BMC Medical Education

RESEARCH

Open Access

The digital well-being among learners in higher education: a scoping review

Farhana Harzila Mohd Bahar[1,2], Nurhanis Syazni Roslan[2], Nicholas Pang Tze Ping[3], Nurul Alimah Abdul Nasir[4], Mohd Salami Ibrahim[5], Siti Khadijah Adam[6], Shazrina Ahmad Razali[7] and Muhamad Saiful Bahri Yusoff[6*]

Abstract

Introduction Digitalisation has changed how we learn and share knowledge. The rapid growth of technology has transformed how people interact with themselves, each other, and their environment, impacting their well-being. Despite increasing attention in this area, existing studies often examine related constructs, such as technostress, problematic internet use, or digital addiction, in isolation rather than conceptualising digital well-being as a multidimensional and integrative construct. This review aimed to systematically map the functional elements of digital well-being among higher education learners and their relation with overall well-being outcomes.

Method Primary literature from January 2018 to October 2023 was collected using the three-phase search strategy according to the Joanna Briggs Institute (JBI) scoping review guideline. Terms 'digital well being' OR 'digital well-being' OR 'digital wellbeing' AND 'higher education' AND 'learners' were searched from the Web of Science, PubMed and Scopus databases. In this review, functional elements were conceptualised as both characteristics of the digital environment and the cognitive, behavioural, and emotional processes through which learners engage with these environments. All peer-reviewed articles that describe the effects of digitalisation on the well-being of all learners in higher education institutions were included.

Results Out of the 348 articles initially identified, 34 were reviewed, covering 10,838 undergraduate and postgraduate students from 23 countries. Among studies that reported age, participants ranged from 17 to 48 years, reflecting variation across study populations. Eight interconnected themes emerged: digital self-regulation, digital self-efficacy, digital intention, digital conduct, digital engagement, digital support, digital resources, and digital safety. Among these, digital self-efficacy is conceptualised as a central enabling component within the proposed framework, shaping learners' ability to engage meaningfully in a digital environment. Poor self-regulation was the most frequently reported source of adverse outcomes, while digital conduct and safety remained underexplored with limited evidence of their direct impact on well-being.

Conclusions Digital well-being appears to be shaped by the interaction of individual capabilities, behavioural patterns, and digital environments. The proposed framework offers a conceptually grounded synthesis that may inform future research, particularly in the development of measurement tools and context-sensitive strategies to support digital well-being in higher education.

*Correspondence:
Muhamad Saiful Bahri Yusoff
saifulbahri@upm.edu.my

Full list of author information is available at the end of the article

Keywords Ddigital well-being, Digital technologies, Scoping review, Higher education students

Introduction

The term 'digital well-being' refers to an individual's state of mind in a society where digital media and technology permeate every aspect of daily life. It also refers to maintaining one's well-being or striving for optimal balance between benefits and drawbacks when immersed in a digital and technical setting [1–3]. In the context of higher education learning, digital well-being is an important consideration, given the increasing use of technology in learning and the potential adverse effects on learners' well-being.

Digitalisation has generally transformed higher education by changing how knowledge is acquired and shared. Online learning platforms and virtual classrooms have made education more accessible to all learners, allowing them to access educational resources, lecture materials, and interactive simulations anytime. These platforms enable self-learning and more personalised study approaches [4]. Furthermore, virtual reality (VR) and augmented reality (AR) technologies have enhanced training opportunities across various disciplines such as engineering, architecture, medicine and beyond. For instance, in the medical field, VR and AR technologies provide engaging and realistic simulated environments for surgical training, anatomy education, and clinical skill development among learners [5].

This rapid spread and use of digital technology have fundamentally altered how people interact with themselves, others, and their surroundings. In fact, technology has become an integral feature of contemporary society, transforming every aspect of human life, including personal, professional, social, and educational [6]. In higher education, the information ecosystem and digital tools significantly influence the success of both learners and training programs. However, these advancements also raise important concerns regarding the effects of digital technology on human health, including increased cognitive load, digital fatigue, sleep disruption, and psychological stress, which require careful consideration [7].

Existing literature highlights the importance of balanced technology use to optimise learning outcomes while minimising negative psychological and behavioural effects. Current research has explored various interventions, including digital well-being applications, technology-enhanced learning platforms, and the use of artificial intelligence (AI) and chatbots to support teaching and learning in higher education [8–11]. However, much of the existing literature tends to examine specific constructs such as technostress, problematic internet use, or digital addiction in isolation, rather than conceptualising digital well-being as a multidimensional and integrative construct [12–14].

While prior studies have provided valuable insights into these individual outcomes, there remains limited integrative evidence on digital well-being as a comprehensive concept, particularly among higher education learners. Furthermore, the rapid shift to remote learning and increased reliance on digital technologies during the COVID-19 pandemic introduced specific challenges, including social isolation, reduced face-to-face interaction, increased screen exposure, and heightened academic stress, which may have influenced learners' digital experiences and well-being [15]. Notably, a large proportion of existing studies were conducted during the COVID-19 period, which may influence the generalisability of findings to post-pandemic learning environments.

The literature also lacks consensus on the reliable and valid measurement tools as well as formal models of digital well-being. To move forward, a framework of digital well-being should be developed that recognises differences between individuals in how they balance the benefits and drawbacks of technology. Instead of viewing digital well-being through a simple cause-and-effect lens, it should be understood as a dynamic system shaped by individual, technological, and situational factors [1]. This calls for a descriptive and rigorous theoretical development of a digital well-being framework that captures the complex interactions between technology use, mental health, and social dynamics [12–14].

Hence, this study examines the literature on digital well-being in the context of higher education and addresses two research questions: [1] What are the functional elements that negatively and positively influence the impact of digital technologies on higher education learners' well-being? and [2] How do these functional elements of digital well-being relate to overall well-being outcomes? In this review, the term 'functional elements' refers to both characteristics of the digital environment and the cognitive, behavioural, and emotional processes through which learners engage with these environments, collectively influencing their well-being. Furthermore, this study extends beyond prior reviews by systematically synthesising these functional elements into an integrated conceptual framework, thereby addressing the lack of a comprehensive model that explains how digital experiences shape well-being among higher education learners.

Methods

This scoping review was conducted following a protocol [16] developed in accordance with the Joanna Briggs Institute (JBI) guideline for scoping reviews [17]. The

review process took place from December 1, 2023, to April 30, 2024. It was carried out by a team consisting of three medical educationists and one psychiatrist from various medical institutions in Malaysia (FHMB, NSR, MSBY, and NPTP), all with expertise in educational theory and well-being research.

Inclusion criteria

Types of participants

The scoping review focused on published primary research on the effects of digitalisation on the well-being of all learners in higher education institutions. These include undergraduate and postgraduate students across universities, colleges, and other recognised post-secondary education settings. Resources that illustrate the impact of digitalisation on the general population were excluded from the review.

Concept

This scoping review included primary resources that examined the factors influencing digital well-being among learners in higher education. These impacts on digital well-being may manifest as positive or negative, significantly shaping individuals' overall experiences in the digital environment. Positive digital well-being refers to the capacity to maintain and promote one's well-being while navigating digital and technological spaces [2]. In contrast, negative impacts highlight the potential adverse consequences of ineffective digital engagement management. This review also included articles examining the impacts and relationships of digitalisation across various dimensions of overall well-being, encompassing mental, intellectual, emotional, professional, spiritual, and physical aspects [3, 7, 18].

Context

This review specifically focused on the context of higher education, encompassing a diverse range of learners, including both undergraduate and postgraduate students, who are engaged in various academic disciplines and fields of knowledge within the broader scope of higher education institutions. By including this wide spectrum, the review aimed to provide a more comprehensive understanding of the topic within the context of higher education.

Sources

This scoping review focused on original research articles that employed quantitative, qualitative, or mixed-methods approaches, specifically addressing digital well-being among higher education learners. Only studies published in English between January 2018 and October 2023 were included. The timeframe from January 2018 onwards was selected to reflect the rapid expansion of digital technologies in higher education, particularly in relation to online learning. Other types of research papers were excluded to maintain the data's relevance, authenticity, and reliability.

Search strategy

This review followed a three-phase search strategy, as recommended by the JBI Scoping Review Guidelines [17]. In the first phase, initial keywords were identified from the titles and index terms of relevant reviews. These keywords were further refined using Medical Subject Headings (MeSH) and tested with a combination of Boolean search terms. The keyword search terms were: ("digital well being" OR "digital well-being" OR "digital wellbeing") AND "higher education" AND "learners". To ensure conceptual clarity and alignment with the review objective, the search strategy focused specifically on "digital well-being" as the primary construct, rather than incorporating related constructs such as technostress, problematic internet use, or digital addiction, which were considered conceptually overlapping but beyond the primary scope of this review. In the second phase, a comprehensive search was conducted using these identified keywords and index terms across databases, including Scopus, PubMed, and Web of Science. These databases were selected due to their broad interdisciplinary coverage across health, education, and technology-related fields, and their widespread use in systematic and scoping reviews. The third phase involved reviewing the reference lists of all included studies.

Selection of sources

All identified sources were exported to Microsoft Excel, and duplicates were removed. The record selection process was conducted using predefined inclusion criteria. An initial screening was conducted independently by two researchers (FHMB, NSR) based on titles and abstracts. Inter-rater reliability was assessed using Cohen's kappa based on independent screening decisions, demonstrating substantial agreement ($\kappa = 0.77$) [19]. Discrepancies were initially resolved by a third researcher (MSBY). Full-text screening was subsequently conducted independently by two researchers (FHMB, NSR). Any disagreements were further evaluated independently by two additional researchers (MSBY, NPTP), and where discrepancies remained, consensus was reached through discussion among all four researchers. Records not meeting the inclusion criteria were excluded, and reasons for exclusion were documented. The selection process was then reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) flow diagram [20].

Data extraction

The data from the included records were extracted using the data extraction form (Appendix A). The extracted data of interest included the title, authors, year of publication, methods, geographical distribution, age, participant category, digital components and well-being outcomes. The data extraction was conducted independently by FHMB. To ensure the reliability and consistency of the data extraction process, the involved reviewer discussed her extraction strategy and conducted a pilot extraction of five records. The reviewer also addressed the outcome of the data extraction with other reviewers. Due to resource constraints, full dual-independent data extraction was not conducted.

Data presentation

Using a thematic analysis approach, the reviewer systematically examined the data with the assistance of ATLAS.ti version 23. The analysis followed the structured six-step framework outlined by Naeem et al. (2023) [21] as illustrated in Fig. 1. The process began with selecting quotations, extracting relevant excerpts and findings from each included article. These excerpts were then examined to derive keywords that captured salient concepts. Next, the keywords were organised into codes to preserve contextual meanings and functional attributes. The codes were subsequently clustered into broader themes, which were iteratively reviewed and refined. The themes were synthesised during conceptualisation to articulate their interrelationships and their links to positive, neutral, or negative well-being outcomes. Finally, these insights were integrated into a conceptual model of digital well-being, providing a clear link between the evidence in the literature and the theoretical framing.

While scoping reviews are commonly associated with descriptive mapping approaches, a thematic analysis was adopted in this study to enable a structured synthesis of patterns across heterogeneous studies. This approach is appropriate when the objective is to explore conceptual relationships within the literature, rather than merely describe study characteristics. In this review, thematic analysis was applied in a systematic and iterative manner to identify functional elements and organise them into meaningful categories, supporting conceptual interpretation without extending to theory generation.

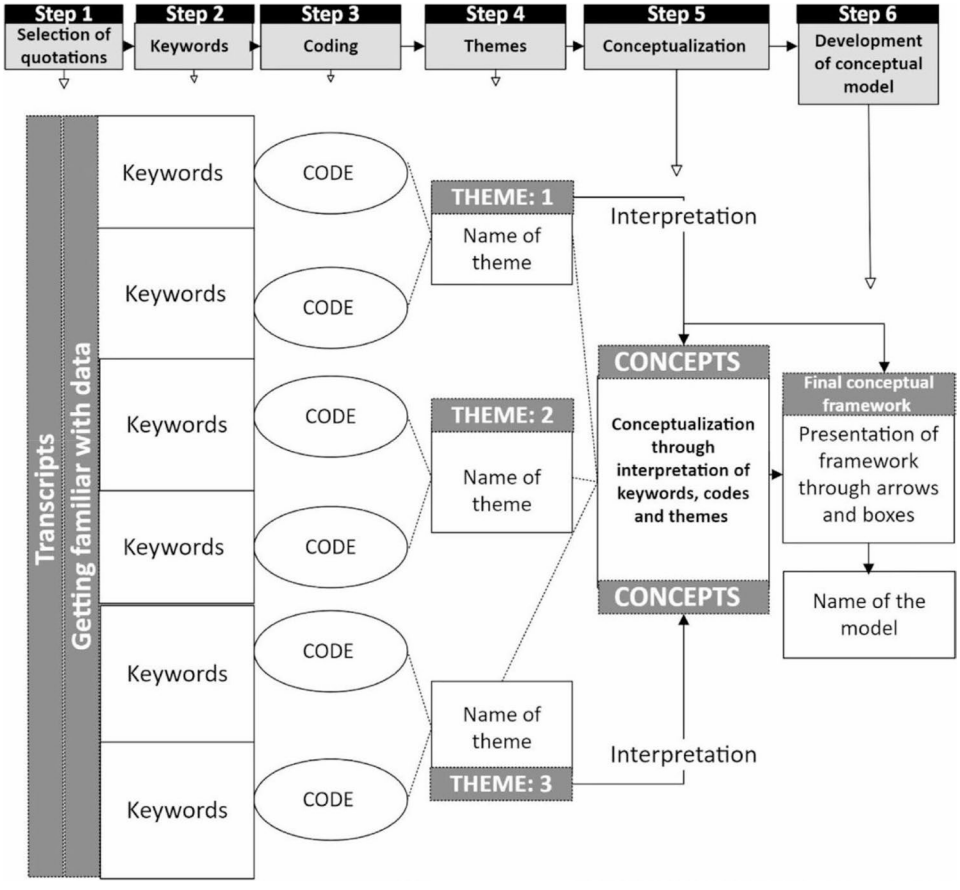

Fig. 1 Systematic thematic analysis process [21]

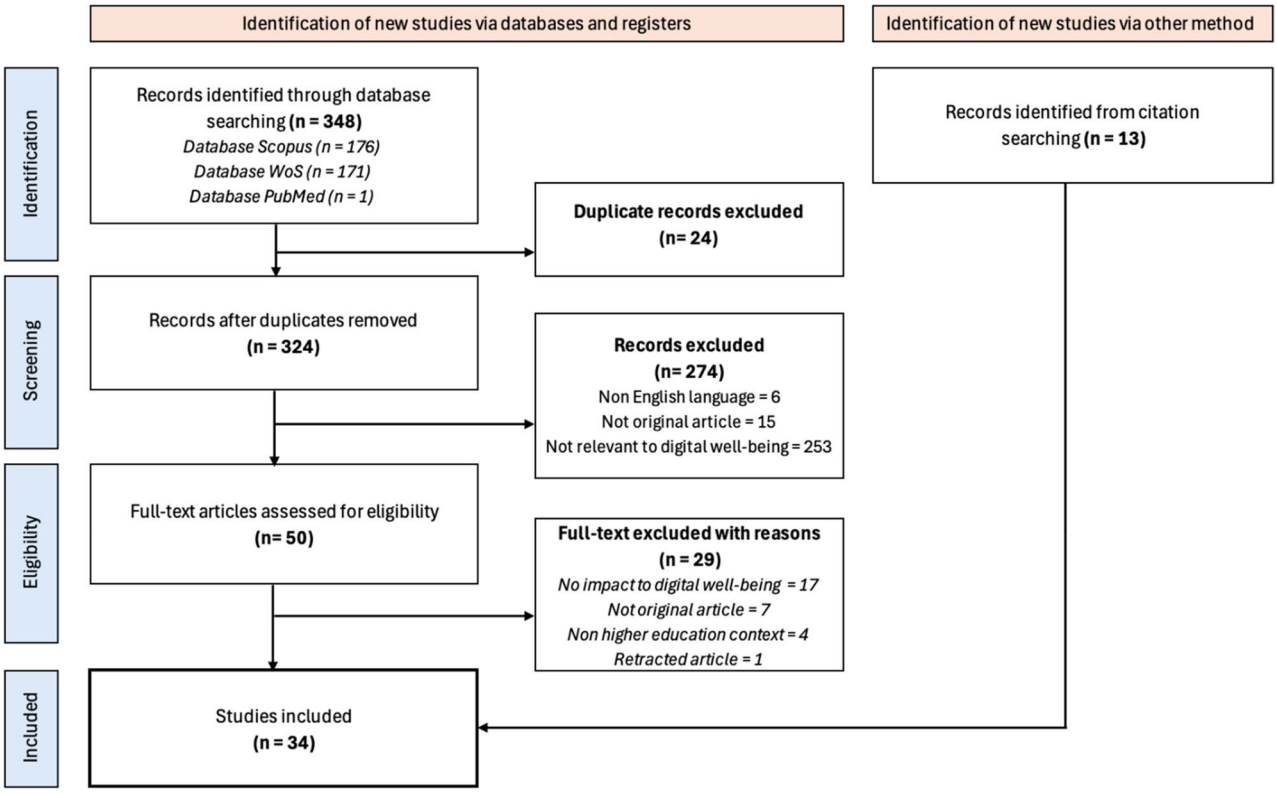

Fig. 2 : Flowchart of the literature selection process

Table 1 Types of participants and research designs across the included studies

		No. of Participants/ Articles, n (%)
Type of Participants	Undergraduate	7813 (72)
	Postgraduate	1018 (9)
	Not mentioned / Mix	2007 (19)
Methods	Quantitative	17 (50)
	Qualitative	7 (21)
	Mixed method	10 (29)

The extracted data were then presented in tabular form, including the frequencies and percentages for geographical distribution, age, and participant category. The scoping review findings were reported in adherence to the PRISMA-ScR reporting standards [20]. As this study is a scoping review, a formal quality appraisal of the included studies was not conducted. While critical appraisal can be incorporated in scoping reviews, JBI guidance indicates that it is not mandatory, as the primary aim is to map the breadth and nature of available evidence rather than evaluate study quality. Nevertheless, study characteristics were systematically charted and presented in tabular form to enhance transparency and provide a comprehensive overview of the included evidence (Appendix A).

Result

As shown in Fig. 2 and 34 studies were selected from an initial screening of 348 identified records. Of these, the majority of studies ($n = 32$, 94%) were conducted during and following the COVID-19 period from 2020 onwards. Among the 34 included studies, 50% ($n = 17$) used quantitative methods, 21% ($n = 7$) used qualitative methods, and the remaining 29% ($n = 10$) used mixed methods (Table 1). Demographically, these 34 studies encompassed 10,838 students, of whom 72% were undergraduates and 9% were postgraduate students representing 66 higher education institutions across 23 countries, as illustrated in Fig. 3. However, approximately 19% of studies did not specify whether participants were undergraduate or postgraduate students, limiting the ability to classify them into distinct academic levels.

Through a systematic coding process, we identified a wide range of functional elements that shape the positive and negative impacts of digital technologies on the well-being of higher education learners. Initially, individual factors were extracted from the reviewed studies, each accompanied by its citation number (Table 2). These were then coded based on conceptual similarities, and we identified eight emerging themes: Digital Self-regulation, Digital Self-efficacy, Digital Intention, Digital Conduct, Digital Engagement, Digital Support, Digital Resource, and Digital Safety.

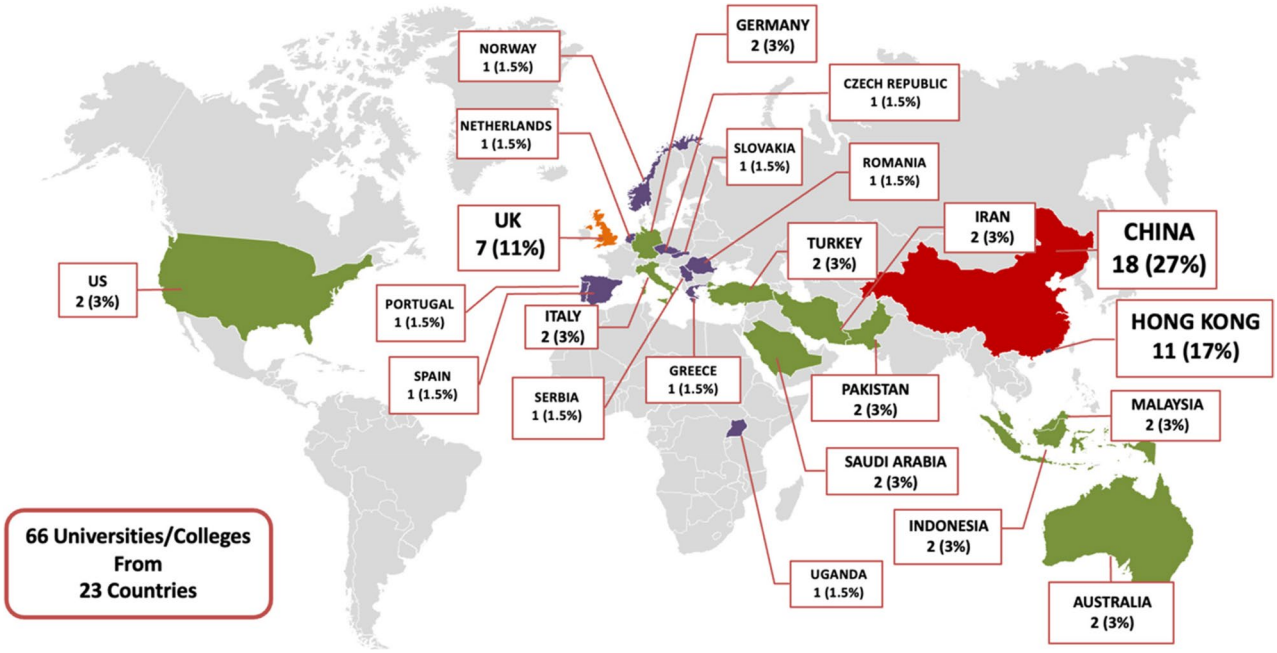

Fig. 3 Global representation of higher education institutions in the reviewed studies

To provide conceptual clarity, we developed our own working definitions for each theme. Rather than adopting existing definitions, our approach was to synthesise insights from the literature and translate them into definitions that are theoretically grounded yet contextually relevant to the focus of digital well-being in higher education. Each theme represents a cluster of related functional elements, which are described below along with their observed relationships to positive, neutral, or negative well-being outcomes as reported in the literature (Table 3).

To further address the second research question, the identified themes were systematically mapped across multiple dimensions of well-being, including mental, emotional, intellectual, professional, spiritual, and physical domains (Table 4). This mapping was derived directly from the reported well-being outcomes in the included studies, as summarised in Table 2. It illustrates how functional elements, as grouped into themes, contribute to different dimensions of well-being.

As shown in Table 4, the identified themes demonstrate varying degrees of representation across the six well-being dimensions. Notably, Digital Self-regulation was associated with all six dimensions, indicating its broad presence in the literature in relation to learners' mental, emotional, intellectual, academic, spiritual, and physical well-being. This pattern suggests that challenges related to regulating digital use are frequently reported across multiple aspects of well-being. In contrast, themes such as Digital Conduct and Digital Safety were linked to fewer well-being dimensions. However, this more limited representation may reflect the relatively smaller number of studies addressing these themes, rather than indicating a lesser role in digital well-being.

Overall, the pattern observed indicates that learner-related functional elements, such as self-regulation, self-efficacy, and intention, are more consistently reported across multiple well-being dimensions, whereas other elements appear more context-specific within the current body of literature. These findings directly address the second research question by demonstrating that functional elements are unevenly distributed across well-being dimensions, highlighting the multidimensional nature of digital well-being among higher education learners.

Digital self-regulation

We defined digital self-regulation as the ability to regulate an individual's behaviour, emotions, and interactions in digital environments. It involves managing online impulses, maintaining focus on academic tasks, and regulating screen time while navigating digital distractions. Functional elements within this domain captured multiple facets of learners' struggles to manage their digital behaviours in both academic and personal contexts. Specific behaviours associated with this theme included smartphone use at night, which was frequently linked to disrupted sleep cycles, fatigue, anxiety and diminished academic concentration [22]. Closely aligned were patterns of smartphone addiction, manifested through compulsive use and a loss of control over screen time, often resulting in procrastination, reduced focus, and negative emotional outcomes such as stress,

Table 2 Summary of codes and their alignment with themes of the digital well-being and general well-being outcomes

Codes	Themes	General Well-being outcomes
Smartphone use at night [22] Smartphone addiction [22–26] Mobile checking habit [27] Screen time [28–30] Internet addiction [23, 31, 32] Social media addiction [23, 33] Smartphone distraction [34, 35] Intensive technology use/overload [36, 37] Mental focus [22] Spiritual mindfulness (coping strategy) [38] Digital self-control [38, 39] Financial compulsiveness [25]	Digital Self-regulation	Poor sleep quality [22] Anxiety, panic, insecure, disconnected, less self-control / higher disturbances [22] Procrastination, lower wellbeing [27] No effect on wellbeing [28, 30] Depression [23, 31, 33] Stress, anxiety [29] lower general satisfaction [35] Techno-isolation (loneliness) [37] More aware & mindful [39] Depression, anxiety, stress and neuroticism [26] Anxiety, depression, amotivation [36] Academic anxiety [32] Reducing Nomophobia [38]
Analyzing skills [40] Critical thinking skills [40] Communication skills [40, 41] Referencing skills [42] Adaptability [29])] Digital literacy [28, 29, 37, 41, 43, 44] Digital proficiency [45]	Digital Self-efficacy	Satisfaction [42] Stress, anxiety, losing temper easily [29] Satisfaction [28] Increase Motivation [29] Less confident / confident [41] More adaptable [44] Positive psychological wellbeing [45] Less stress [37]
Goal setting [22, 39] Goal -help seeking [41] Goal - make friends [46] Academic motivation [36]	Digital Intention	More aware & mindful [39] Relieve stress [41] Satisfaction [46]
Positive behaviour online [43] Professionalism [43] ethical conduct [43]	Digital Conduct	Comfortable, feel safe [43]
Interaction with peers [47–49] Psychological contract (interaction with institute) [32] Emoji - language [41] Flexibility - not to show face/ camera [41, 47] Camera use [47] Interaction with teachers [47, 48] Fast feedback & correction [48] Interaction with AI [42]	Digital Engagement	Satisfaction, Anxiety [48] Discomfort [46] Academic anxiety [32] Help in expression / positive atmosphere [41] Comfortable / confident with stranger [41] Anxiety, Stress, Satisfaction, Reduce Reduce cognitive load [47] Satisfaction [49] Comfort, peace, happiness, increase motivation [42]
Family support [29, 50] Acquaintances support [37] flexibility - work at own pace (organization support) [48] University support [29] Tech company support [28] Organization guideline [37] Educational course support [28, 51]	Digital Support	Increase motivation [29, 50] Stress, anxiety [29] less stress [37]

Table 2 (continued)

Codes	Themes	General Well-being outcomes
Accessibility [40, 48]	Digital Resource	Frustration [37, 48]
functionality [52]		Satisfaction [52]
Device compatibility [37]		Anxiety, stress (More distraction than assistance) [53]
Digital self-control tools [53]		No effect on wellbeing [54]
Notification disabling [54]		Increase intrinsic motivation [36]
Techno-ease, techno reliability, techno sociality [36]		Increase motivation, self-satisfaction, students' control [51]
Screen share [53]		Satisfaction [49]
unresponsive tools [48]		Positive psychological wellbeing [45]
multiple devices [48]		
Flexibility of chatbot [42]		
User friendly [55]		
learning design/variety of pedagogy [49, 55]		
Interactive features [45, 52]		
Financial risks [25]	Digital Safety	Mental and emotional friction [25]

Table 3 Thematic distribution of well-being outcomes in the reviewed literature

	Positive Well-being	Neutral	Negative Well-being
Digital Self-regulation	*	*	****
Digital Self-efficacy	***		*
Digital Intention	**		
Digital Conduct	*		
Digital Engagement	***		**
Digital Support	***		*
Digital Resource	***	*	**
Digital Safety			*

* 1-2 articles

** 3-4 articles

*** >=5 articles

**** >10 articles

depression, and neuroticism [22–26]. Mobile checking habits, as described in prior research, further illustrated this compulsive dimension, as the repeated urge to monitor devices was shown to fragment attention and undermine productivity, reinforcing cycles of procrastination and lower well-being [27]. Excessive screen time further highlighted mixed findings, while some studies reported associations with eyestrain, stress, and academic dissatisfaction [29], others found no significant effects on well-being [28, 30]. In more severe cases, internet and social media addiction were consistently linked to depression, social withdrawal, and academic anxiety [23, 31–33]. In addition, smartphone distraction underscored the difficulty of sustaining concentration in study contexts, as constant notifications and alerts disrupted learning processes [34, 35]. The sense of technology overload captured broader emotional strain, with learners reporting

Table 4 Mapping of digital well-being themes across general well-being dimension

Themes	Mental	Emotional	Intellectual	Professional/ Academic	Spiritual	Physical
Digital Self-regulation	Anxiety, panic, depression, stress [22, 23, 29, 31, 33, 36]	Insecure, disconnected, emotional disturbance, neuroticism techno-isolation [22, 26, 37]	Reduced focus [22]	Procrastination, lower well-being, academic anxiety [27, 32]	Mindfulness [38, 39]	Poor sleep quality [22]
Digital Self-efficacy	Reduced stress, positive psychological well-being [37, 45]	Satisfaction, motivation, confidence [28, 29, 41, 42]	Critical thinking, analytical skills [40]	Adaptability, performance, digital literacy [28, 29, 44]	-	-
Digital Intention	Relieve stress [41]	Satisfaction [45]	Goal setting [22, 39]	Academic motivation [36]	Mindfulness [39]	-
Digital Conduct	-	Comfortable, feel safe [43]	-	Professionalism, [43]	Ethical behaviour [43]	-
Digital Engagement	Anxiety, stress [32, 47, 48]	Satisfaction, comfort, happiness [41, 42, 49]	Expression, understanding [41, 47]	Academic anxiety [32]	-	Reduced cognitive load [47]
Digital Support	Stress, anxiety [29]	Motivation, reassurance [29, 50]	-	Academic support [28, 51]	-	-
Digital Resource	Anxiety, stress, frustration [37, 48, 53]	Satisfaction [49, 51, 52]	Learning efficiency, intrinsic motivation [36]	Students' control, productivity [51]	-	-
Digital Safety	Mental friction [25]	Emotional insecurity [25]	-	-	-	-

anxiety, amotivation, and loneliness as a result of intensive digital demands [36, 37]. Beyond academic performance, financial compulsiveness was also noted because of poor digital control, which has implications for poorer well-being [25].

Despite the predominantly adverse effects related to difficulties in digital self-regulation, coping strategies were also identified. Spiritual mindfulness emerged as a protective factor, promoting awareness, balance, and reduced nomophobia [38]. Similarly, digital self-control techniques, including intentional disconnection, app-blocking tools, and time-management practices, were reported to enhance focus and reduce stress [38, 39]. These findings highlight the difficulty of resisting constant digital stimuli and indicate the importance of adopting strategies that promote concentration and emotional balance within digital environments.

Digital self-efficacy

Digital self-efficacy refers to an individual's confidence in their ability to effectively use digital tools and technologies to accomplish tasks. It emphasises the belief in one's capacity to solve problems, navigate software, and learn new digital skills in rapidly changing technological environments. Functional elements within this domain reflected the skills and capacities that enable learners to operate effectively in digital environments. Analytical skills supported the ability to interpret and apply digital information in academic contexts, while critical thinking emphasised evaluating sources for credibility and relevance [40]. These skills were complemented by communication competencies, ranging from participation in online discussions to collaboration on digital platforms, improving academic engagement and building learners' confidence and adaptability in group settings [40, 41]. Moreover, referencing skills emerged as an essential indicator of learners' ability to use digital resources responsibly in academic work [42].

Adaptability was another critical element, reflecting learners' capacity to adjust to new software, platforms, and technological changes without significantly disrupting learning progress [29]. Broader aspects of digital literacy also featured prominently, encompassing competencies such as navigating learning management systems, using productivity tools, and leveraging digital platforms for research and collaboration [28, 29, 37, 41, 43, 44]. Significantly, digital proficiency, which goes beyond literacy to reflect greater fluency, efficiency, and adaptability in managing complex digital tasks, was associated with enhanced psychological well-being, as learners with stronger proficiency reported higher confidence, motivation, and adaptability in balancing digital demands [45].

Across the studies, digital self-efficacy was consistently linked with well-being outcomes. Learners with higher digital competence reported greater satisfaction with their academic experience [28, 42], higher motivation and adaptability [29, 44] and improved confidence in managing digital learning environments [41]. Conversely, lower self-efficacy was associated with stress, anxiety, and emotional reactivity, including frustration or irritability when navigating digital challenges [29]. Stronger digital literacy also correlated with reduced stress and improved psychological balance [37]. Collectively, these functional elements highlight the centrality of self-efficacy in digital contexts and extend beyond technical competence. Learners with strong digital self-efficacy demonstrate resilience, adaptability, and confidence, which not only support effective academic performance but also strengthen their ability to regulate behaviours, engage intentionally, and participate meaningfully in digital communities.

Digital intention

Digital intention suggests a deliberate and thoughtful approach to using digital resources for goals and support. Unlike impulsive or passive use, intentional digital behaviours reflect self-directed choices that promote focus, connection, and well-being. Goal setting emerged as an essential functional element, with learners using digital tools to plan tasks, monitor progress, and align activities with their academic objectives. Such purposeful engagement not only enhanced learning efficiency but also encouraged greater mindfulness and awareness in digital practices [22, 39]. Building on this, help-seeking behaviours highlighted learners' intentional use of digital platforms to access academic support and peer guidance. This proactive approach was consistently linked to stress relief and improved confidence in managing academic challenges [41]. Digital intention also extended to the social domain, as learners deliberately engaged with online spaces to form new friendships and strengthen social networks. These connections contributed to higher satisfaction and a sense of belonging, underscoring how intentional digital interaction can reinforce emotional well-being [46]. Building on these intentions, learners also demonstrated sustained academic motivation through purposeful digital use, drawing on online platforms and resources to reinforce their goals [36].

Collectively, these functional elements indicate that digital intention was consistently associated with positive outcomes. Across the reviewed studies, intentional digital use was linked to greater mindfulness, reduced stress, enhanced satisfaction, and sustained academic motivation. Notably, no neutral or negative outcomes were reported in relation to this theme.

Digital conduct

Digital conduct, as defined in this review, refers to the behaviours and actions individuals exhibit while interacting with digital technologies and online environments. Among the themes identified, this area was the least explored in the literature, with only limited studies directly addressing it. The functional elements identified included positive online behaviour, such as respectful and constructive peer interactions, professionalism in maintaining appropriate standards of communication and responsibility, and adherence to ethical guidelines, including responsible information sharing and academic integrity [43]. Collectively, these behaviours were associated with a greater sense of comfort and safety in digital environments, as well as the development of interpersonal trust [43].

Digital engagement

We defined digital engagement as the active interaction of individuals with digital platforms, content, and communities. This theme was well represented in the literature, with studies identifying a wide range of functional elements shaping learners' experiences. Peer interaction emerged as a notable aspect, fostering collaboration, social support, and a sense of community [47–49]. Engagement with educators was also highlighted, where meaningful exchanges and opportunities for dialogue reinforced learning processes and promoted learner confidence [47, 48]. At the institutional level, digital communication with universities and academic systems influenced perceptions of support; particularly, a reduced sense of institutional commitment was associated with heightened academic anxiety [32].

In addition to these interpersonal and institutional interactions, digital engagement extended to using AI agents, which offered comfort, motivation, and a sense of companionship in academic contexts [42]. Other functional elements were linked to communication practices, including the use of emoji language, which helped learners express emotions more effectively and contributed to a positive online atmosphere [41]. Flexible approaches to camera use, such as the option not to show one's face, were identified as reducing anxiety and increasing comfort, particularly in interactions with peers and strangers [41, 47]. Related to this, camera usage in online classrooms was associated with both reduced cognitive load when flexibility was allowed and with stress or discomfort when mandatory [47]. Rapid feedback and timely correction were also noted as essential aspects of digital engagement, contributing to learner satisfaction and supporting sustained attention to academic tasks [48].

Overall, digital engagement demonstrated a dual profile. Positive outcomes included satisfaction, comfort, motivation, and reduced cognitive load. In contrast, negative outcomes were observed in experiences of discomfort during high-stakes interactions and increased academic anxiety associated with a weakened sense of institutional commitment.

Digital support

Digital support is the help given to an individual using digital technologies. It aims to assist users in effectively using digital tools, improving their skills, and addressing any problems they encounter. Digital support was found to originate from diverse sources. Family members played an essential role in sustaining motivation and providing emotional reassurance [29, 50], while peers and acquaintances offered encouragement and reduced stress through collaborative assistance [37]. Universities also contributed by establishing structures that helped learners manage academic tasks more effectively [29].

Beyond interpersonal forms, institutional and organisational support further shaped learners' experiences. Organisational guidelines and flexibility, such as opportunities to work at one's own pace, were linked to lower stress and improved coping [37, 48]. In addition, support from technology companies and structured educational courses provided technical scaffolding, equipping learners with strategies and resources to better engage with digital tools [28, 51].

The outcomes associated with digital support were predominantly positive. Increased motivation was frequently reported [29, 50] alongside reduced stress and anxiety when adequate support was accessible [37]. Negative effects were only noted in isolated cases where support mechanisms were absent or perceived as insufficient [29].

Digital resource

Another emerging theme from our review is digital resource, which refers to any tool or digital feature that helps improve accessibility and usability of digital systems. Studies highlighted a wide range of positive features. Accessibility options and device compatibility were central in ensuring inclusive participation and smoother user experiences [37, 40, 48]. Tools that promoted self-regulation, such as digital self-control features and notification management systems, supported learners in managing distractions and maintaining focus [53, 54]. Pedagogical design elements, including interactive and varied learning approaches, further contributed to learner satisfaction and engagement [49, 52, 55]. Similarly, resources emphasising techno-ease, reliability, and sociality were associated with increased intrinsic motivation and enhanced perceptions of control [36, 51].

However, limitations of digital resources were also evident. Unresponsive systems, the need for multiple devices, and poorly designed or distraction-prone tools were linked to frustration, anxiety, and stress [48, 53].

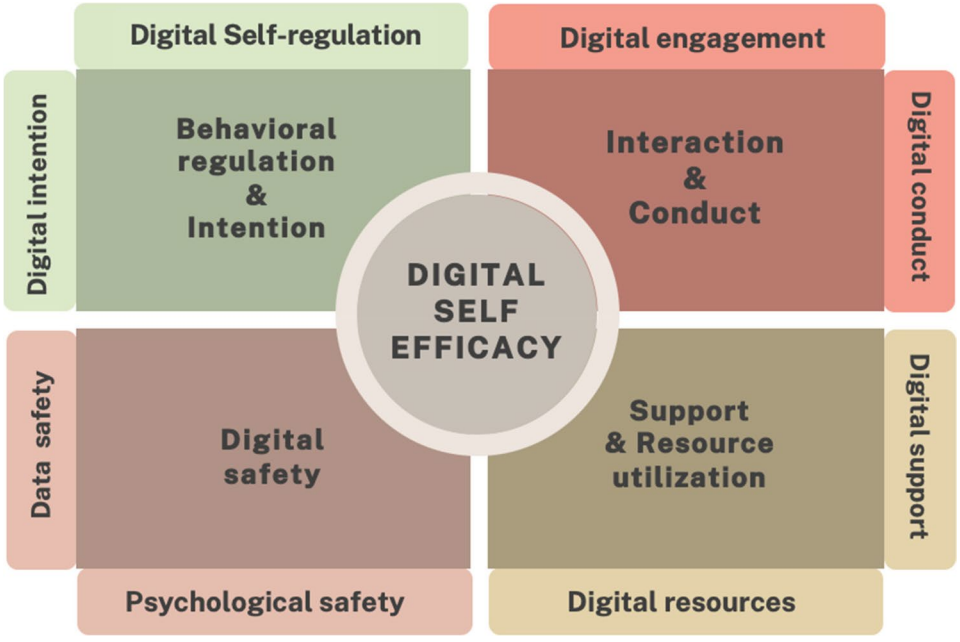

Fig. 4 Digital well-being framework: leads to feeling good and functioning well in the digital space

In particular, when digital platforms imposed excessive demands on learners, the resulting cognitive strain undermined their ability to focus effectively. While most outcomes highlighted the benefits of well-designed resources, one to two studies reported neutral effects, suggesting that certain features, such as notification disabling, may not directly influence well-being despite improving usability [54].

Overall, digital resources were most strongly associated with positive outcomes, including satisfaction [49, 52], improved motivation [36] and greater self-regulated learning capacity [51]. At the same time, the evidence demonstrated that the quality and responsiveness of digital tools play a decisive role, with poorly functioning or overwhelming resources more likely to contribute to negative well-being outcomes.

Digital safety

Another comparatively underexplored theme identified in the review was digital safety. Digital safety involves protecting individuals and their data while using digital platforms. This field of cybersecurity focuses on maintaining the integrity, confidentiality, and privacy of information and ensuring a safe online experience by being aware of risks and implementing protective measures. Evidence on digital safety was comparatively limited across the reviewed studies, yet the theme emerged as a critical concern in digital environments. The discussion of safety focused primarily on financial risks, such as vulnerability to online fraud or scams, and the associated sense of insecurity [25]. The perception of being unsafe online was consistently linked with negative outcomes, particularly mental and emotional friction, which disrupted participants' sense of stability and confidence in digital spaces [25]. No positive or neutral associations were identified.

Framework for digital well-being

The synthesis of findings from the reviewed studies informed the development of a conceptual framework that positions digital self-efficacy at the core of learners' digital experiences (Fig. 4). This framework is organised into four interrelated clusters encompassing eight themes. The behavioural regulation and intention cluster comprises digital self-regulation and digital intention, reflecting learners' ability to monitor and control their digital behaviours while engaging purposefully in a digital environment. The interaction and conduct cluster includes digital engagement and conduct, which capture how individuals connect with peers, educators, institutions, and technologies, as well as the standards of professionalism, respect, and ethical responsibility that underpin those interactions. The support and resource utilisation cluster combines digital support and digital resources, highlighting the significance of accessible assistance and the effective deployment of technological tools in sustaining participation and productivity. The digital safety cluster integrates data safety and psychological safety, encompassing the protection of personal information and learners' sense of comfort, trust, and security in digital contexts. Together, these clusters illustrate the multidimensional nature of digital self-efficacy, showing how regulation, interaction, support, and safety intersect to shape learners' academic and psychological experiences.

Discussion

Digital self-efficacy as the core component of digital well-being

Our synthesis suggests that digital self-efficacy can be conceptualised as a central functional element within the proposed framework. Learners' confidence in navigating digital tools not only directly supported positive well-being outcomes but also enhanced the effectiveness of other themes mentioned in the framework. Evidence demonstrates that higher levels of self-efficacy function as a protective factor, mitigating stress and reinforcing academic motivation. Conversely, lower self-efficacy has been consistently associated with disengagement, elevated anxiety, and broader psychological distress, often serving as a key mediator in the relationship between academic stress and negative well-being outcomes [56, 57].

When learners feel capable of managing digital tasks, they are more likely to approach them with persistence and effective strategies. This idea is consistent with Self-Determination Theory (SDT), developed by Deci and Ryan [58]. SDT explains that motivation is driven by three basic psychological needs: autonomy, competence, and relatedness. Within the digital context, these needs intersect with well-being in meaningful ways. Competence is nurtured through digital self-efficacy, as confidence in one's ability to navigate tools and platforms reduces frustration and fosters sustained engagement. This interpretation is also supported by Bandura's Social Cognitive Theory, which emphasises the role of self-efficacy beliefs in shaping behaviour, motivation, and adaptive responses in complex environments [59]. Autonomy is reflected in learners' ability to regulate their digital use purposefully, choosing when and how to engage online rather than feeling controlled by technology. From another perspective, Technostress Theory highlights how excessive digital demands and information overload may challenge individuals' capacity for self-regulation, leading to cognitive strain and reduced well-being [60]. Relatedness emerges in digital spaces through collaborative platforms and peer interactions, which provide social support and a sense of belonging. Together, these perspectives help explain how digital self-efficacy, self-regulation, and social interaction collectively contribute to digital well-being. Rather than attributing these mechanisms to a single theoretical model, these complementary frameworks offer a more nuanced understanding of how learners engage with digital environments [61, 62].

Importantly, the prominence of digital self-efficacy within the synthesised literature is consistent with empirical evidence demonstrating its role in reducing psychological distress while enhancing motivation and academic performance in digital learning environments [56, 57]. This provides conceptual support for its positioning as a central enabling component within the framework. However, it should be noted that this positioning reflects a conceptual model grounded in SDT, rather than a definitive empirical conclusion, and should be considered a foundation for future empirical validation.

Interconnections between self-efficacy and other themes

Digital self-efficacy does not function in isolation. Instead, it interconnects with and amplifies the effectiveness of other dimensions of digital well-being. From SDT perspective, self-efficacy promotes the internalisation of behaviours by enhancing perceived competence, which in turn allows for more independent control over learning activities [58]. This offers a theoretical justification for why certain learners benefit more from functional elements like self-regulation, engagement, and support than others.

Learners with higher self-efficacy are more likely to set deliberate goals and sustain purposeful digital intention, minimising cognitive overload during digital tasks [63]. Their confidence also enhances digital engagement, as they participate more actively in online communities and collaborative platforms, strengthening social connections and peer learning [64].

Self-efficacy also shapes how learners work with digital resources. It mediates the link between digital literacy and academic performance, indicating that confidence and capability are how skills translate into outcomes [65]. Relatedly, self-efficacy underpins digital self-regulation by enabling strategic learning behaviours such as planning, monitoring, and managing attention. It helps learners resist distraction and persist with complex tasks in online settings. Evidence in e-learning contexts consistently associates higher self-efficacy with stronger self-regulated learning strategies [66, 67]. Supportive conditions further amplify these effects. Digital support from peers, educators, and institutional systems plays a compensatory role for learners with lower baseline self-efficacy, offering guidance and reassurance that help sustain motivation [68].

These interconnections indicate that digital well-being emerges from the interaction between multiple functional elements rather than any single domain in isolation. Positive outcomes are more likely when digital self-efficacy co-occurs with strong support, effective engagement, and well-designed resources, whereas negative outcomes are often associated with poor self-regulation and insufficient support. This interpretation is further supported by structural equation modelling evidence demonstrating that engagement, teacher support, and facilitating conditions jointly influence academic performance and well-being [69].

Notably, digital conduct and digital safety remain comparatively underexplored domains. While existing studies suggest their role in promoting respectful interactions, ethical awareness, and psychological comfort, environments characterised by poor digital conduct or safety

concerns may heighten social anxiety and negatively impact well-being [70]. This highlights the need for further research to better understand how ethical behaviour, privacy, and perceived safety contribute to sustainable digital well-being. Collectively, these findings reinforce that digital self-efficacy operates as an integrative mechanism that enables other functional elements to translate into meaningful well-being outcomes.

Broader perspectives on digital well-being

Our findings align with broader conceptualisations that define digital well-being as a dynamic equilibrium between connectivity and disconnectivity, shaped by individual characteristics, technological design, and contextual circumstances [1]. From this perspective, digital well-being is not a static condition but a continuous adjustment process that requires individuals to disrupt maladaptive usage patterns while cultivating healthier digital practices.

Notably, the literature cautions against equating occasional digital struggles with clinical disorders. While many learners experience distractions, fatigue, or periods of over-engagement, these fluctuations should not be pathologised. Mislabelling such experiences as disorders risks stigmatising normal variations in technology use. Instead, they should be understood as signals of reduced digital well-being, which can be mitigated through proactive strategies such as strengthening digital self-efficacy, fostering peer and institutional support, and promoting meaningful engagement in digital environments [1, 71].

Implications for higher education

Emerging evidence indicates that educational interventions targeting digital self-efficacy, such as digital training modules, informal practice, and autonomy-supportive learning environments, can measurably improve learners' mental well-being, reduce stress, and increase resilience when navigating online tasks (72). These findings demonstrate the importance of positioning digital self-efficacy as a core component of digital well-being strategies in higher education.

From the learners' perspective, the findings of this review highlight the importance of strengthening both digital self-efficacy and digital self-regulation. As demonstrated in the results section, poor self-regulation was the most frequently associated factor with negative well-being outcomes, including stress, anxiety, and reduced satisfaction. Therefore, learners need to develop not only technical competence but also behavioural strategies to manage distraction, regulate screen time, and maintain focus during digital learning [66, 67]. In addition, the consistent positive association observed for digital intention suggests that purposeful and goal-directed engagement with digital tools can enhance motivation, satisfaction, and emotional well-being. These findings are aligned with evidence indicating that learners' stress levels, well-being, and perceived support are closely interrelated, with supportive environments contributing to improved learning experiences (73). This is particularly relevant in programmes that involve complex and digitally mediated learning environments, such as medical and healthcare education, where learners engage with simulations, integrated learning systems, and information-rich content that require high levels of self-regulation and sustained cognitive focus.

For educators, the findings emphasise the importance of fostering supportive and well-structured digital learning environments. The results demonstrated that digital engagement, particularly through interaction with peers and instructors, timely feedback, and flexible participation, was associated with both positive and negative outcomes depending on how it was implemented. This suggests that the quality of engagement is critical in shaping learners' experiences. Educators play an important role in reducing anxiety and enhancing motivation by providing clear guidance, responsive communication, and opportunities for meaningful interaction. Consistent with prior evidence, teacher support has been shown to enhance learners' well-being, increase learning interest, and reduce stress levels (73). In healthcare education contexts, this includes guiding learners through digitally mediated clinical training, simulation-based learning, and online case discussions, where structured support is essential to reduce cognitive overload and anxiety.

At the institutional level, the findings highlight the critical importance of facilitating conditions, reflected in the themes of digital support and digital resources. The results showed that accessible support systems, reliable infrastructure, and user-friendly platforms were consistently associated with positive outcomes such as increased motivation, satisfaction, and reduced stress, whereas inadequate systems and limited support were linked to frustration, anxiety, and disengagement. This indicates that digital well-being is not solely determined by individual capability but is strongly shaped by institutional environments.

Importantly, the significant effect of facilitating conditions identified in this review suggests that they function as structural enablers of both digital self-efficacy and well-being. When learners are supported by stable systems, clear guidance, and accessible assistance, they are more likely to develop confidence in using digital tools, sustain engagement, and effectively manage academic demands. In contrast, poorly supported environments increase cognitive load, reduce usability, and undermine both confidence and well-being. This is consistent with evidence indicating that facilitating conditions, together with engagement and support, are key determinants of academic performance and psychological outcomes in higher education contexts [65, 69]. This is especially

critical in healthcare training environments, where unreliable systems or poorly designed platforms may not only hinder learning but also affect learners' confidence in applying digital tools in clinical practice.

From a policy perspective, these findings highlight the need for institutions to move beyond individual-level interventions and adopt a systemic approach to digital well-being. This includes integrating digital well-being into institutional strategies, ensuring platform usability and reliability, providing proactive technical and academic support, and designing learning environments that minimise unnecessary cognitive burden. In addition, institutions should regularly assess learners' digital readiness and experiences to identify gaps in access and support. Such system-level strategies are essential to ensure that facilitating conditions effectively support both academic performance and learners' digital well-being.

However, building self-efficacy in isolation is insufficient. Instead, a holistic strategy is needed, like the one that integrates individual skill confidence with institutional supports and sensitivity to contextual challenges. Even learners with strong self-efficacy benefit when faculty provide encouragement, when digital infrastructures are reliable and accessible, and when institutional policies actively reduce sources of technological stress. To that end, developing a digital well-being measurement scale may help identify gaps in learners' digital readiness, including self-efficacy, support, and self-regulation, thereby informing more targeted interventions.

Limitation

This scoping review has several limitations. The review was conducted using three major bibliographic databases: Scopus, PubMed, and Web of Science, which were selected for their broad interdisciplinary coverage across health, education, and technology-related fields. While this approach was considered sufficient to capture the majority of relevant literature aligned with the review objectives, the exclusion of additional specialised databases, such as ERIC and PsycINFO, as well as grey literature including conference proceedings, theses, and policy reports, may have limited the identification of some context-specific or emerging studies.

In addition, the focus on digital well-being as the primary construct may have excluded studies addressing related concepts such as technostress, problematic internet use, and digital addiction, which represent overlapping dimensions of digital experience. Furthermore, the search strategy also focused on the population term 'learners', which may not have captured all relevant synonyms such as students, undergraduates, or university students, potentially limiting retrieval.

The review was also restricted to English-language publications, which may have limited the inclusion of culturally and regionally diverse perspectives. Furthermore, the data extraction process was primarily conducted by a single researcher, which may introduce a risk of bias despite efforts to ensure consistency through discussion and verification.

Finally, a large proportion of the included studies ($n = 32$, 94%) were conducted during and following the COVID-19 period from 2020 onwards, with only two studies published prior to this period in 2018 and early 2020. This context may have influenced learners' digital experiences, as increased reliance on remote learning, social isolation, and heightened stress levels could have amplified both positive and negative outcomes. Therefore, the generalisability of the proposed framework to post-pandemic educational settings should be interpreted with caution.

Conclusion

This scoping review synthesises existing evidence on digital well-being among higher education learners by identifying eight functional elements and organising them into a multidimensional conceptual framework. Rather than examining isolated constructs, this study brings together current findings to illustrate how digital well-being may emerge from the interaction between individual capabilities, behavioural patterns, and digital environments. Within this framework, digital self-efficacy is conceptualised as a central enabling component that interacts with other functional elements to shape learners' digital experiences. This highlights the importance of understanding digital well-being as a multidimensional construct shaped by the interaction between learner-related and environmental factors.

Future research should focus on empirically examining the proposed framework, particularly through longitudinal and mixed-methods approaches that can explore how these functional elements interact over time. In addition, further investigation is warranted for underexplored domains such as digital conduct and digital safety, as well as the development of more consistent and psychometrically sound measurement approaches for digital well-being.

The findings also have broader implications for stakeholders involved in the design and governance of digital environments. In particular, the roles of digital self-regulation and digital resources point to the need for user-centred design that supports focus, usability, and manageable cognitive load. Similarly, digital support and digital safety highlight the importance of institutional systems and policies that promote accessibility, trust, and psychological security. Aligning individual capabilities with technological design and institutional support may help inform more context-sensitive approaches to digital well-being in higher education.

Appendix

No.	Title of articles	Author, year of publication	Geographical distribution	Participants Age (Average or range)	Participants Category (n)	Digital components / functional elements	Well-being outcomes	Methods
1	Smartphone Use and Psychological Well-Being Among College Students in China: A Qualitative Assessment	[22]	7 colleges in China	Not mentioned	Undergraduate (70)	1. Nomophobia (smartphone addiction) / Fear of missing out (FOMO) 2. Smartphone use late night 3. Smartphone high dependency 4. Individual goal setting5. Mental focus	1. Anxiety, insecure, panic, disconnected (Nomophobia) 2. Disturbed sleep quality (Smartphone use late night)3. less self-control / higher disturbances (Smartphone high dependency)	Quali
2	Studying problems, not problematic usage: Do mobile checking habits increase procrastination and decrease well-being?	[27]	Johannes Gutenberg University of Mainz, Germany.	23	Undergraduate (532)	Mobile checking habit	Procrastination, lower well-being	Quanti
3	Teaching and learning "Digital Wellbeing"	[28]	Politecnico di Torino, Italy.	21	Undergraduate (102)	1. Educational course on DWB (Benessere Digitale course)2. Digital literacy3. Tech company support4. Screen time	1. Satisfaction (Educational course) 2. No effect on Well-being (Screen time)	Mixed. Case study
4	Problematic use of the internet, smartphones, and social media among medical students and relationship with depression: An exploratory study	[23]	Mbarara University of Science and Technology (MUST), Uganda	23.37 ± 3.38	Medical Undergraduate (269)	Internet addiction, social media addiction, smartphone addiction	Depression	Quanti
5	Designing and implementing virtual education course of media literacy for medical sciences students: An experimental study	[40]	Shahid Sadoughi University of Medical Sciences, Yazd Iran	19-30	Undergraduate (27) & Postgraduate (61)	1. Accessibility 2. Analyzing skills 3. Communication skills 4. Think critically about content (All are media literacy)	Not mentioned	Experimental study, quanti
6	Exploring the impact of the covid-19 pandemic on university students' learning life: An integrated conceptual motivational model for sustainable and healthy online learning	[29]	Few Public & private universities in Malaysia	18-28	Undergraduate (419) & Postgraduate (67)	1. Sudden online (adaptability)2. Digital literacy3. Screen time4. Family support5. University support	1. Stress, anxiety (Sudden online, screen time, family support, university support) 2. Losing temper easily 3. Increase Motivation (Digital literacy, family support)	Mixed quali quanti
7	Design an Adaptive Mobile Scaffolding System According to Students' Cognitive Style Simplicity vs Complexity for Enhancing Digital Well-Being	[51]	Saudi Arabia	Not mentioned	Undergraduate (71)	1. Specified mobile scaffolding according to cognitive style (educational application)	1. Increase motivation, self satisfaction, students' control	Mixed. Quasi-experimental

No.	Title of articles	Author, year of publication	Geographical distribution	Participants Age (Average or range)	Participants Category (n)	Digital components / functional elements	Well-being outcomes	Methods
8	Defining Digital Wellbeing Literacy in Remote Work Integrated Learning	[41]	Australian-basedUniversity Business School.	Not mentioned	Undergraduate (6) -Others are Higher education staff)	1. Digital wellbeing literacy capability2. Language - wellbeing literacy (communication skill)3. Flexibility (not to show face)4. Emoji - language5. Goal - Help seeking	1. Less confident / confident (literacy capability)2. Comfortable / confident with stranger (Flexibility)3. Help in expression / positive atmosphere (Emoji)4. Relieve stress (Goal – Help seeking)	Quali
9	Use of digital self-control tools in higher education – a survey study	[53]	1 institute in Germany	27.18	Undergraduate (219) & Postgraduate (54)	1. Digital self-control tools (app)2. Screen share (one of digital self-control tool	1. Anxiety, stress -More distraction than assistance (Digital self-control tools)	Mixed quanti quali
10	Digital proficiency and psychological well-being in online learning: Experiences of first-generation college students and their peers	[45]	Public university on the west coast of the United States	Not mentioned	Undergraduate (309)	1. Digital Proficiency 2. Interactive features	1. Positive psychological wellbeing	Quanti
11	"Seeing and Being Seen" or Just "Seeing" in a Smart Classroom Context When Videoconferencing: A User Experience-Based Qualitative Research on the Use of Cameras	[47]	Universitat Ramon Llull (URL), La Salle, Barcelona, Spain	18-25	Undergraduate (79)	1. Camera use during online learning2. Interaction (student to student & to instructor), distraction	1. Anxiety, Stress, Satisfaction (Camera use during online learning) 2. Reduce Cognitive load -due to increase understanding	Quali
12	Digital Well-Being and Satisfaction of University Students with Online Education	[52]	Faculty of Aeronautics, Technical University of Košice, Slovakia	Not mentioned	Undergraduate (53)	Characteristic of online platform (functionality, interactive features)	Satisfaction	Mixed quanti quali
13	Exploring the Dimensions of Smartphone Distraction: Development, Validation, Measurement Invariance, and Latent Mean Differences of the Smartphone Distraction Scale (SDS)	[34]	English-speaking university in the United Kingdom (UK)	21.1	Undergraduate (730) & Postgraduate (95)	Smartphone distraction (problematic smartphone use)	Positive and negative well-being (Item only)	Quanti
14	Nurturing Minds and Sustainability: An Exploration of Educational Interactions and Their Impact on Student Well-Being and Assessment in a Sustainable University	[48]	STEM (science, technology, engineering, andmathematics) university, Romania	Not mentioned	Undergraduate (871)	1. Flexibility - work at own pace2. fast feedback & correction3. Interaction4. Accessibility (internet connection, unresponsive tools, multiple devices)	1. More engaged -satisfaction (Interaction)2. Isolated, poor engagement (Interaction)3. Anxiety - Lack interaction 4. Frustration (Accessibility)	Quanti
15	Co-Designing AI Agents to Support Social Connectedness Among Online Learners: Functionalities, Social Characteristics, and Ethical Challenges	[46]	Georgia Tech's Online Master of Science in Computer Science (OMSCS) program, USA	24-31	Undergraduate (23)	1. Characteristic of AI agent in facilitating social connection2. Goal - Social connection beyond classes / make friends	1. Discomfort (Characteristic of AI agent)2. Satisfaction (Goal- Social connection)	Quali, co-design workshop

No.	Title of articles	Author, year of publication	Geographical distribution	Participants Age (Average or range)	Participants Category (n)	Digital components / functional elements	Well-being outcomes	Methods
16	Examination of non-cognitive variables affecting academic achievement: a conceptual model proposal	[30]	Turkey	17-48	Undergraduate (241)	Screen time	No significant relation on psychological wellbeing	Quanti
17	Chatbot Positive Design to Facilitate Referencing Skills and Improve Digital Well-Being	[42]	Master of Education, King Faisal University, Kingdom of Saudi Arabia	Not mentioned	Postgraduate (150)	1. Referencing skills (AI) 2. Interaction with AI3. Facilitating independent / flexibility of chatbot	1. Satisfaction (Referencing skills AI)2. Motivation, comfort, peace, happiness (Interaction with AI)	Quanti, experimental study
18	Raising Awareness of Smartphone Overuse among University Students: A Persuasive Systems Approach	[24]	Portugal	18-24	Undergraduate (16)	Period of smartphone usage	Decrease well-being	Mixed quali quanti
19	Wellbeing Amid Digital Risks: Implications of Digital Risks, Threats, and Scams on Users' Wellbeing	[25]	Universities in Norway	Not mentioned	Undergraduate (4) & Postgraduate (13)	Digital risk:-1. Physical- muscle overused, tired eyes , postural problems2. Psychological - addiction,3. Financial - buying compulsiveness, scam4. Social - need for attention, acknowledgement, fear of isolation, fear of missing out (GOAL)	Fear of online fraud, mental & emotional friction (Financial)	Quali
20	Participatory digital approaches to embedding student wellbeing in higher education	[55]	The Open University & University of Warwick, Coventry, United Kingdom.	<25 - >56 (mixed with others)	Undergraduate (17) & Undergraduate (13)	1. User friendly2. Variety of pedagogy / learning design	Feel valued (User friendly & variety of pedagogy)	Mixed quali quanti
21	A study of university law students' self-perceived digital competences	[43]	Law School within a UK university	Baby boomers - Gen Z	Undergraduate (28) & Undergraduate (31)	1. Positive behaviour online2. Digital Literacy3. Professionalism / Ethical conduct4. Digital Competencies	Comfortable, feel safe (Positive behaviour online)	Mixed quanti quali
22	A cross-sectional study of discipline-based self-perceived digital literacy competencies of nursing students	[44]	Royal College of Nursing, UK	Baby boomers - Gen Z	Undergraduate (146) & Postgraduate (36)	Digital literacy	More Adaptable	Mixed quanti quali
23	The Analysis of Psychological Aspects of Online Education: Depression andHappiness and Their Relationship with College Students' Academic Achievement	[31]	Kerman University ofMedical Sciences, Iran	22 +- 4	Undergraduate (400) & Postgraduate (110)	Internet addiction	1. Decrease happiness 2. Depression	Quanti

No.	Title of articles	Author, year of publication	Geographical distribution	Participants Age (Average or range)	Participants Category (n)	Digital components / functional elements	Well-being outcomes	Methods
24	Assessing stress, protective factors and psychological well-being among undergraduate nursing students	[50]	Bachelor of nursing, Australian regional university	36.23	Undergraduate(538) & postgrad experience (working)(7)	Family support	Motivation	Quanti
25	Exploring college students' technostress phenomenon in using ed-tech	[37]	Management-study program, private college of economics in Garut, West Java, Indonesia	Not mentioned	Undergraduate (46)	1. Digital literacy2. Organization guidance3. Device compatibility4. Acquaintances support 5. Intensive technology use	1. Less stress (Digital literacy & Acquaintances support)2. Frustration (Device compatibility)3. Techno-isolation -loneliness (Intensive technology use)	Quali
26	The relationship of smartphone addictionwith psychological distress and neuroticismamong university medical students	[26]	Faculty of medicine, USM, Malaysia	19 - 23	Medical Undergraduate (574)	Smartphone addiction	Depression, anxiety, stress and neuroticism	Quanti
27	Beyond the Buzz: Investigating the Effects of aNotification-Disabling Intervention on SmartphoneBehavior and Digital Well-Being	[54]	University of Amsterdam, Netherlands	24.45	Mix university students & panel company) (205)	Notification-disabling	Unaffected / not significant	Mixed method, RCT
28	Digital distraction levels of university students in emergency remote teaching	[35]	Sakarya university, Turkey	22.75	Mix undergraduate & postgraduate (1532)	Digital distractions (sending instant messages, controlling the clock, boredom, social media posting, and system usability scores)	lower general satisfaction	Quanti
29	Factors for Sustainable Online Learning in Higher Educationduring the COVID-19 Pandemic	[49]	11 universities in Hong Kong	Not mentioned	Undergraduate (400)	1. Interaction between students2. Course design	Satisfaction	Quanti
30	Technostress and academic motivation: direct and indirect effects on university students' psychological health	[36]	five European countries (Czech Republic, Greece, Italy, Serbia, United Kingdom)	22.36	Undergraduate (1211) & Postgraduate (330)	1. Techno overload2. Academic motivation3. Techno-ease, techno-reliability, techno-sociality	1. Anxiety, depression & amotivation (Techno overload)2. Increase intrinsic motivation (Techno-ease, academic motivation)	Quanti
31	Internet Addiction and Academic Anxiety AmongChinese College Students During COVID-19: TheMediating Role of Psychological Contract	[32]	11 universities and colleges in China	Not mentioned	(270)	1. Internet addiction2. Psychological contract (interaction with institution)	Lesser psychological contract then increased academic anxiety (not directly impacted by internet addiction)	Quanti
32	Social Media Usage and Depressive Symptoms in UniversityStudents: A Correlation Study	[33]	2 public universities in Pakistan	20-31	Undergraduate (104) & Postgraduate (26)	Social media (no specific factors on social media)	Depression	Quanti

No.	Title of articles	Author, year of publication	Geographical distribution	Participants Age (Average or range)	Participants Category (n)	Digital components / functional elements	Well-being outcomes	Methods
33	Spiritual Mindfulness-Based Intervention for Nomophobia: A Randomized Controlled trial	[38]	Private university in Yogyakarta, Indonesia	21-24	Undergraduate (60)	Spiritual mindfulness, self control skill	Reducing Nomophobia	Quanti, RctIntervention - practice of zikr + other skills
34	"I finally felt I had the tools to control these urges": Empowering Students to Achieve Their Device Use Goals Withthe Reduce Digital Distraction Workshop	[39]	University of Oxford, UK	18 - >36	Undergraduate (98) & Postgraduate (182)	1. Goal setting2. Digital self-control skills (time, blocking/ hide distraction	More aware & mindful	Mixed quanti quali (feedback post workshop) open trial without control group

Acknowledgements
Not applicable.

Authors' contributions
FHMB, NSR, and MSBY substantial contributions to the design of the work; the acquisition, analysis, interpretation of data for the work; AND draft the work for important intellectual content; AND approve the final version to be published; AND agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.NPTP, NAAN, MSI, SKA, and SAR substantial contributions to the interpretation of data for the work; AND draft the work or reviewing it critically for important intellectual content; AND approve the final version to be published; AND Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding
This research is part of a larger project supported by the Fundamental Research Grant Scheme (FRGS/1/2024/SSI09/USM/02/12), Ministry of Higher Education, Malaysia.

Data availability
All data generated or analysed during this study are included in this published article and its supplementary information files. This study is a scoping review based on previously published literature; therefore, no primary datasets were generated.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Medical Education, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia
[2]Department of Medical Education, School of Medical Sciences, Universiti Sains Malaysia, Kota Bharu, Kelantan, Malaysia
[3]Psychiatry and Psychological Health Department, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia
[4]Department of Medical Education, Faculty of Medicine, Universiti Teknologi MARA, Sungai Buloh, Selangor, Malaysia
[5]Department of Medical and Health Professional Education, Faculty of Medicine, Universiti Sultan Zainal Abidin, Kuala Terengganu, Terengganu, Malaysia
[6]Department of Medical Education, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia
[7]Medical Education Unit, Faculty of Medicine and Health Sciences, Universiti Malaysia Sarawak, Kota SamarahanSarawak, Malaysia

Received: 7 March 2026 / Accepted: 30 April 2026
Published online: 16 May 2026

References

1. Vanden Abeele, Mariek MP. Digital wellbeing as a dynamic construct. Communication Theory Acad oup com. 2021;31(4):932–55. https://doi.org/10.1093/ct/qtaa024.
2. Arslankara VB, Demir A, Öztaş Ö, Usta E, Altıparmak AA. Digital well-being scale validity and reliability study. J Teacher Educ Lifelong Learn (TELL). 2022;4(2):263–74.
3. Gui M, Fasoli M, Carradore R. Digital well-being. Developing a new theoretical tool for media literacy research. Italian J Sociol Educ. 2017;9(1):155–73. https://doi.org/10.14658/pupj-ijse-2017-1-8.
4. Lazarenko VA, Kalutskiy PV, Dremova NB, Ovod AI. Adaptation of higher medical education to the conditions of digitalization of healthcare. Vysshee Obrazovanie v Rossii=Higher Education in Russia. 2020;29(1):105–15. Available from: https://vovr.elpub.ru/jour/article/view/2080?locale=en_US. Cited 2025 Jan 17.
5. Hsieh MC, Lee JJ. Preliminary study of VR and AR applications in medical and healthcare education. J Nurs Health Stud. 2018;3(1):1. https://doi.org/10.21767/2574-2825.100030.
6. Khan M, Mahar A. New technologies and digital literacy in education: a shifting paradigm. Pakistan Social Sci Rev. 2018;2(1):108–18.
7. Burr C, Taddeo M, Floridi L. The ethics of digital well-being: a thematic review. Sci Eng Ethics. 2020;26(4):2313–43. https://doi.org/10.1007/S11948-020-00175-8/FIGURES/2. PubMed PMID: 31933119.
8. Almoallim S, Sas C. Toward research-informed design implications for interventions limiting smartphone use: functionalities review of digital well-being apps. JMIR Form Res. 2022;6(4):e31730. doi:10.2196/31730 PubMed PMID: 35188897.
9. Alshammary FM, Alhalafawy WS. Digital platforms and the improvement of learning outcomes: evidence extracted from meta-analysis. Sustainability. 2023;15(2):1305. https://doi.org/10.3390/SU15021305.
10. Fang X, Ng DTK, Leung JKL, Chu SKW. A systematic review of artificial intelligence technologies used for story writing. Educ Inf Technol (Dordr). 2023;28(11):14361–97. https://doi.org/10.1007/S10639-023-11741-5/METRICS.

11. Pereira DSM, Falcão F, Costa L, Lunn BS, Pêgo JM, Costa P. Here's to the future: conversational agents in higher education- a scoping review. Int J Educ Res. 2023;122:102233. https://doi.org/10.1016/J.IJER.2023.102233.
12. Büchi M. Digital well-being theory and research. New Media Soc. 2024;26(1):172–89.
13. Smits M, Kim CM, van Goor H, Ludden GDS. From digital health to digital well-being: systematic scoping review. J Med Internet Res. 2022;24(4):e33787 https://www.jmir.org/2022/4/e33787. 2022;24(4):e33787. doi:10.2196/33787 PubMed PMID: 35377328.
14. Al-Mansoori RS, Al-Thani D, Ali R, Yan Z. Designing for digital wellbeing: from theory to practice a scoping review. Hum Behav Emerg Technol. 2023;2023(1):9924029. https://doi.org/10.1155/2023/9924029.
15. Sá MJ, Serpa S. COVID-19 and the promotion of digital competences in education. Univers J Educational Res. 2020;8(10):4520–8. https://doi.org/10.13189/UJER.2020.081020.
16. Bahar FHM, Roslan NS, Ping NPT, Yusoff MSB. Digital well-being among learners in higher education: a scoping review protocol. Education in Medicine Journal. Penerbit Universiti Sains Malaysia. 2024;181–6. https://doi.org/10.21315/eimj2024.16.4.14.
17. Peters MD, Godfrey, Christina, McInerney P, et al. Chapter 11: Scoping reviews. JBI manual for evidence synthesis. JBI Adelaide, Australia; 2020:467–73.
18. Yusoff M. Digital wellbeing in medical education. In: Conference: The webinar on future of medical education - adaptation for medical education in the post-pandemic era at University of Lahore & University College of Medicine and Dentistry, Pakistan. University of Lahore & University College of Medicine and Dentistry, Pakistan; 2020.
19. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159. doi:10.2307/2529310 PubMed PMID: 843571.
20. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Ann Intern Med. 2018;169(7):467–73. https://doi.org/10.7326/M18-0850/SUPPL_FILE/. M18-0850_SUPPLEMENT.PDF PubMed PMID: 30178033.
21. Naeem M, Ozuem W, Howell K, Ranfagni S. A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. Int J Qual Methods. 2023;22. https://doi.org/10.1177/16094069231205789/ASSET/E357FD53-F41B-4C14-9E5F-7B0D7DE07181/ASSETS/IMAGES/LARGE/10.1177_16094069231205789-FIG2.JPG.
22. Dai C, Tai Z, Ni S. Smartphone use and psychological well-being among college students in China: a qualitative assessment. Front Psychol. 2021;12. https://doi.org/10.3389/fpsyg.2021.708970.
23. Sserunkuuma J, Kaggwa MM, Muwanguzi M, Najjuka SM, Murungi N, Kajjimu J, et al. Problematic use of the internet, smartphones, and social media among medical students and relationship with depression: an exploratory study. PLoS ONE. 2023;18(5 May). https://doi.org/10.1371/journal.pone.0286424. PubMed PMID: 37235547.
24. Abreu C, Campos PF. Raising awareness of smartphone overuse among university students: a persuasive systems approach. Informatics. 2022;9(1). https://doi.org/10.3390/informatics9010015.
25. Dutt B. Wellbeing amid digital risks: implications of digital risks, threats, and scams on users' wellbeing. Media Commun. 2023;11(2):355–66. https://doi.org/10.17645/mac.v11i2.6480.
26. Lei LYC, Al-Aarifin Ismail M, Mohammad JAM, Bahri Yusoff MS. The relationship of smartphone addiction with psychological distress and neuroticism among university medical students. BMC Psychol. 2020;8(1). https://doi.org/10.1186/s40359-020-00466-6 . PubMed PMID: 32917268.
27. Meier A. Studying problems, not problematic usage: Do mobile checking habits increase procrastination and decrease well-being? Mob Media Commun. 2022;10(2):272–93. https://doi.org/10.1177/20501579211029326.
28. Monge Roffarello A, De Russis L. Teaching and learning digital wellbeing. Future Generation Comput Syst. 2023;149:494–508. https://doi.org/10.1016/j.future.2023.08.003.
29. Al-Kumaim NH, Alhazmi AK, Mohammed F, Gazem NA, Shabbir MS, Fazea Y. Exploring the impact of the covid-19 pandemic on university students' learning life: an integrated conceptual motivational model for sustainable and healthy online learning. Sustain (Switzerland). 2021;13(5):1–21. https://doi.org/10.3390/su13052546.
30. Yildiz Durak H, Şimşir Gökalp Z, Seki T, Saritepeci M, Dilmaç B. Examination of non-cognitive variables affecting academic achievement: a conceptual model proposal. Qual Quant. 2023;57(6):4985–5006. https://doi.org/10.1007/s11135-022-01580-w.
31. Nouhi E, Avaznia A, Shoraka HR. The analysis of psychological aspects of online education: depression and happiness and their relationship with college students' academic achievement corresponding author. J Educational Psychol Res J Edu Psyc Res. 2022;4. Available from: https://www.opastonline.com.
32. Chen S, Wang W. Internet addiction and academic anxiety among chinese college students during COVID-19: the mediating role of psychological contract. Psychol Res Behav Manag. 2023;16:3949–62. https://doi.org/10.2147/PRBM.S428599.
33. Mateen M, Agha SA. Social media usage and depressive symptoms in university students: a correlation study. Clin Counselling Psychol Rev. 2023;5(1):1–16. https://doi.org/10.32350/ccpr.51.01.
34. Throuvala MA, Pontes HM, Tsaousis I, Griffiths MD, Rennoldson M, Kuss DJ. Exploring the dimensions of smartphone distraction: development, validation, measurement invariance, and latent mean differences of the smartphone distraction scale (SDS). Front Psychiatry. 2021;12. https://doi.org/10.3389/fpsyt.2021.642634.
35. Göl B, Özbek U, Horzum MB. Digital distraction levels of university students in emergency remote teaching. Educ Inf Technol (Dordr). 2023;28(7):9149–70. https://doi.org/10.1007/s10639-022-11570-y.
36. Vallone F, Galvin J, Cattaneo Della Volta MF, Akhtar A, Chua S, Ghio E, et al. Technostress and academic motivation: direct and indirect effects on university students' psychological health. Front Psychol. 2023;14. https://doi.org/10.3389/fpsyg.2023.1211134.
37. Yunita S, Susilawati S, Riniawati R, Fajriah YN. Exploring college students' technostress phenomenon in using ed-tech. J Res Instructional. 2023;3(2):242–57. https://doi.org/10.30862/jri.v3i2.280.
38. Safaria T, Arini DP, Saputra NE. Spiritual mindfulness-based intervention for nomophobia: a randomized controlled trial. Islamic Guidance Couns J. 2023;6(2). https://doi.org/10.25217/0020236404400.
39. Lyngs U, Lukoff K, Slovak P, Inzlicht M, Freed M, Andrews H et al. I finally felt i had the tools to control these urges: empowering students to achieve their device use goals with the reduce digital distraction workshop. in: conference on human factors in computing systems - proceedings. association for computing machinery; 2024. https://doi.org/10.1145/3613904.3642946.
40. Ahmadi M, Madadizadeh F, Aghda MA, Khodayarian M. Designing and implementing virtual education course of media literacy for medical sciences students: an experimental study. J Health Lit. 2021;6(3):32–46. https://doi.org/10.22038/jhl.2021.59640.1177.
41. An N, Vesty G, Cheong C. Defining digital wellbeing literacy in remote work integrated learning. Australasian J Inform Syst. 2023;27. https://doi.org/10.3127/AJIS.V27I0.3969.
42. Zaky YAM. Chatbot positive design to facilitate referencing skills and improve digital well-being. Int J Interact Mob Technol. 2023;17(9):106–26. https://doi.org/10.3991/ijim.v17i09.38395.
43. Martzoukou K, Kostagiolas P, Lavranos C, Lauterbach T, Fulton C. A study of university law students' self-perceived digital competences. J Librariansh Inform Sci. 2022;54(4):751–69. https://doi.org/10.1177/09610006211048004.
44. Martzoukou K, Luders ES, Mair J, Kostagiolas P, Johnson N, Work F, et al. A cross-sectional study of discipline-based self-perceived digital literacy competencies of nursing students. J Adv Nurs. 2024;80(2):656–72. https://doi.org/10.1111/jan.15801 . PubMed PMID: 37489586.
45. Deng X, Yang Z. Digital proficiency and psychological well-being in online learning: Experiences of first-generation college students and their peers. Soc Sci. 2021;10(6). https://doi.org/10.3390/socsci10060192.
46. Wang Q, Jing S, Goel AK, Co-Designing AI. Agents to support social connectedness among online learners: functionalities, social characteristics, and ethical challenges. In: DIS 2022 - proceedings of the 2022 ACM Designing interactive systems conference: digital wellbeing. association for computing machinery, Inc; 2022:541–56. https://doi.org/10.1145/3532106.3533534.
47. Petchamé J, Iriondo I, Azanza G. Seeing and being seen or just seeing in a smart classroom context when videoconferencing: a user experience-based qualitative research on the use of cameras. Int J Environ Res Public Health. 2022;19(15). https://doi.org/10.3390/ijerph19159615. PubMed PMID: 35954978.
48. Tripon C, Gonța I, Bulgac A. Nurturing minds and sustainability: an exploration of educational interactions and their impact on student well-being and assessment in a sustainable university. Sustain (Switzerland). 2023;15(12). https://doi.org/10.3390/su15129349.
49. Chu AMY, Liu CKW, So MKP, Lam BSY. Factors for sustainable online learning in higher education during the COVID-19 pandemic. Sustain (Switzerland). 2021;13(9). https://doi.org/10.3390/su13095038.
50. He FX, Turnbull B, Kirshbaum MN, Phillips B, Klainin-Yobas P. Assessing stress, protective factors and psychological well-being among undergraduate

nursing students. Nurse Educ Today. 2018;68:4–12. https://doi.org/10.1016/j.nedt.2018.05.013 . PubMed PMID: 29870871.
51. Alhalafawy WS, Najmi AH, Zaki MZT, Alharthi MA. Design an adaptive mobile scaffolding system according to students' cognitive style simplicity vs complexity for enhancing digital well-being. Int J Interact Mob Technol. 2021;15(13):108–27. https://doi.org/10.3991/ijim.v15i13.21253.
52. Sekelová I, Korba P, Koščáková M, Al-Rabeei S. Digital well-being and satisfaction of university students with online education. EAI/Springer innovations in communication and computing. Springer Science and Business Media Deutschland GmbH; 2023. pp. 35–51. https://doi.org/10.1007/978-3-031-28225-6_3.
53. Biedermann D, Kister S, Breitwieser J, Weidlich J, Drachsler H. Use of digital self-control tools in higher education – a survey study. Educ Inf Technol (Dordr). 2024;29(8):9645–66. https://doi.org/10.1007/s10639-023-12198-2.
54. Dekker CA, Baumgartner SE, Sumter SR, Ohme J. Beyond the buzz: investigating the effects of a notification-disabling intervention on smartphone behavior and digital well-being. Media Psychol. 2024. https://doi.org/10.1080/15213269.2024.2334025.
55. Lister K, Riva E, Kukulska-Hulme A, Fox C. Participatory digital approaches to embedding student wellbeing in higher education. Front Educ (Lausanne). 2022;7. https://doi.org/10.3389/feduc.2022.924868.
56. Li X, Matar Hasan Alharbi W. Impact of digital feedback, self-efficacy, and autonomy on motivation and general english performance in online courses. Learn Motiv. 2025;90:102121. https://doi.org/10.1016/J.LMOT.2025.102121.
57. Kristensen SM, Larsen TMB, Urke HB, Danielsen AG, Academic, Stress. Academic self-efficacy, and psychological distress: a moderated mediation of within-person effects. J Youth Adolesc. 2023;52(7):1512–29. https://doi.org/10.1007/S10964-023-01770-1/. METRICS PubMed PMID: 36995523.
58. Ryan RM, Deci EL. Self-Determination Theory. Encyclopedia of quality of life and well-being research. 2023;6229–35. https://doi.org/10.1007/978-3-031-17299-1_2630.
59. Wang X, Zhang R, Wang Z, Li T. How does digital competence preserve university students' psychological well-being during the pandemic? An investigation from self-determined theory. Front Psychol. 2021;12:652594. https://doi.org/10.3389/FPSYG.2021.652594. /FULL PubMed PMID: 33967915.
60. Rosli MS, Saleh NS, Md. Ali A, Abu Bakar S. Self-determination theory and online learning in university: advancements, future direction and research gaps. Sustain (Switzerland). 2022;14(21). https://doi.org/10.3390/SU142114655.
61. Zhang H. Cognitive load as a mediator in self-efficacy and English learning motivation among vocational college students. PLoS ONE. 2024;19(11):e0314088. 10.1371/. JOURNAL.PONE.0314088 PubMed PMID: 39570816.
62. Getenet S, Cantle R, Redmond P, Albion P. Students' digital technology attitude, literacy and self-efficacy and their effect on online learning engagement. Int J Educational Technol High Educ. 2024;21(1):1–20. https://doi.org/10.1186/S41239-023-00437-Y/TABLES/6.
63. Zakir S, Hoque ME, Susanto P, Nisaa V, Alam MK, Khatimah H, et al. Digital literacy and academic performance: the mediating roles of digital informal learning, self-efficacy, and students' digital competence. Front Educ (Lausanne). 2025;10:1590274. https://doi.org/10.3389/FEDUC.2025.1590274/BIBTEX.
64. Tao X, Hanif H, Lieqin W. The effects of self-regulated learning strategies on academic procrastination and academic success among college EFL students in China. Front Psychol. 2025;16:1562980. https://doi.org/10.3389/FPSYG.2025.1562980/BIBTEX.
65. Faza A, Lestari IA. Self-regulated learning in the digital age: a systematic review of strategies, technologies, benefits, and challenges. Int Rev Res Open Distrib Learn. 2025;26(2):23–58. https://doi.org/10.19173/IRRODL.V26I2.8119.
66. Mensah C, Kugbonu MA, Appietu ME, Nti GA, Forson MA. Social support, computer self-efficacy, online learning engagement and satisfaction among undergraduate hospitality students. Cogent Educ. 2024;11(1). https://doi.org/10.1080/2331186. X.2024.2335803;CTYPE:STRING:JOURNAL.
67. Wijaya TT, Yu B, Xu F, Yuan Z, Mailizar M. Analysis of factors affecting academic performance of mathematics education doctoral students: a structural equation modeling approach. Int J Environ Res Public Health. 2023;20(5):4518. https://doi.org/10.3390/ijerph20054518. PubMed PMID: 36901528.
68. Ifenthaler D, Cooper M, Daniela L, Sahin M. Social anxiety in digital learning environments: an international perspective and call to action. Int J Educational Technol High Educ. 2023;20(1):1–18. https://doi.org/10.1186/S41239-023-00419-0/TABLES/5.
69. Van Der Linden M. Commentary on: Are we overpathologizing everyday life? A tenable blueprint for behavioral addiction research. Addictions as a psychosocial and cultural construction. J Behav Addict. 2015;4(3):145–7. https://doi.org/10.1556/2006. 4.2015.025 PubMed PMID: 26551902.
70. Rohde J, Marciniak MA, Henninger M, Homan S, Ries A, Paersch C et al. Effects of a digital self-efficacy training in stressed university students: a randomized controlled trial. PLoS One. 2024;19(10). https://doi.org/10.1371/JOURNAL.PONE.0305103. PubMed PMID: 39480821.
71. Wijaya TT, Rahmadi IF, Chotimah S, Jailani J, Wutsqa DU. A Case study of factors that affect secondary school mathematics achievement: teacher-parent support, stress levels, and students' well-being. Int J Environ Res Public Health. 2022;19(23):16247. https://doi.org/10.3390/ijerph192316247. PubMed PMID: 36498321.

Publisher's note