TEACHERS' DIGITAL RESILIENCE COMPETENCE IN MOBILE LEARNING CONTEXTS

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Abstract. This conceptual paper examines teachers' digital resilience competence in mobile learning contexts marked by crises, connectivity disruptions and unequal access to digital resources. Drawing on the DigComp 2.2, DigComp 3.0 and DigCompEdu frameworks and relevant research on emergency remote teaching, it conceptualises digital resilience as the capacity to sustain, adapt and restore educational activities while safeguarding learners' participation and digital well-being. Four interrelated components are distinguished: technological-adaptive, pedagogical-design, organisational-managerial, and socio-emotional and ethical. The paper discusses practical strategies such as offline access, alternative communication channels, modular microlearning, flexible assessment, coordination with families and clear digital communication boundaries. A conceptual alignment between DigCompEdu areas and digital resilience components is proposed. The paper identifies implications for teachers' professional development and future research on diagnostic tools and resilient STEM instruction.

Keywords: digital resilience; mobile learning; teachers' digital competence; emergency remote teaching; educational continuity; adaptability; digital well-being.

Introduction

Amid global digitalisation and the rapid expansion of mobile learning, education systems face challenges that threaten the continuity, quality and safety of educational provision. Pandemics, martial law, technical failures, limited access to resources and socio-political crises require educators to adapt quickly. In this context, digital resilience becomes a key concept: the ability of an education system or an individual participant to maintain effective functioning in dynamic or crisis-affected digital environments.

Digital transformation in education and educators' preparedness for changing conditions have attracted considerable international research interest. A review of this work suggests that digital resilience can be understood beyond the technical protection of data, as a broader pedagogical and organisational approach.

The DigComp 2.2 and DigComp 3.0 frameworks provide reference points for general digital competence, whereas DigCompEdu specifies digital competence in educators' professional practice [1, 10, 11]. In the present paper, digital resilience is interpreted not merely as an extension of digital literacy but as a strategic capacity for adaptation and recovery. Building on Weller and Anderson's account of institutional responses to digital change [2], the concept is extended here to teachers' ability to maintain educational continuity through open educational resources, alternative technological arrangements and professional networks.

Digital resilience became particularly relevant during the COVID-19 pandemic. Bond et al. [3] mapped the first global semester of emergency remote teaching in higher education, documenting diverse institutional and pedagogical responses to the crisis. Bozkurt and Sharma [4] highlighted the distinct emergency conditions under which remote teaching was introduced. These studies indicate

why crisis-responsive teaching cannot be reduced to the availability of digital tools: timely pedagogical adaptation and attention to learners' circumstances also matter.

Mobile learning changes the nature and location of educational interaction. Kukulska-Hulme [5] describes mobile learning as a catalyst for reconsidering learning beyond fixed classroom boundaries. Gikas and Grant [6] found that smartphones and social media could support authentic interaction and collaboration in higher education while also introducing difficulties and limitations. These findings provide a basis for considering both opportunities and vulnerabilities when mobile technologies are used in school education.

Research into educators' readiness for online teaching further underlines the need for differentiated professional development. Scherer et al. [7] identified distinct readiness profiles among higher education teachers, associated with their confidence, preparation and experience. These findings suggest that professional development for digital resilience should be responsive to teachers' starting points and should address complex pedagogical decisions under uncertainty, rather than technical skills alone. Trust and Whalen [8] likewise emphasised the importance of preparing schoolteachers for emergency remote teaching and learning from colleagues and professional networks.

At the policy level, an OECD working paper [9] compares national strategies for integrating digital technologies into education. Although it was published before the pandemic and does not itself establish the effects of specific resilience measures, it provides context for understanding the strategic planning needed to support digital educational provision. Drawing together these perspectives, this paper conceptualises teachers' digital resilience competence as a multidimensional construct combining technological adaptability, pedagogical flexibility, organisational coordination and ethical responsibility.

Conceptualising teachers' digital resilience competence

Digital resilience brings together technological, pedagogical, organisational and socio-emotional dimensions in order to support educational flexibility and protect digital well-being. It involves not only possession of technical skills but also teachers' ability to mobilise their digital competence, as described in DigCompEdu, in response to real disruptions affecting mobile learning.

The key characteristics of digital resilience are:

- **Continuity:** the capacity to maintain learning despite changing external conditions;
- **Adaptability:** a flexible response to changes in digital tools and modes of access;
- **Digital safety:** the protection of personal data and privacy of participants in education;
- **Psychological well-being:** efforts to minimise technology-related stress and support emotional well-being.

In this paper, teachers' digital resilience competence is defined as an integrated capacity to plan and implement educational activities effectively while maintaining their quality under crisis or unstable conditions. It comprises four interconnected components: technological-adaptive, pedagogical-design, organisational-managerial, and socio-emotional and ethical.

Technological-adaptive component. This component involves confident use of mobile technologies and the ability to respond promptly to technical failures. Teachers should be able to switch among online and offline, synchronous and asynchronous modes of work and use alternative

services and platforms, including messengers and cloud-based tools, as backup communication channels.

In mobile learning, technological resilience extends beyond the ability to operate a smartphone. It includes building parallel digital pathways through cloud-based solutions and multiple communication channels. Ecosystems such as Google Workspace and Microsoft 365 can support continued access to materials, provided they are configured appropriately. Offline availability of documents enables learners to continue working without a stable connection. Teachers therefore need to use primary learning management systems (for example, Moodle, Google Classroom or Microsoft Teams), rapid messaging tools (Telegram, Viber or WhatsApp where suitable) and fallback options such as email or previously downloaded learning materials.

Pedagogical-design component. This component focuses on developing adaptive curricula and lesson scenarios. Microlearning divides content into manageable units, while formative assessment can support learner autonomy and help maintain instructional continuity when digital access is limited.

Digital resilience requires moving from rigid, linear lesson planning towards modular and adaptive designs that incorporate microlearning and flexible assessment. Learning content can be divided into short, self-contained units, such as videos lasting up to five minutes and interactive exercises taking approximately ten minutes. These are illustrative design options rather than universally prescribed durations. Such units may help learners make use of brief periods of connectivity and sustain concentration under technical constraints. Automated formative quizzes with immediate feedback and peer assessment may also support student responsibility and ease the teacher's workload, where implementation conditions allow.

Organisational-managerial component. This component concerns planning under uncertainty and coordinating activities with school administrators and parents. Participation in professional digital communities is important for sharing experience and information about safe educational practices.

In mobile learning, where the boundaries between school and home become less distinct, teachers' organisational role develops in several directions, including flexible learning plans and coordination within the teacher–school administration–parent partnership.

Resilient practice involves replacing exclusively rigid timetables with modular structures. Teachers can prepare learning content so that, during power or network outages, students have clear instructions for independent work. This includes offline assignment packages and cloud-based services that synchronise learning progress when connectivity returns.

Organisational resilience also requires a coordinated information system. Teachers and school leaders should agree on rules for mobile-device use and communication to avoid fragmented demands on learners. Teachers may guide parents in configuring the home learning environment, enabling them to act as partners rather than observers, and jointly establish contingency plans for major disruptions, including preselected alternative communication channels.

Socio-emotional and ethical component. This component is directed towards preventing technology-related stress and developing ethical digital behaviour. Teachers should create a supportive environment that reduces the negative effects of excessive digital demands on learners.

Digital resilience cannot be separated from the psychological well-being of participants in education. Preventing stress and burnout, fostering ethical digital conduct, and creating inclusive learning environments are therefore central considerations.

Continuous connectivity and frequent interface changes may contribute to cognitive overload. Possible responses include agreed periods for asynchronous communication (for example, a school-level agreement not to send routine messenger notifications after 7 p.m.), carefully selected gamification to support engagement, and instruction in digital time management. Such measures should be tailored to local circumstances rather than treated as universal rules.

The use of mobile technologies also raises risks of cyberbullying and plagiarism. Teachers should foster academic integrity and respectful online communication. This involves not only monitoring behaviour but also helping students understand the long-term implications of their digital footprints.

Teachers should also consider the emotional needs of learners affected by displacement, housing instability and other stressful circumstances. Creating opportunities for achievable success in virtual classrooms and allowing an individual pace of learning can help reduce excessive digital demands.

Alignment between digital competence frameworks and digital resilience

The relationship between established competence frameworks and digital resilience can be described as a distinction between what teachers are able to do with digital technologies and how they use those abilities when learning conditions become unstable. DigComp 2.2 and DigComp 3.0 describe general digital competence, while DigCompEdu addresses teachers' professional competence. Table 1 presents an author-developed conceptual mapping of selected DigCompEdu areas to the proposed resilience components; it is not an official mapping published by the European Commission [1, 10, 11].

Table 1. Conceptual alignment of digital competence frameworks (DigComp 2.2/3.0 and DigCompEdu) with teachers' digital resilience

DigCompEdu competence area	Resilience component	Conceptual relationship
Professional engagement	Organisational-managerial	Digital collaboration strengthens coordination and continuity of education.
Digital resources	Technological-adaptive	Flexible selection and backup of resources supports continuity of access.
Teaching and learning	Pedagogical-design	Adaptive instructional design supports the continuity of learning activities.
Assessment	Organisational-managerial	Digital assessment and feedback can help sustain quality under crisis conditions.

Analysis of these relationships provides a basis for constructing a theoretical model of competence; however, its practical relevance depends on whether teachers can overcome barriers encountered in digital environments. In mobile learning, digital resilience becomes a set of applied practices for addressing critical contradictions.

First: unequal access to technologies. Even when education is highly digitalised, students do not have the same technical resources or internet reliability. Teachers' resilience is therefore reflected in their ability to design low-tech alternatives: learning materials usable with limited bandwidth or offline, supporting equitable access regardless of a family's available equipment.

Second: the expectation of constant availability. A continuous stream of messenger notifications can blur professional and personal boundaries. Digital resilience involves not only technical endurance but also the ability to establish digital boundaries. Teachers can promote a culture of asynchronous communication with clear response windows, which may support the well-being of all participants.

Third: privacy risks associated with personal devices. The use of students' own mobile devices for learning expands potential risks to personal data. Teachers should critically evaluate the safety of selected applications, instruct students in digital hygiene, and cultivate responsible attitudes towards digital footprints and privacy.

Conclusions and future research

Developing digital resilience competence enables teachers not only to use technologies but also to restore and adapt educational activities in response to disruption. The four proposed components offer a conceptual basis for discussing the conditions of educational continuity in mobile learning. As this is a theoretical synthesis, the model requires empirical validation before claims can be made about its effectiveness in specific settings.

Further research should focus on designing professional development programmes for teachers of mathematics and science; developing diagnostic instruments to assess levels of digital resilience competence; examining cloud technologies and interactive simulations as resources for resilient instruction in programming and STEM subjects; and investigating how artificial intelligence might support the automation of alternative learning pathways during crises.

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