): Establishing the Boundaries and Identifying the Partners. *New Review of Academic Librarianship*, *22*(1), 1–4. https://doi.org/10.1080/13614533.2015.1137466

World Bank Group. (2021, April 28). *What is Learning Poverty?* [Text/HTML]. World Bank. https://www.worldbank.org/en/topic/education/brief/what-is-learning-poverty

World Bank Group. (2024). *World Bank Open Data: South Sudan*. https://data.worldbank.org/country/south-sudan

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Sage.

Yunusa, A. A., Sanusi, I. T., Dada, O. A., Oyelere, S. S., Agbo, F. J., Obaido, G., & Aruleba, K. (2021). The impact of the COVID-19 pandemic on higher education in Nigeria: University lecturers' perspectives. *International Journal of Education and Development Using Information and Communication Technology*, *17*(4), 43–66.

AUTHORS

Libbie Farrell graduated from the College of Global Futures at Arizona State University in Tempe, Arizona, with a Master of Science in Global Technology and Development. She is a U.S. Peace Corps Coverdell Fellow recipient and served as a Community Economic Development volunteer in Timor-Leste from 2019-2020. Her research focuses on sustainable development, community development, and the capabilities approach to development. (E-mail: libbie.farrell1@gmail.com)

Dr. Laura Hosman is an Associate Professor at Arizona State University, with a joint appointment at the School for the Future of Innovation in Society and the Polytechnic School. Her action-oriented work focuses on the social impacts of new technologies in developing countries, particularly in education, lifelong learning, and information literacy. She is co-founder and co-director of the SolarSPELL initiative at ASU. Dr. Hosman holds an MA from the University of Amsterdam and an MA and PhD from the University of Southern California. (E-mail: laura.hosman@asu.edu)

Cassie Barrett is the Senior Student Engagement Coordinator for the global educational initiative SolarSPELL. She has a Master's degree in Peace and Justice from the University of San Diego. As a former Peace Corps volunteer in Rwanda, she taught English to both youth and adult populations. Cassie is deeply passionate about advancing educational equity and exploring the intersection of restorative justice and human rights. (E-mail: cbarre38@asu.edu)

Rachel Nova is a Project Manager for the SolarSPELL Initiative at Arizona State University. Prior to this, she was a Coverdell Fellow at ASU, where she completed a master's degree in Learning Sciences and a Graduate Certificate in Nonprofit Leadership and Management. Prior to joining ASU, she served in the Peace Corps in Benin, taught English in France, and coordinated educational programming for refugee women in the greater Phoenix area. (E-mail: rnova@asu.edu).