A Comprehensive Approach to Understanding E-resilience in Education
A Review of the Literature

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ABSTRACT

This paper explores how e-resilience in educational systems is understood by the current literature and what the main drivers and challenges are to achieving e-resilience. To answer the research questions, the paper follows the PRISMA systematic literature review, which consists of a literature identification, a literature screening, and literature analysis. A total of 247 papers were identified as relevant, of which 243 papers were screened and 53 papers were analysed. The paper concludes that e-resilience in education is defined in a comprehensive way taking into account the system and the technological, human, and interactive dimensions. The current literature focuses primarily on the enumeration of challenges experienced by educational systems to overcome shocks. Further empirical research is needed to understand what these challenges entail and how they can be overcome.

Keywords: E-resilience, educational systems, digital technology, COVID-19, SDG 4

1. INTRODUCTION

Educational systems need to be prepared to overcome shocks as quickly and effectively as possible, as they have done during the global health pandemic COVID-19 (COVID-19). At the time, digital technologies were the main elements that enabled educational systems to continue functioning. In this context, the concept of e-resilience became relevant because the capacity of educational systems to overcome such shocks was linked not only to the resilience of the actors but also to the system's capacity to use digital technologies (Ramos and Hynes 2022). This paper undertakes a systematic literature review to shed light on the current academic understanding of e-resilience in educational systems.

The Economic and Social Commission for Asia and the Pacific (ESCAP), the organisation that coined the term of e-resilience, defines it as "the ability of ICT systems to withstand and recover from and change in the face of an external shock" (ESCAP 2022). Yet, already in 2013, Weller and Anderson considered that the digitalisation of higher education changes the practice of education but not its function (2013, 53). Within the scope of education, e-resilience can thus be considered a multidimensional concept that focuses on the information and communications technology (ICT) or digital capacity of systems and individuals to absorb change and recover (Beale 2020). With the outbreak of COVID-19, the digitalisation of higher education became a tool for overcoming the shock brought about by the pandemic, which gave rise to the concept of e-resilience in educational systems.

The operation and use of digital infrastructures was a critical element for educational systems to cope with the impact of COVID-19. When physical education was disrupted during spells of lockdown, educational systems needed to have a functioning digital infrastructure as well as actors in the system with adequate digital capabilities. Inclusivity and intersectionality between the different stakeholders and system levels became crucial to overcome shocks. The concept of e-resilience in education should therefore take into account the roles and capabilities of the many stakeholders (e.g. students, parents, teachers, and institutions), in addition to the ICT infrastructure in and of itself (OECD 2020).

Despite the importance of e-resilience in education following COVID-19, this concept has not been studied in itself nor in the context of educational systems (Heeks and Ospina 2019). While there are several case studies that examine the responses of countries or institutions to COVID-19 (Daly 2021; Eri et al. 2021), as well as studies focusing on the impact of COVID-19 on the learning outcomes of students (Beale 2020; Cassidy 2016), the systematic picture regarding the factors that drive and challenge a system to be e-resilient remains unclear. Consequently, this article employs a systematic review of the relevant literature with a focus on the concept of e-resilience within educational systems.

2. METHODOLOGY

This paper explores how e-resilience in educational systems is understood by the current literature and what the main drivers and challenges to achieving e-resilience are. The paper follows the PRISMA systematic literature approach, which consists of a three-step process: (i) literature identification using 3 different identification methods, (ii) literature screening, and (iii) literature

analysis (Page et al. 2021) (see Figure 1). During the "identification" of the relevant literature, we approached the literature search in three complementary ways: a systematic scoping of platforms (Tier 1); the use of a litoscope toolkit (Tier 2); and the inclusion of hand-searching readings (Tier 3). Because there is no consistent terminology across disciplines for the terms "e-resilience in education", we queried for several key concepts, in order to retain the maximum possible number of relevant e-resilience publications. The terms queried for were: *e-resilience*, *digital resilience*, *cyber resilience*, *information systems*, *information technology*, *educational resilience*, *academic resilience,* and *ICT*. We classified the found elements as one of three levels of society: macro, meso, or micro. In addition, we analysed whether these drivers or challenges were considered technological, human, or human/technological intersections (see Table 1).

	Systematic Search (Tier 1)	**Litoscope Search (Tier 2)**	**Traditional Search (Tier 3)**
Identification	**Papers identified:** (n=160) *From:* EBSCO (n = 13) Emerald Insight (n = 11) ITID (n = 7) JSTOR (n = 69) OECD Library (n = 1) PKP (n = 1) Springer (n = 16) Web of Science (n = 12) ScienceDirect (n = 1) Taylor & Francis (n = 29)	**Papers identified:** (n=54) *From:* Web of Science (n = 54)	**Paper/Book chapters identified:** (n = 33) *From:* Updated Search outlets of Tier 1 and Tier2 Forward and Backward Referencing from identified papers in Tier1 and Tier2 Grey literature
	Removed before screening: Duplicate papers (n = 2)	**Removed before screening:** Not accessible (n = 2)	**Removed before screening:** Not accessible (n = 0)
Screening	**Screened** (n = 158)	**Screened** (n = 52)	**Screened** (n=33)
	Excluded: None (n = 0)	**Excluded:** Not in English (n = 2)	**Excluded:** None (n = 0)
Included	**Assessed for relevance** (n = 158)	**Assessed for relevance** (n = 50)	**Assessed for relevance** (n = 33)
	Papers excluded: Not education or ICT-related (n = 145)	**Papers excluded:** Not education or ICT-related (n = 3)	**Papers excluded:** Not education or ICT-related (n = 5)
	Included from Tier 1 (n = 13)	**Included from Tier 2** (n = 12)	**Included from Tier 3** (n=28)
Total Papers Included (n = 53)			

Figure 1: Literature search and inclusion overview[1]

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[1] Detailed search results and summary tables are available upon request with the authors.

3. RESULTS

Conceptualising e-resilience in educational systems

The concept of resilience in education is extensively covered. However, there is limited research on the concept of e-resilience in education. While this paper has an academic focus, also among industry the role of e-resilience in education is explored (IEEE 2022). Some authors understand resilience as a concept that focuses on one of the following four dimensions: individual, process, context, or system (Beltman 2021). Other authors view resilience as a dynamic and interactive concept that needs to be considered in all dimensions, particularly context (Shafi and Templeton 2020). This is in line with the organisational resilience literature that stresses that the stages of anticipation, coping and adaption require different organisational skills to build resilience and the iterative nature of the system (Duchek 2020; Lengnick-Hall, Beck, and Lengnick-Hall 2011). Measurement of resilience is done empirically on individual level, yet that does not cover actual measurements of system resilience (Ahern et al. 2006).

Studies that focus on the individual dimension generally focus on dimensions and qualities that influence the capacity of an individual to overcome challenges (e.g., teacher resilience). Studies that understand resilience as a process consider it essential to explore how individuals build resilience over time and how they take ownership of the transition period in order to overcome obstacles. Studies that focus on the context recognise that resilience allows for multiple assessments or measurements to be taken depending on the context in which the shock occurs (Beltman 2021). The system focused approach to resilience considers it essential to include various level in the systems that are interconnected within a larger context (Beltman 2021). Recent studies support this last approach, highlighting the need to study the interaction between the individual and the context in which they find themselves (Shafi and Templeton 2020, 32–35). Within this interactive system, resilience "considers both individual agency as well as the range of complex systems that the individual is part of" (Shafi and Templeton 2020, 32).

The concept of resilience has been studied in the context of education. Several studies highlight that resilience is a significant predictor for understanding the capacity of the educational system to overcome a shock, as well as the ability of students and teachers to maintain their level of performance in class (Beale 2020; Gu 2018; Mansfield et al. 2018; Shafi and Templeton 2020). For example, Schwarze and Woznitza and Mansfield et al. build on the model of Bronfenbrenner, presented in 1979, and propose a contextual model of resilience in which resilience encompasses the interaction of different levels or systems (Mansfield et al. 2018, 56; Schwarze and Wosnitza 2018). Hence, resilience in education is understood as a process in which the micro, meso, exo, and macro levels or systems interact with one another (Schwarze and Wosnitza 2018). This approach, similarly to the most recent approach mentioned by Shafi and Templeton, highlights the importance of the individual agency as well as the complex systems in which the interaction occurs (2020, 32–35). Resilience is defined by the "quality of both individuals and their environments" (Gu 2018, 29 referring to the work of Ungar et al (2013)).

The approach to system resilience in education has been well accepted since 2004 (Cassidy 2016; Gu 2018; Mansfield et al. 2018; Martin and Marsh 2006; Shafi and Templeton 2020; Walker et al. 2004). This approach refers to the ability of an educational system to absorb the change and quickly adapt to the altered environment while preserving its core function, namely the delivery of education (Cassidy 2016; Gu 2018; Mansfield et al. 2018; Martin and Marsh 2006; Walker et al. 2004). Within this approach, resilience in education includes a time dimension, which refers to the capacity of educational systems to overcome a shock both during and after it has occurred and to build back up to a higher standard (innovate). Hence, these system studies focus on the capacity of the educational systems to ensure continuity of education during a shock, as well as their capacity to recover and adapt after the shock (Heeks and Ospina 2019).

The ability of educational systems to adapt and improve is based on their capacity to learn from the shocks they encounter (Heeks and Ospina 2019). For example, studies conducted in higher education have found that resilient educational systems need to capture the ability of the system to maintain the efficient delivery of education while adjusting to the change in the environment and the means of delivering education (Beale 2020; Gu 2018). Additionally, teachers are considered unique agents capable of adjusting to shocks due to the "strength and conviction of teachers' vocational commitment […] which distinguishes teaching from many other jobs and occupations" (Gu 2018, 17).

With the outbreak of COVID-19, the approach to system resilience in education changed. In 2019, a sudden lockdown affected educational systems around the world. Students and instructors were not allowed to go to the building where education was delivered while educational systems were obliged to continue providing their services due to the essential role that education plays in modern societies. Hence, educational systems needed to change the way they imparted education and rely on technology to succeed in doing so.

With COVID-19, the concept of system resilience in education has to shift to system e-resilience in education. This new approach to the concept incorporates the importance of technology factors in achieving resilient educational systems. In educational systems, there is mainly a focus on human-centric technologies which builds in the human requirements, desires, and capacities to deal with the system (Agarwal et al. 2020). However, Weller and Anderson have already included the digital dimension in their concept of resilience in educational systems (2013). They addressed the capacity of the educational system to innovate by adjusting to digitalisation; specifically through the use of Massive Open Online Courses (MOOCS) and Open Access Publishing. They named this ability "digital resilience" and evaluated the system's potential to improve educational offerings by adapting to changes in evolving technology (Weller and Anderson 2013). In 2016, UN-ESCAP introduced the concept of "e-resilience" to a system. This concept was used to understand the extent to which an ICT infrastructure was effective in overcoming challenges associated with disaster management (ESCAP 2022). Therefore, the concept of technology as an important element in assisting societies to overcome a shock was introduced.

In 2017, Rothrock highlighted several elements that are relevant to understanding the transformation that systems undergo to adjust to shocks (that is to say, panarchy) and addressed the need to frame the concept within a larger system strategy (Rothrock 2017). The system strategy includes the country, institutions (e.g., the educational system), and individuals. Hence,

technology has to be considered in the context of the larger system's goals (outcome). This approach takes into account the complexity of digital systems and emphasizes that technology has to be functional and flexible in order to respond to shocks and to ensure the continued operation of the larger system, such as an educational system. Heeks and Ospina point out that while the notion of "what is resilience" is well-established in the literature of information systems (IS), the question "resilience of what" remains to be more clearly identified (2019). Their categorisation includes several different identities of resilient systems, including a human system (with mainly more or less resilient human input in an IS), a resilient information system itself (with a focus on the resilience of ICT infrastructure and digital networks), and a resilience of the outcome system – evaluating the impact of IS on the resilience of other external systems. These systems are capable of being resilient in and of themselves, but clearly, they also interact with one another. The concept of e-resilience is operationalised in their work, and it includes both foundational and enabling attributes. The foundational attributes included the system's robustness, self-organisation, and learning, whereas the enabling attributes included redundancy, rapidity, scale, diversity, and equality (Heeks and Ospina 2019, 72).

Additionally, van de Laar also addressed the importance of reviewing e-resilience as a systems approach and added, more in line with the educational resilience system literature, that educational systems consist of four different levels, each of which interacts with ICT systems (2020). The four levels are: individual, programme, institutional, and macro. Each level includes various stakeholders and takes into account their skills to use these systems. The individual level includes actors such as students, parents, and teachers, who need to access and use technology to overcome a shock and be able to receive or provide education. The programme level includes the educational programmes that deliver education and that use ICT systems as a way to provide education. The institutional level provides the general ICT infrastructure of an organization (e.g., services and support). The macro level provides beyond educational legislation and policy also the telecommunication infrastructure that allows the other three levels to function. Hence, the e-resilience system is nested, with macro level factors (such as ICT infrastructure) highly influencing the e-resilience of the individual, programme, and institutional levels.

In practice, the categorisations of Heeks and Ospina (2019) and (van de Laar 2020) are mutually compatible and can be transposed from one to the other. At their core, both approaches aim at identifying elements that contribute to or challenge e-resilience at different levels, the states of which collectively characterise an entire system's e-resilience. While, arguably, some of these factors are more fundamental to a system's e-resilience than others, they all feature some degree of complementarity, which should be analysed in its own right because it provides a framework to describe the functional aspects of the system.

Drivers and challenges in e-resilience in education

In this section, the identified reading are analysed to identify drivers and challenges at different levels of the educational system (micro, meso, and macro) and reflects on the importance of the dimensions of ICT within the concept of resilience in education. In terms of levels, the micro level refers to the drivers and challenges faced by individual students or teachers (Beale 2020; Cassidy 2016), while the meso level refers to institutional drivers or challenges. The macro level refers to drivers or

challenges that are contextually determined, for instance, the network resilience of a country (Sterbenz et al. 2013).

As for the dimensions, the study identifies a technological and a human dimension, along with a dimension consisting of the two, as earlier mentioned.

The technological dimension refers to the availability and functioning of hardware and software. Examples include a lack of electronic devices, which prevents students working from home from using the educational materials provided online, or a lack of internet connectivity in a region, which inhibits students from participating in online classes (Moore, Vitale, and Stawinoga 2018; Starr, Hayes, and Gao 2022). The term "human dimension" refers to the individual characteristics or experiences that support or limit the capacity of an individual to learn or to provide education. This primarily refers to the ability to learn or teach in a setting favourable to provide or receive education. Examples are inability to attend classes due to personal health or caregiver obligations (Binod Sinha 2021). The intersectional dimension refers to the interaction between humans and technology. For example, when infrastructural settings are favourable (i.e., the technological dimension), yet the digital capacity and skills of the users (both students and teachers, i.e., the human dimension) do not enable them to use the infrastructure (Assareh and Hosseini Bidokht 2011).

Table 1 summarizes the drivers and challenges identified in the literature on e-resilience in education. The drivers and challenges are categorized by levels and dimensions. Table 1:

Table 1: Drivers and challenges of e-resilience in education (Authors' compilation)

LEVEL	DIMENSION		
	TECHNOLOGICAL	HUMAN	INTERSECTION
MICRO	**Challenges** - Hardware/ software not accessible to everyone (Assareh and Hosseini Bidokht 2011; Daly 2021; Moore, Vitale, and Stawinoga 2018) - Internet connection not accessible to everyone (Arora et al. 2020; Daly 2021; Nadler 2020; Weller and Anderson 2013; Williams 2021; Zusman et al. 2020)	**Challenges** - Students flying back to their country and not being allowed back (Daly 2021) - Students find difficulties to create social connections and friendships (Baxter 2012) - Educators' wellbeing negatively affected (Gao and Zhang 2020; OECD 2020) - Teachers find difficulties to adjust to new needs based on specialized disciplines and fields (OECD 2020) - Students show limited resilience character (Beale 2020; Cassidy 2016; Eri et al. 2021; Martin and Marsh 2006) - Students receive less monitoring of and support on study progress which derived in disengagement (Nadler 2020; OECD 2020) - Individuals experience difficulties to handle communication on line and "Zoom fatigue" which increases psychological demand (Nadler 2020; Williams 2021) -Teachers lack needed empathy towards students (Arora et al. 2020; Bozkurt et al. 2020; Neuwirth, Jović, and Mukherji 2021) - Teachers and students experience privacy breach (Nadler 2020) - Students dropout through lower per capita spending on education (4% less in Africa) (Daly 2021) - Students participate less and teachers have limited ability to engage students during online education (Nadler 2020; Neuwirth, Jović, and Mukherji 2021; Williams 2021) - Individuals experience difficulties to overcome social distancing hardships, e.g. share feelings of isolation (Ando 2021) - Individuals experience difficulties to cope with additional home responsibilities when studying from home (Baxter 2012; Neuwirth, Jović, and Mukherji 2021) - Individuals experience detrimental effect of shock in health and employment, e.g. trauma, anxiety (Bozkurt et al. 2020; Neuwirth, Jović, and Mukherji 2021; Sarra, Fontanella, and Di Zio 2019; Martin and Marsh 2006) - Parents experience difficulties to also undertake the educational role of schools (Bozkurt et al. 2020; Neuwirth, Jović, and Mukherji 2021) **Drivers** - Individuals enhance self-discipline (Gelles et al.	**Challenges** - Limited digital literacy in the population and among students and educators. Digital literacy affected by age (Assareh and Hosseini Bidokht 2011; Martzoukou et al. 2020; Portillo et al. 2020; Reynolds and Parker 2018) - The same content in a different format (electronic vs. paper) can create a different relation with the learning process (Bozkurt et al. 2020; Nadler 2020) - Students and educators dealing with Zoom fatigue (Nadler 2020; Williams 2021) - Digital divide / Triple vulnerability of students from low social-economic background: health risk, inappropriate working environment, and insufficient access to hard/software (Bozkurt et al. 2020; Neuwirth, Jović, and Mukherji 2021; OECD 2020) - Lower confidence of mainly women and elder learning to use computers (Assareh and Hosseini Bidokht 2011; Bozkurt et al. 2020) - Reduced e-learning competencies of teachers and instructors and reduced availability of training in e-learning didactics (Assareh and Hosseini Bidokht 2011; Quaicoe and Pata 2020) **Driver** - Experience social and technical support from the community (Bozkurt et al. 2020) - Gamification techniques implemented by teachers to improve student's motivation and participation (Meza-Mejía 2017) - Development of online education etiquette (Neuwirth, Jović, and Mukherji 2021)

		2020) - Teachers feel stimulated with new opportunities to upgrade online skills (Gao and Zhang 2020) - Individuals open up and recognize importance of sharing emotions and vulnerabilities (Ando 2021)	
MESO	**Challenges** - Limited available system capacity for digital education (Eri et al. 2021; Heeks and Ospina 2019; Hopkins and Lipman 2019; Ramos and Hynes 2022) - Limited access to hard/software allocation (Arora et al. 2020; Daly 2021; Zusman et al. 2020) - Limited free data for students in cooperation with tele companies (Apuke and Iyendo 2018; Daly 2021) - Limited adaptation of core academic processes (Abdullah, Husin, and Haider 2020) **Drivers** - Advantages of online platforms (Abdullah, Husin, and Haider 2020) - Well-functioning social media platforms to enhance communication (AI-Youbi et al. 2020) - Fast-pace digitalisation at institutional level to adjust to shock (Appolloni et al. 2021) - Circular and sustainable characteristics of online education (Appolloni et al. 2021) - Institutional support in resources and logistics, and in leadership support (Gotangco et al. 2020)	**Challenges** - Individuals find difficulties to adjust due to the (lack of) institutional autonomy based on state intervention (OECD 2020) - Educational institutions are often slowly changing institutions (OECD 2020) - Institutions experience a localised approach while still maintaining state consistency (OECD 2020; Zusman et al. 2020) - Limited possibilities to care for most vulnerable members (including students) (Abdullah, Husin, and Haider 2020; Nadler 2020; OECD 2020; Williams 2021) - Limited coordination between stakeholders and resources (OECD 2020) - Limited support for educators to develop their competencies (Grant and Clarke 2020; OECD 2020) **Drivers** - Individuals build partnerships beyond the institutions and including the community, parents, employers (OECD 2020) - Individuals make use of the wider role of educational institution, which many times goes beyond delivering education (OECD 2020) - Institution, staff and students make use of social media platforms for fast and efficient communication (AI-Youbi et al. 2020)	**Challenges** - Lack or limited training for teachers to teach online (Abdullah, Husin, and Haider 2020; Beale 2020; Dias and Diniz 2012; Niculescu, Rees, and Gash 2017; OECD 2020; Quaicoe and Pata 2020) - Lack of electronic library and platform to access scientific research papers and data bases needed in the classroom (Apuke and Iyendo 2018) - Focus on academic integrity, ethics and privacy concerns related to online education (Abdullah, Husin, and Haider 2020; Bozkurt et al. 2020) **Drivers** - Implementation of online education etiquette and teacher guidelines (Neuwirth, Jović, and Mukherji 2021; Niculescu, Rees, and Gash 2017)
MACRO	**Challenges** -Effective technological infrastructure to ensure sustainable connectivity (Arora et al. 2020; Daly 2021; Sterbenz et al. 2013; Weller and Anderson 2013; Zusman et al. 2020) -Digital divide and unequal access to online learning sources due to, for example, location (urban vs rural areas), and wealth of country (lower income countries vs. high income contributes) (Bacher-Hicks, Goodman, and Mulhern 2021)	**Challenges** - Individuals experience limited funding allocated to cope with the shock (Daly 2021) - International students flying back to their home country and not being allowed back due to visa restrictions (Daly 2021) - Digital divide: reaching out to marginalised groups, especially young girls, to continue their education while not being allowed out of the house (Abbasi 2021) - Digital divide: online education often provided in the national language, triggering a language barrier for minority groups (e.g. indigenous groups) (Abbasi 2021) **Drivers** - Investment of public funds in higher education (Daly 2021) - Coordination from the state to enact laws or ensure appropriate mechanisms that enable actions from educational institutions (Appolloni et al. 2021; Daly 2021; Eri et al. 2021; OECD 2020; Weller and Anderson 2013)	

The literature analysed focuses primarily on the challenges and on the human dimension (see Table 1). In relation to the challenges, the literature highlights the elements that interrupt the possibility of continuing with education in an "ideal" way. The challenges are mentioned as barriers to study, such as a lack of familiarity with the technology or the impediment to finding an environment conducive for studying. The drivers are mentioned less frequently. These mainly address the importance of a supportive infrastructure that coordinates efforts and the individual impetus to be resilient. The micro level of the human dimension is the one that is most frequently referred to in the literature. Further studies are needed to understand if the micro level of the human dimension is, in fact, the most relevant factor to consider when addressing e-resilience.

4. DISCUSSION

Our inventory of challenges reveals that technological challenges are found at the micro, meso, and macro levels and are similar at all levels. While there is only one main challenge at the macro level, being network security and connectivity in case of shock, this challenge determines educational resilience at all levels. Without a well-functioning technological infrastructure and sufficient connectivity, ensuring high quality education for all – in line with SDG4 – becomes difficult (Arora et al. 2020; Daly 2021; Sterbenz et al. 2013; Weller and Anderson 2013; Zusman et al. 2020). The nestedness of the e-resilience system is a significant bottleneck, as a lack of macro-level infrastructure directly impacts the e-resilience of lower level actors. It is beyond any individual or institutional ability to overcome insufficient macro level infrastructure and services. However, the literature also identified micro and meso-level specific technological challenges, such as a lack of well-functioning learning management platforms, the lack of software licences at the educational institutional level, as well as a lack of devices or internet access at the household or individual level. Without sufficient e-learning systems in place, such as electronic library services or video-conferencing software licences, institutions, in the event of a shock, will need to invest in technology in order to ensure that the educational system continues to function. Such institutional investments take time, often resulting in educational losses in the short run after a shock.

A weaker e-resilience in an education system is a direct consequence of the digital divide. Poorer countries, institutions, and households, in general, will face greater technological challenges. Yet, the lack of a sufficiently developed technological infrastructure will prevent optimal learning, leading to an increased inequality in educational attainment in the short run and, most likely, also to increased socio-economic inequality in the long run.

The challenges mentioned in the literature in relation to the intersectional dimension are more apparent at the meso and micro levels. Even when all technological facilities are available at an institutional level, we still need to be mindful about the skill development needed to use the services (Beale 2020; OECD 2020). In the event that there is no didactical support for teachers to offer materials in an effective manner or didactical training for students to use the materials effectively, then the learning through the use of online educational offerings may not actually happen. Globally, digital literacy is still lower among vulnerable groups, which results in an unequal negative impact on educational attainment following a shock (Zelezny-Green, Ronda; Vosloo, Steven; Conole, Gainne; Curran, Susan 2022).

Furthermore, globally, digital literacy is not gender balanced, and it is generally lower for vulnerable groups such as older workers, minority groups, indigenous people, and migrants (ITU 2022; Starr, Hayes, and Gao 2022). Moreover, the digital divide is more apparent in poorer regions or countries, owing to a lack of access to technology and its benefits, as well as greater inequality (Quaicoe and Pata 2020; Zelezny-Green, Ronda; Vosloo, Steven; Conole, Gainne; Curran, Susan 2022). In view of those facts, the less digitally literate a group is, the less likely it is to be e-resilient. This barrier could be overcome with a strong educational system that has the capacity to train students quickly and provide them with the technology they need. However, the individual barriers, such as a lack of quiet in a household or the impossibility of being granted a visa to re-enter a country, go beyond the possibilities of the educational systems. Hence, and as is briefly mentioned in the literature, cooperation amongst sectors becomes essential to allow individuals and educational systems to attain e-resilience.

It is interesting to note, however, that even when technological access and necessary skills are in place, educational systems may not be e-resilient in the event of a shock. The majority of the drivers and challenges mentioned in the literature are found in the human dimension, indicating that even with well-functioning ICT, an educational system is not e-resilient. At the macro level, sustainable investments in the education sector, as well as rapid policy adjustment in the aftermath of a shock, are needed (Eri et al. 2021; Weller and Anderson 2013). If that speedy response is not present, policymakers at the institutional level will be challenged, as they will not have sufficient flexibility to accommodate the needs of their staff and students. At the micro level, the most significant challenges that can arise after a shock are mainly those pertaining to health, stress, and uncertainty (see Table 1). In particular, students that benefit from strong guidance and interaction will suffer more when faced with uncertain situations (Beale 2020; Cassidy 2016; Eri et al. 2021; OECD 2020; Martin and Marsh 2006).

5. CONCLUSIONS

The literature shows that e-resilience in education is defined comprehensively as the ability of an educational system to overcome shocks and deliver and receive education while taking into account the dimensions of technology, human capabilities, and the interactions thereof. Adapting to provide relevant solutions requires extensive coordination (and consensus) across levels and dimensions. Educational systems should be able to learn from and evolve around a crisis. A proper technological infrastructure to sustain the delivery of education through technological pathways is essential. However, this alone does not guarantee the e-resilience of an educational system. The majority of the challenges mentioned in the literature come from within the human dimension, which refers to the actual capacity of the individual to overcome the shock. However, there are few studies that address how individuals manage to overcome those challenges and how technological advancements in the educational system and countries affect the capacity of individuals to overcome.

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