

Digital Competency of Higher Education Students in the Context of COVID-19

Xiangshan Ye, University College London, United Kingdom

The IAFOR International Conference on Arts & Humanities in Hawaii 2023
Official Conference Proceedings

Abstract

The COVID-19 pandemic has exerted a detrimental impact on students' learning. This is because although online pedagogy has been widely adopted in educational settings, many students have felt unprepared. Therefore, digital competency is crucial for students to cope with the unprecedented situation. It is also critical for international institutions and educators to revise digital competency frameworks and digital education plans to enhance the practical exercise, considering the multidimensional conceptualisation and the current circumstances. This study has adopted a mixed-method research approach. It conducted a web-based questionnaire to explore 48 participants' self-assessment of their digital competency alongside interviews with six students to acquire in-depth insights into their understanding of digital competency and digital education. From the six sub-disciplines adapted from Covello and Lei (2010), students generally perceive that they possess adequate digital competency to cope with the pandemic; however, they could benefit more from further support and education from their institutions.

Keywords: Digital Competency, Digital Education, Higher Education, COVID-19 Pandemic

iafor

The International Academic Forum

www.iafor.org

Introduction

In January 2020, the World Health Organisation (WHO) announced that the novel coronavirus (2019-nCoV), commonly known as COVID-19, constituted a Public Health Emergency of International Concern (WHO, 2020a) and subsequently declared it to be a global pandemic (WHO, 2020b). Since then, COVID-19 has gone on to affect almost all countries and territories across the world, with a high number of confirmed cases and deaths. Although young adults have not been identified as a high-risk group, no one is completely immune from the virus (Aristovnik et al., 2020). Considering the vulnerability of educational settings and their role in the transmission of the virus within communities, the majority of higher education institutions across the world have followed lockdown and social distancing protocols, which have resulted in school closures and the discontinuation of face-to-face lessons (Pokhrel & Chhetri, 2021; Rashid & Yadav, 2020). The number of learners who were forced to stay at home and who experienced disruption to their studies reached a peak in April 2020, with an estimated 1.58 billion learners from 194 countries affected. This represented 91.3% of all enrolled learners across the world (UNESCO, 2020).

Consequently, the past two years have witnessed a paradigm shift in knowledge dissemination by educators - from traditional methods to modern practices based around virtual classrooms (Mishra, Gupta & Shree, 2020; Pokhrel & Chhetri, 2021). Indeed, online learning has become a panacea for the pedagogical challenges that have arisen during the pandemic. Meanwhile, the pandemic has also provided people with an opportunity to familiarise themselves with the digital educational environment (Dhawan, 2020). However, students have often had a relatively negative perception of their institution's application and readiness for online learning during the pandemic (Laksana, 2021; Martin, Stamper & Flowers, 2020), whereas, in contrast, most authorities and institutions have been confident in their ability to implement online education. Such paradox has led me to reflect on the underlying reasons for the under-preparedness of students, and one of my assumptions is that a lack of confidence in applying digital skills in the real-life context could be a vital factor.

The reflection resonates with the concept of competency-based education. In terms of its definition, competency-based education is a student-centred, outcome-orientated, and dynamic approach that incorporates the instructions and evaluations on mastery of learning in the real-world context (Gervais, 2016). The United Nations (UN) has proposed 17 Sustainable Development Goals (SDGs). In the education sector, SDG-4 has introduced the objective to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN, 2015, p.17). The Organization for Economic Co-operation and Development (OECD) and the Partnership for 21st Century Skills (P21) have reiterated the necessity of competency-based education, instead of mere knowledge transfer for lifelong learning (Paek, Um & Kim, 2021). Digital competency has been presented as one of the most crucial competencies for life in the twenty-first century (OECD, 2010). Following the calls of these influential global organisations, multiple countries have included and prioritised competency-based education in their pedagogical plans (Pichette & Watkins, 2018; State Council of the PRC, 2021). Moreover, some countries and territories have introduced a digital competency framework to support citizens' digital competence building. Examples include the European Union (Vuorikari et al., 2016) and Quebec (Karsenti et al., 2020). In the context of the pandemic, digital competency has become pivotal in large-scale social digitalisation due to the online education plan and the need to prepare students to continue uninterrupted learning. Given these issues, this study was designed to examine whether students have received the required education to enhance their digital competency and to

investigate how they perceive the development and challenges regarding digital environments in the context of the COVID-19 pandemic.

Literature Review

From literacy to digital competency: progressing definitions

The concept of digital competency has been continuously evolving both within academia and in various international institutions. In this process, terms such as digital literacy, ICT skills, and 21st-century skills, have often been used interchangeably (Ilomäki, Kantosalo & Lakkala, 2011). The commonly identified synonym for digital competency is digital literacy. This terminology can be traced back to the early 1990s when Gilster (1997, cited in Calvani et al., 2008) adopted the term digital literacy to emphasise the capability for critical thinking instead of mere skills. Subsequently, a considerable amount of research has treated digital literacy and digital competency as a single concept (Adeyemon, 2009; American Library Association, 2000; Krumsvik, 2008; Otieno, 2020).

Spante et al. (2018) suggested that the definition of digital competency involves the use of digital literacy, and that digital literacy underpins the concept of digital competency. However, Falloon (2020) argued that while digital literacy focuses on the knowledge and skills for applying ICT resources, digital competency includes a broader conceptualisation which embraces digital literacy and extends it to social and emotional mindsets. Similarly, Janssen et al. (2013) implied that the term competence implies a more comprehensive educational conceptualisation underpinned by systematic knowledge, skills and attitudes. Yet, despite these debates, the most generally accepted definition of digital competency is that proposed by the European Parliament and the Council that involves "...the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet" (European Parliament and the Council, 2006, cited in Janssen et al., 2013, p.473). While the scholars have still noticed the complexity and multifacility of digital competency; therefore, different frameworks, containing merged pivotal elements, have been continually refined and extended (Ferrari, Punie & Redecker, 2012; Karsenti et al., 2020).

The underlying reasons for the challenge in producing a consensual definition relate to the constant evolution of society and culture based on rapid technological change (Helsper, 2008; Ilomäki, Kantosalo & Lakkala, 2011). In addition, some policy-related reports have suggested that the approaches to embedding digital competency in the curricula should be dynamic and adjustable to enable learners to adapt to the most contemporary technologies (Ala-Mutka, Punie & Redecker, 2008). Such plurality also brings the dilemma of how to synthesise such a wide variety of views. Reflecting this challenge, Solove (2007) commented that the commonality can be inherently related to other issues in many different ways, and thus, if one chooses to adopt a broad concept, it risks being over-inclusive or too vague.

Digital competency as a multidimensional concept: sub-disciplines and assessments

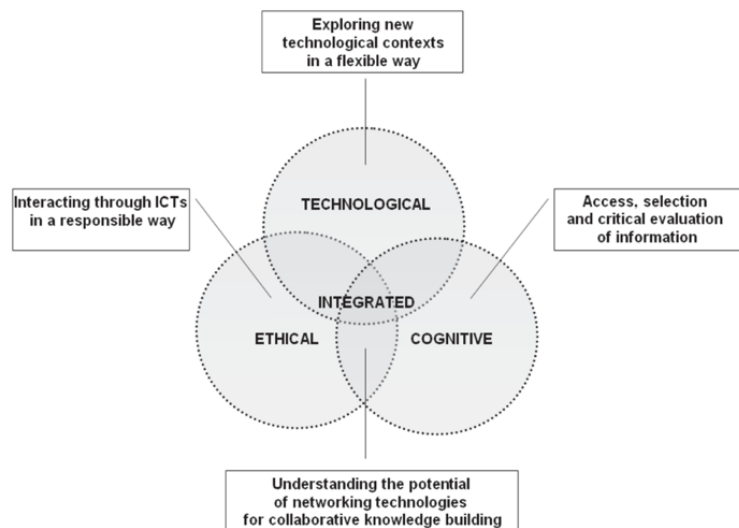
The European Commission introduced a self-assessment grid in its DIGCOMP study, which serves as a tool for individuals to depict their own level of digital competence (Ferrari & Punie, 2013). From DIGCOMP 1.0 to DIGCOMP 2.0, Vuorikari et al. (2016) have further developed an updated vocabulary choice to scope competency more comprehensively. For instance, they have introduced the term 'digital environment' to include more aspects of

digital actions. However, the competency areas have not changed, despite the slight modifications to accommodate new technologies. The DIGCOMP projects have identified five areas of competency - information, communication, digital content-creation, safety, and problem-solving. The first three areas tend to be linear, while the latter two are more transversal (Ferrari & Punie, 2013; Vuorikari et al., 2016).

Calvani et al. (2008) remarked that digital competency is a rather complex concept that integrates multiple abilities and skills in a way that cannot be quantified with a single test (see Figure 1). Likewise, Aviram and Eshet-Alkalai (2006) conceived digital competency as a three-dimensional hybrid concept involving technical-procedural, cognitive and emotional-social skills.

Figure 1

Intersecting areas of digital competency

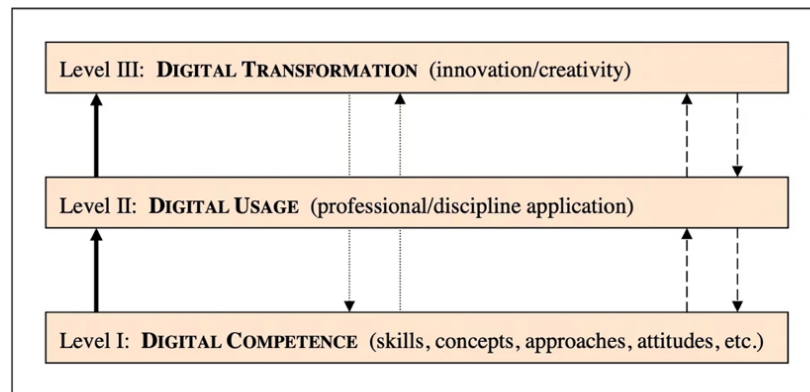


Source: Calvani et al. (2008, p.187)

Although Martin & Grudziecki (2006) conceived digital competency as a more fundamental level of digital development, their model implies fluidity and transferability among cognitive, functional, and creative aspects (see Figure 2).

Figure 2

Levels of digital development



Source: Martin & Grudziecki (2006, p.255)

Calvani et al. (2008) stated that the selection of the tools used to assess digital competency is an intricate process due to its complexity, and some instruments can only provide a partial or temporary indication. Although various assessment tools have been produced, such as the National Educational Technology Standards (NETS), the information literacy standards promoted by the Association of College and Research Libraries (ACRL), iSkills, suggested by Educational Testing Service (ETS), and PISA (Iannuzzi, 2000; Niederhauser & Lindstrom, 2006; Sparks, Katz & Beile, 2016), most assessment grids concentrate on skill-based scales. Furthermore, some target populations below post-secondary education.

Covello and Lei (2010) claimed that if a single assessment instrument could incorporate the integration of multidimensional digital competency, it would be able to produce more holistic results. The perception of digital competence could also vary if different self-assessment measures are adopted (Zhao, Llorente & Gómez, 2021). From the numerous existing studies on digital competency, in this study, I have adopted six main sub-disciplines adapted from Covello and Lei (2010). These encompass the dimensions mentioned in the literature, which taken together can broadly represent this multifaceted concept. These six sub-disciplines are: *Information Literacy* (Ferrari & Punie, 2013; Katz, 2005; Van Laar, 2020); *Computer Literacy* (Bawden, 2001; Martin & Grudziecki, 2006); *Media Literacy* (Buckingham, 2003; Hidayat, 2021; Jenkins et al., 2006); *Communication Literacy* (Vuorikari et al., 2016; Yu et al., 2010); *Visual Literacy* (Hattwig et al., 2013; Laksana, 2021); and *Technology Literacy* (Davies, 2011).

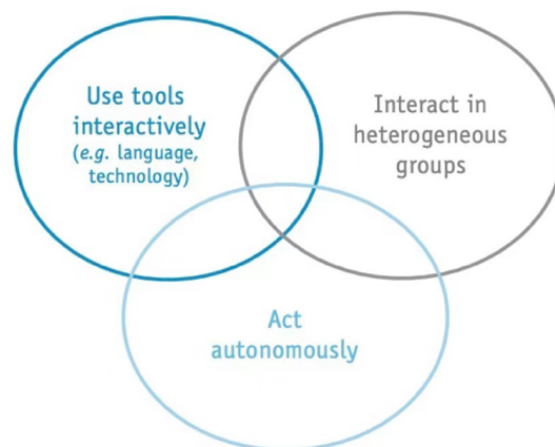
Connections of digital competency to the overall competencies

The OECD (2005) project, Definition and Selection of Competencies (DeSeCo), constitutes a conceptual framework for navigating competency development. Figure 3 below displays the three broad categories of critical competencies. Digital competency plays a pivotal role in general competency. This is specifically the case in relation to the first key competency identified by DeSeCo, which highlights the use of technology as a new means to interact and communicate (Ilomäki, Kantosalo & Lakkala, 2011). Additionally, competency-based education aims to contribute to lifelong learning, and research has shown that increased digital competency can indeed aid such learning and provide career advantages (Bundy,

1998). Katz (2005) also stated that ICT assessment enables institutions and educators to provide support for digital initiatives and can guide curricula innovation and evaluation. Furthermore, not only should digital competency be included in the curriculum due to its advantages, but certain other activities which confer digital competency should also be included (Martin & Grudziecki, 2006). Learning digital competency within the educational context is a necessary paradigm which should be adopted (Ala-Mutka, Punie & Redecker, 2008; Martin & Grudziecki, 2006).

Figure 3

The DeSeCo Project's conceptual framework for key competencies



Source: OECD (2005, p.5)

Although digital education has normally been taken to have the same meaning as online education or e-learning (Posadzki et al., 2019), in this study, this term is used to refer to the teaching and learning of digital skills and competencies in educational settings. This is similar to Buckingham's (2003) comments on media education. From this perspective, digital competency is therefore the outcome of what learners acquire in terms of digital skills and awareness. Based on this working definition, Sá and Serpa (2020) suggested that it is necessary to endow students with digital competencies via formal digital education. Furthermore, Kyaw et al. (2019) indicated that digital education could serve as an effective measure to enhance students' communication skills. Additionally, Buckingham (2003) indicated that equipping students with essential ICT skills should be incorporated into the curriculum as educators must respond to the technological development encountered by students in their daily lives. Finally, Edwards (2015) emphasised that development of digital competency also links to the social and cultural contexts.

However, Jenkins et al. (2006) argued that there are three core problems in digital education. The first is the participation gap, which is also commonly referred to as the digital divide. The digital divide is interrelated with digital competency since the concept concerns the discrepancy in digital access among social groups, resulting in gaps in their levels of digital competency (Ilomäki, Kantosalo & Lakkala, 2011). This issue arises from differential access to digital devices and to the knowledge and proficiency necessary to use digital tools (Van Dijk, 2006). Edwards (2015, p.268) has further revealed the problems with "hidden curricula", suggesting that there are some knowledge and resource gaps between different socio-

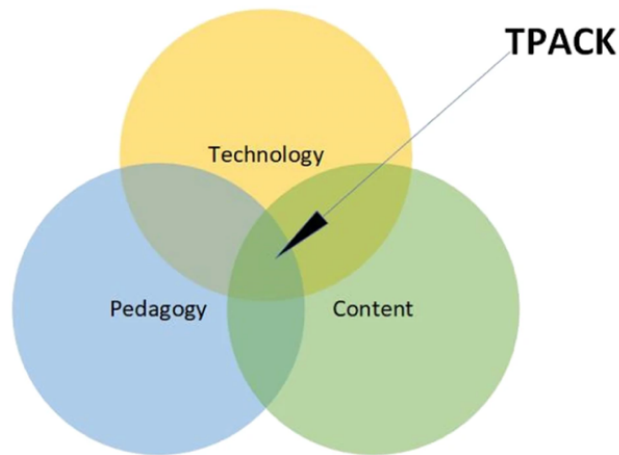
economic classes that are hard to bridge. Jenkins et al. (2006) concluded that tackling the digital divide relies less on technology and more on delivering the requisite skills. The second problem is the transparency problem which relates to the frequent inability of young people to apply critical thinking in the digital world (Jenkins et al., 2006). This issue links to the cognitive dimension of digital competency, as Calvani et al. (2008) noted. Buckingham (2003) also remarked that some of today's digital cultures tend to be unrealistic, and that students need to be able to distinguish between the virtual and real-world and be capable of validating different cultures. Lastly, the ethical challenge reflects the ethical dilemmas that the digital environment often presents young people with (Jenkins et al., 2006). Calvani et al. (2008) investigated the ethical dimension of digital competency, and proposed that learners should be capable of reflecting on their ethical choices and interacting with others constructively and with a sense of responsibility while in the digital environment (Jenkins et al., 2006).

Mapping digital competency to the COVID-19 pandemic: significance and practicality

Due to COVID-19, online learning has become a prerequisite (Mishra, Gupta & Shree, 2020). However, digital competency, especially in higher education, requires more attention (Sillat, Tammets & Laanpere, 2021). Sá and Serpa (2020) have claimed that schools need to reinvent themselves to provide students and teachers with adequate skills to cope with the radically altered situation the pandemic has brought about. However, many students have complained about online learning since they lack the necessary digital competencies in this unprecedented situation (Hidayat, 2021). The divide in accessing the digital environment is one cause of students' unpreparedness. Laksana (2021) pointed out that a proportion of students with inadequate digital infrastructure perceive the pandemic as having caused significant disruption to their standard study patterns. Moreover, Dhawan (2020) indicated that teachers could make more efforts in the online teaching process to support students in coping with the potential obstacles. Additionally, a framework has emerged which encapsulates the knowledge and skills which are needed. This is the Technological Pedagogical Content Knowledge model (TPACK) (see Figure 4). This model indicates that technology should be integrated within the pedagogical context, and it comprises a three-way lens to support students during the pandemic (Turnbull, Chugh & Luck, 2021).

Figure 4

The TPACK model



Source: Turnbull, Chugh & Luck, 2021, p.6403

Put simply, digital education is vital in the context of COVID-19 since it enables students to build acquaintances and develop critical thinking skills to evaluate information obtained from media platforms (Hidayat, 2021). Burns, Dagnall and Holt (2020) have found that the pandemic has had a considerable impact on students' well-being. The reasons for this range from the negative news from external sources to a lack of intrinsic motivation. Therefore, many students have become vulnerable to the digital environment due to the excessive usage necessitated by the pandemic. However, Hidayat (2021) has stated that digital education could minimise negativities such as lazy learning and even cyberbullying by guiding students to adopt higher ethical standards.

Yet despite the significance of digital competency during the pandemic, Lloyd et al. (2012) illustrated four impediments to adapting online education and transferring advanced digital education to higher education: interpersonal barriers, institutional barriers, training and technology barriers, and cost/benefit barriers. These barriers tend to be recognised by both students and teachers, and they contribute to the reasons for the unreadiness for online learning (Lee et al., 2011). However, Turnbull, Chugh and Luck (2021) have indicated that technologies could serve as a transitional tool to overcome the difficulties created by the pandemic. Besides, Lameris and Moumoutzis (2021) have suggested that digital education during the pandemic could offer a resolution to some of these issues, such as teaching students with specific devices to enhance problem-solving.

Methodology

This research sought to answer the following research question: How do higher education students evaluate their digital competency during online education in the context of the COVID-19 pandemic?

This overarching question was supported by three subsidiary questions:

1. Do students interact with digital environments more frequently after the outbreak of the COVID-19 pandemic?

2. How prepared and confident do students feel regarding multiple sub-disciplines of digital competency, and what role has digital education played in supporting students during the pandemic?
3. What opinions do students have concerning the significance of digital competency during online education, and which areas do they believe are inadequate in digital education?

The study opted for a mixed-methods approach as it allows for a more extensive understanding of research questions and yields more complex insights (Cohen, Manion & Morrison, 2018). Considering practicalities, the research design involved two phases which adopted quantitative and qualitative approaches, respectively. Quantitative data was collected from online questionnaires completed by 125 higher education students via social media platforms, predominantly WeChat and WhatsApp. The main part of the questionnaire was designed to allow the participants to undertake critical self-evaluation with reference to the *Sub-Disciplines* as detailed by Covello and Lei (2010) and the *Components of ICT literacy* as presented by Katz (2005). The questions comprised a 5-point Likert scale from "extremely incompetent" to "extremely competent" to allow participants to self-reflect on multiple statements regarding their digital competency. Hafner and Hafner (2003) have indicated that self-assessment can generate more authentic results. The second phase, qualitative data collection, was generated through online semi-structured interviews with six higher education students from different years of study, different higher education institutions, and different countries; hence to represent the overall population as best as possible. Interviews were conducted via Zoom to allow synchronous interviews by videoconferencing which otherwise would not have been possible due to the pandemic-related restrictions (Olliffe et al., 2021).

The quantitative dataset was checked prior to the analysis to ensure that the respondents had completed the consent form and had provided a complete dataset. Five of the questionnaires were invalid as the participants failed to explicitly provide their consent. Another 72 questionnaires with missing answers or which were otherwise incomplete were excluded from the analysis. The remaining 48 valid responses were transferred to SPSS (11 males, 34 females, 3 non-binary; 37 undergraduates, 4 postgraduates, 7 doctorates; $Mage = 21.60$, $SD = 2.64$, range 18-30). A within-subjects ANOVA was conducted to compare the mean duration, following by the descriptive data of participants' evaluations of different sub-disciplines of digital competency. Finally, between-subjects ANOVAs were performed to compare the students' perceptions of digital education from three stages and the average scores of students' self-evaluation. A p-value that was lower than 0.05 would justify the significance of the test (Dahiru, 2008). The transcripts of the interviews were processed through thematic analysis and the identified themes were discussed collectively alongside the quantitative data to allow conclusions to emerge.

Both research phases strictly adhered to BERA's ethical educational research guidelines (BERA, 2018). Sufficient background information was provided with the participants. Furthermore, some research has suggested that the COVID-19 pandemic has been detrimental to students' psychological well-being in various ways (Burns & Holt, 2020; Cao et al., 2020). Therefore, extra care was taken when phrasing the questionnaire to avoid touching upon any sensitive topics.

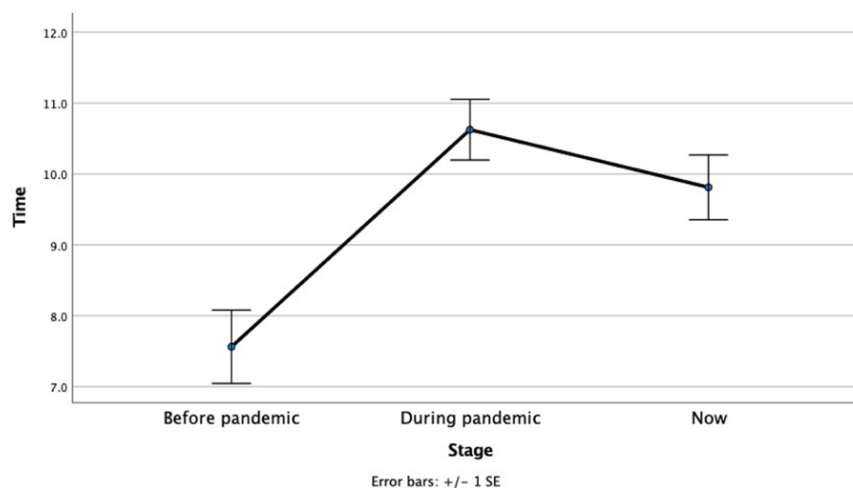
Findings and Discussion

Digital usage in the context of the pandemic

Although there is the natural perception that students have interacted with the digital environment more frequently during the pandemic (Mishra, Gupta & Shree, 2020; Pokhrel & Chhetri, 2021), it is imperative to first assess whether it is genuinely the case that students have used digital devices more often. To do so, I compared the mean time duration across three periods, before the pandemic, during the pandemic, and now. The statistics show that students have spent much more time on digital devices during the pandemic ($M = 10.63$, $SD = 2.97$) than before ($M = 7.56$, $SD = 3.58$). Meanwhile, their current digital usage ($M = 9.81$, $SD = 3.17$) remains high. Although current use has slightly declined from the pandemic stage, it is still considerably higher than before. A one-way within-subjects ANOVA illustrated that the difference between the mean durations was significant ($F = 37.31$, $p < 0.001$) (see Figure 5). Hence, students spent significantly more time on digital devices after the outbreak of the pandemic.

Figure 5

Line chart for comparison of time duration on digital devices



Likewise, all interview participants stated that they used digital devices more frequently during the pandemic, both for study and daily life. However, they reported some struggles with digital usage during the pandemic. This contrasts with Martin, Stamper and Flowers' (2020) results, who concluded high ratings among students for technology-related competency. Participants B, D, and F were all concerned about the issue of internet access, especially regarding the internet connection in China, where people need a Virtual Private Network (VPN) to access multiple foreign platforms (Tang, 2021).

General issues were identified concerning the platforms and internet connection quality. Budur, Demir and Cura (2021) commented that these problems relate to the change efficacy of higher education, specifically highlighting IT readiness. Dhawan (2020) also acknowledged the problems within educational settings. However, in contrast, he indicated that online learning could help students to reach their full potential by practising their use of technology. Zhao, Llorente and Gómez (2021) have stated that proficient digital usage could

help students maintain their academic performance. Therefore, the results clearly illuminate the importance of digital competency during the pandemic.

Self-assessment of digital competency

All the interview participants described themselves as being digitally competent, although most said this with an unsure tone. Students tend to be confident when talking about their overall competency, whereas when they discuss specific aspects of digital competency, they might show less confidence (Martin, Stamper & Flowers, 2020).

As the definition of digital competency includes the criterion of holding a positive attitude towards digital development (Janssen et al., 2013), the responses by Participants A and E could not necessarily be classified as reflecting adequate digital competency since they revealed a ‘muddle-along’ mentality. However, some other responses revealed forward-looking attitudes.

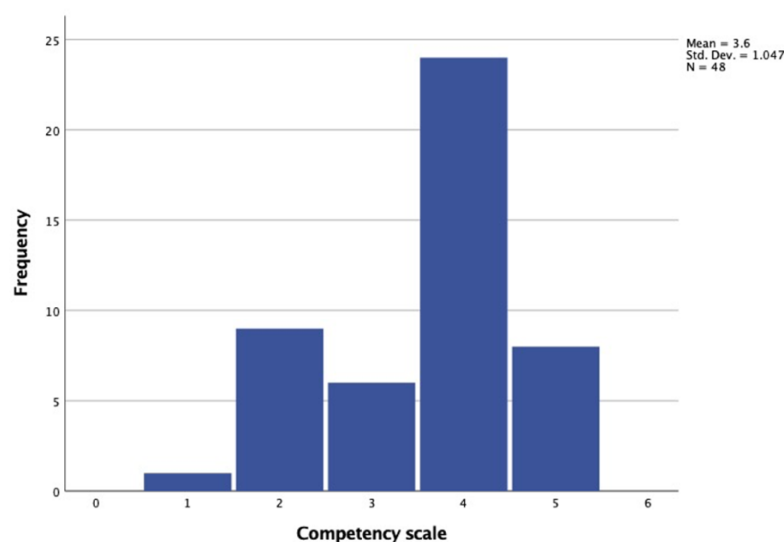
The questionnaire which involved the six sub-disciplines of digital competency adapted from Covello and Lei (2010) asked the participants to conduct a self-assessment. Semantic differential-based scales were adopted to show the students’ perceived level of digital competency (1 = extremely incompetent; 2 = somewhat incompetent; 3 = neither competent nor incompetent; 4 = somewhat competent; 5 = extremely competent).

Information Literacy

The statistics showed that the students felt confident with information literacy ($M = 3.6$, $SD = 1.05$), and 50% of the respondents chose "somewhat competent" to describe their competency (see Figure 6).

Figure 6

Histogram illustrating the frequency distribution of Information Literacy score



The interview responses elaborated the reasons for the students' confidence in information literacy. For instance, some mentioned that they had previously accumulated adequate

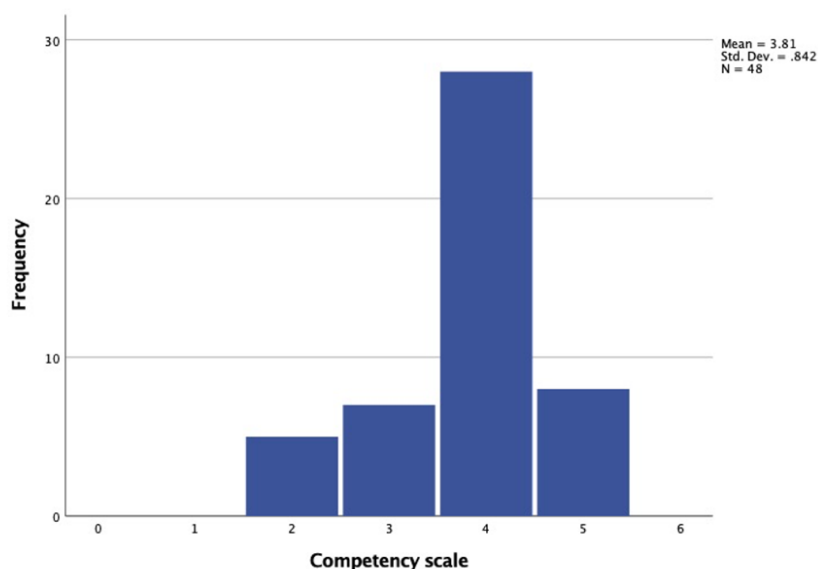
experience in terms of locating and analysing information. Therefore, the pandemic had not had a great effect. The participants' responses accorded with Bawden (2001), who has described information literacy as a transformation from traditional libraries to greater use of digital resources. However, information literacy should be more than what the participants perceived; it also includes generating innovative content from the information collected (Katz, 2005). The potential reasons for the wide range of the responses could be that some students hold a more comprehensive characterisation of information literacy.

Computer Literacy

Students' self-assessment in computer literacy demonstrated the highest mean score among all the scales ($M = 3.81$, $SD = 0.84$). No students selected "extremely incompetent" for this sub-discipline, and 58% of the students considered themselves "somewhat competent" (see Figure 7).

Figure 7

Histogram illustrating the frequency distribution of Computer Literacy score



Responses from the interviews underpinned the students' confidence in their computer literacy. All the participants reported that they have adequate skills to use digital devices and software, which satisfied the criteria that Martin and Grudziecki (2006) suggested for being competent in computer literacy. However, some students raised the issue that certain software is particularly essential for their programme content or career, and that they often feel a lack of mastery when they first encounter such new software.

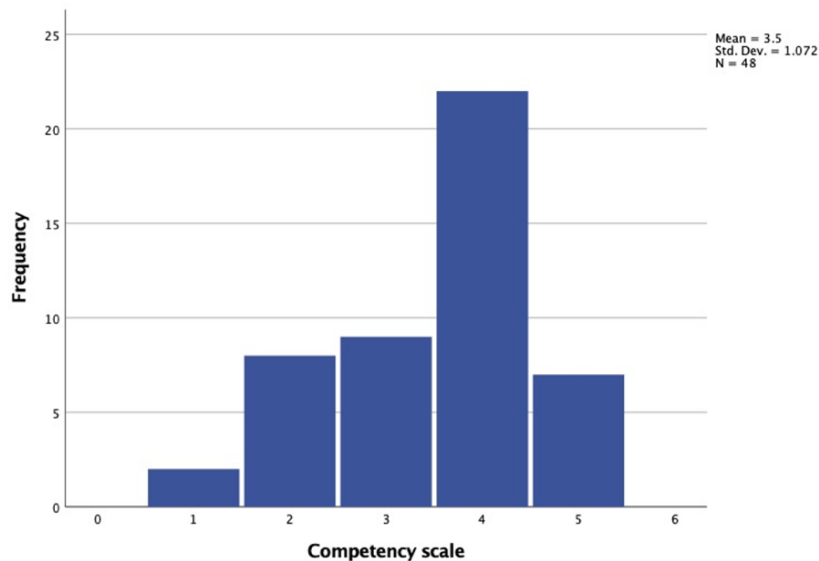
Lameras and Moumoutzis (2021) have contended that being ICT proficient is necessary in the 21st-century as careers are more demanding than ever before. Nevertheless, Medeiros, Ramalho and Falcão (2018) have indicated that students may need more instructions from their teachers to develop their programming skills, and it is normal for beginners to find ICT challenging.

Media Literacy

Students also displayed high confidence in media literacy ($M = 3.5$, $SD = 1.07$); 60% of respondents selected either "somewhat competent" or "extremely competent" for this sub-discipline (see Figure 8).

Figure 8

Histogram illustrating the frequency distribution of Media Literacy score



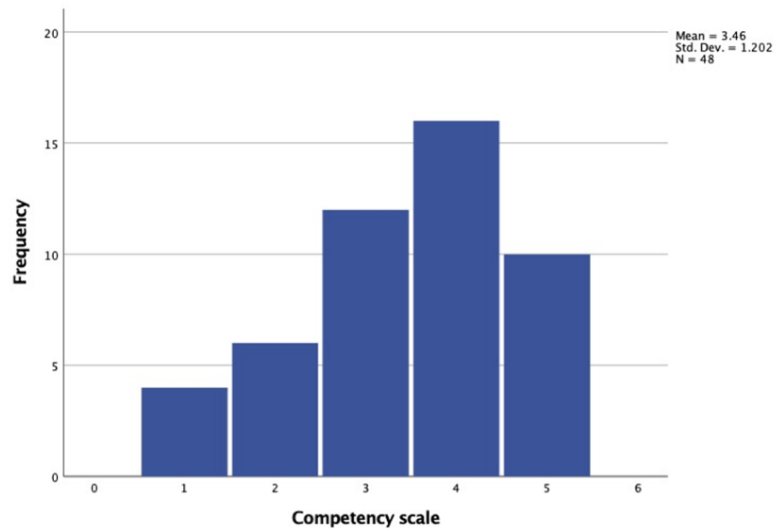
Media literacy was mainly discussed in terms of two aspects in the interviews, namely creativity and criticality, which Buckingham (2003) stated are the core competencies of media usage. Jenkins et al. (2006) presented an informal learning culture called 'affinity spaces', which enable people to engage and participate more actively in the learning process. They stated that such practices can consolidate the knowledge obtained from textbooks. Hence, remaining creative and motivated potentially enhances academic attainment. Furthermore, they also suggested that the massive amount of false information in the digital environment requires individuals to stay alert and critical when identifying and evaluating information. Participant A provided her own experience of her media competency:

Communication Literacy

The data surprisingly showed the lowest mean score in communication literacy ($M = 3.46$, $SD = 1.20$). Although 21% of the students chose "extremely competent", which was the largest score among the six, 25% of the students selected "neither competent nor incompetent", which was also the largest (see Figure 9).

Figure 9

Histogram illustrating the frequency distribution of Communication Literacy score



The widespread response range could be attributed to the ambiguity of how to define interaction during the pandemic. Vuorikari et al. (2016) have suggested that partaking in communities is vital for communication literacy. However, some of the students reported that they felt they did not belong or were even alienated from the community during the pandemic.

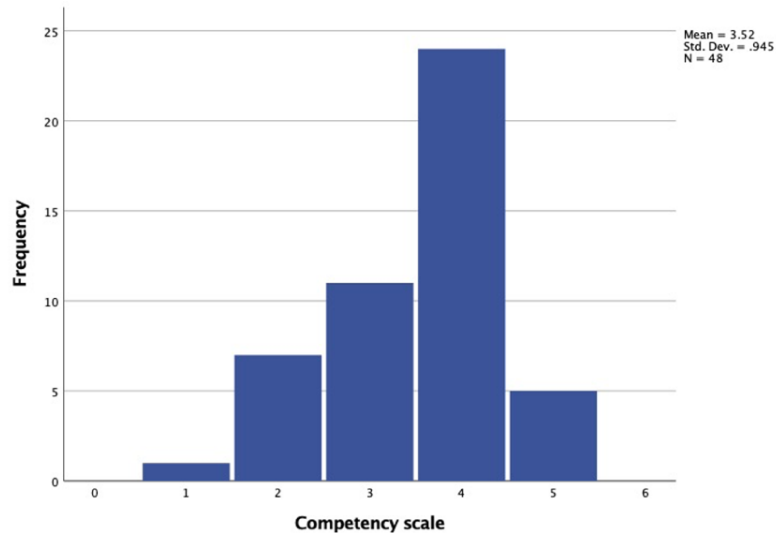
Nevertheless, some of the students reported they have seized the chance to develop their communication skills, which verified Dhawan's (2020) description of the pandemic as an opportunity to enhance students' competencies.

Visual Literacy

The statistics illustrate that the students also felt confident in visual literacy ($M = 3.52$, $SD = 0.95$), and only 2% of the students chose "extremely incompetent" (see Figure 10).

Figure 10

Histogram illustrating the frequency distribution of Visual Literacy score



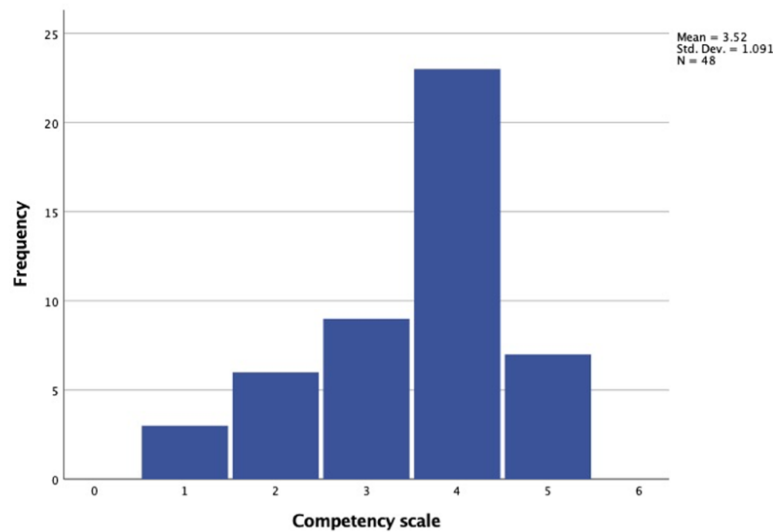
Although some literature has emphasised that visual literacy plays a vital role in individual digital competency (Hattwig et al., 2013; Laksana, 2021), the interview participants tended not to mention visual literacy. The underlying reason might be that visual cues are commonly uncovered in daily life, and the students therefore regarded them as instinctive reactions to interpret the visual messages.

Technology Literacy

The students' self-assessment scores exhibited high confidence in technology literacy ($M = 3.52$, $SD = 1.09$). Although this had the same mean score as visual literacy, the result was more widespread, indicating that the students tended to be unsure about their perception of technology literacy (see Figure 11).

Figure 11

Histogram illustrating the frequency distribution of Technology Literacy score



Interview responses were also polarised. Some participants said they have sufficient strategies for using digital devices effectively. However, some other participants reported that they lack relevant skills and need to improve in this area.

Tang et al. (2021) have identified the significance of motivation in online education, as motivation influences students' attitudes and determination in their learning process. Meanwhile, both the positive feedback from the participants who enjoy technology literacy and the desire of those who currently lack the necessary techniques to improve their skills support Davies's (2011) arguments that technology literacy benefits individual performance.

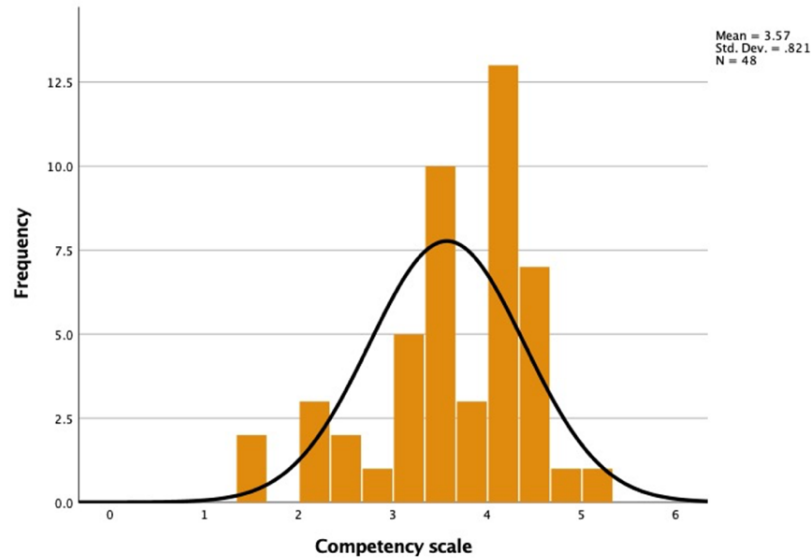
Overall Competency

The overall competency score for each participant was calculated by averaging their six scores from across the sub-disciplines ($M = 3.57$, $SD = 0.82$). Generally speaking, the results showed that the students perceived their digital education as somewhere between "neither competent nor incompetent" and "somewhat competent" (see Figure 12), indicating their digital preparedness for the pandemic to some extent.

The qualitative results were also aligned with the quantitative results, as all the interview participants claimed that they were digitally prepared for the pandemic, as digital skills are transferrable skills which allowed them to be adaptable to different situations (Turnbull, Chugh & Luck, 2021). Although some challenges have emerged, since the consequences of the pandemic have been exceptional, Dhawan (2020) asserted that online education could be a "panacea" for the pandemic. The e-learning process has allowed higher education institutions to contemplate their educational paradigms and for students to reconsider their learning patterns (Dhawan, 2020).

Figure 12

Histogram with average normal distribution of the overall competency



Perspectives on digital education

Tang (2021) has indicated the significance of digital education and support during the pandemic. Additionally, Buckingham (2003) has shown that digital competency can be formed via a series of pedagogical actions. Therefore, I conducted three between-subjects ANOVAs to identify any potential relationships between the students' experiences and intentions in digital education and their overall competency. I compared the students' overall competency to the responses to the three questions shown in Figures 13, 14, and 15. No significant differences were found in the level of formal digital education received ($F = 1.25$, $p = 0.296$), the level of further digital education and support during the pandemic ($F < 1$), or the level of intention to receive more digital education ($F = 1.62$, $p = 0.210$).

Figure 13

Bar chart comparing overall competency score divided by the level of formal digital education received

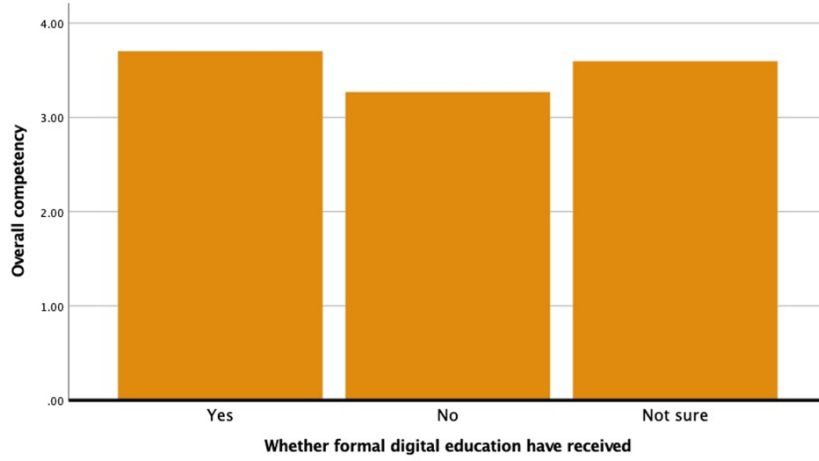


Figure 14

Bar chart comparing overall competency score divided by the level of further digital education received during the pandemic

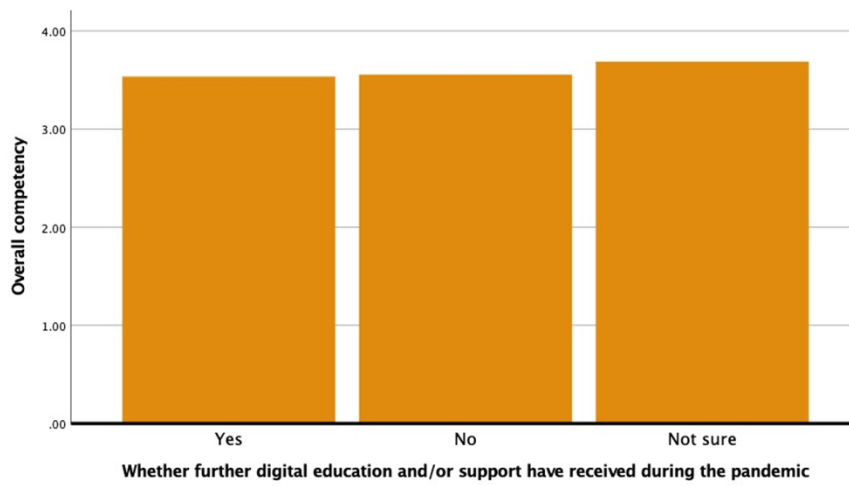
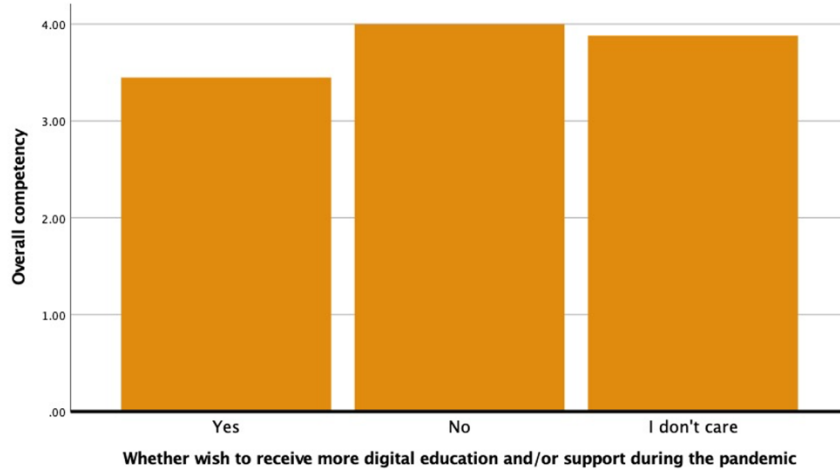


Figure 15

Bar chart comparing overall competency score divided by the level of intention to receive more digital education



One possible explanation could be uncertainty concerning the definition of digital education since most scholars regard the term to have the same meaning as online education (Edwards, 2015; Kyaw et al., 2019; Lee et al., 2011). The results show that 15% of students selected "not sure" for the question about whether they had received digital education. Another explanation was revealed by the interview responses. When the participants were asked how they developed their digital competency, the most common answer was self-learning or that their competency had developed naturally.

These statements verify the view that Generation Z are "digital natives" (Tejedor et al., 2020). For instance, Kirschner and De Bruyckere (2017) have implied that the younger generation has grown up with sophisticated digital environments and are therefore more digitally savvy than their predecessors. Nevertheless, Shatto and Erwin (2016) have claimed that the so-called digital natives might lack the critical thinking skills necessary to validate the information they obtain, suggesting the significance of digital education.

Some participants also claimed that educational settings assist in developing digital competency, and most of the participants stated that it is crucial to include digital education in the formal curriculum. Buckingham (2003) stated that digital education equips learners with critical attitudes towards online information, which means that digital education should serve as an effective tool to mitigate the potential pitfalls faced by Generation Z. Moreover, Xiao (2019) has claimed the overall tendency of digitisation will continue to accelerate, so higher education should be at the forefront of incorporating digital education into educational plans to enable innovation and talent cultivation in the 21st century.

Conclusion

In conclusion, this research has shed light on the significance of digital competency and the imperative of digital education, both during the pandemic and in the post-pandemic era by reviewing students' perceptions regarding both aspects. Due to online education, digital competency has become a vital component of individual competency. Thus, this study

conducted mixed-methods research to investigate students' perspectives and experiences. As a preliminary study, it contributes to the digital competency framework adopted by higher education for revising and adding certain new criteria that have emerged during the pandemic. The study's results highlight the deficiency in digital infrastructure. Institutions should address this by providing students certain essential tools (Rafiq et al., 2021). The most debatable sub-disciplines were communication and technology literacies, which should raise awareness of their adaption in the context of the COVID-19 pandemic. Additionally, this study also suggested the significance and necessity of critical thinking skills in digital environments.

However, despite the value of the study's findings, some limitations must be acknowledged. For instance, the number of participants was lower than expected, while the scale of the research was overly broad as it did not specify a target group. Control of the scale of the study and the other variables would have increased the generalisability of the research.

Future research could adopt this self-assessment instrument to measure students' perceptions of their digital competency. Future validation studies of the assessment grid would also be valuable to confirm its reliability, and to compare and contrast it with other previously developed self-assessment grids. Additionally, future studies could target a specific demographic group or educational setting to control the variables in different pedagogical contexts (Xiao, 2019).

Acknowledgement

This study was initiated during the time studying in the Institute of Education at University College London. I would like to express my sincerest appreciation to my undergraduate dissertation supervisor, Dr Olga Cara, the lecturers who inspired me and guided me through the study, Dr Will Brehm and Dr Nicole Brown, and my family and friends, especially Xuran Fu, whose constant encouragement and unwavering belief in me have been pivotal to my work. My gratitude also goes out to all the participants in this study for their time and contributions.

References

- Adeyemon, E. (2009). Integrating digital literacies into outreach services for underserved youth populations. *The reference librarian*, 50(1), 85-98.
<https://doi.org/10.1080/02763870802546423>
- Ala-Mutka, K., Punie, Y., & Redecker, C. (2008). Digital competence for Lifelong Learning. Luxembourg: Office for Official Publications of the European Communities.
<http://ftp.jrc.es/EURdoc/JRC48708.TN.pdf>
- American Library Association. (2000). Information literacy competency standards for higher education. <http://hdl.handle.net/10150/105645>
- Aristovnik, A., Keržič, D., Ravšelj, D., Tomaževič, N., & Umek, L. (2020). Impacts of the COVID-19 pandemic on life of higher education students: A global perspective. *Sustainability*, 12(20), 8438. <https://doi.org/10.3390/su12208438>
- Aviram, A., & Eshet-Alkalai, Y. (2006). Towards a theory of digital literacy: three scenarios for the next steps. *European Journal of Open, Distance and E-Learning*, 9(1).
<https://old.eurodl.org/?p=archives&year=2006&halfyear=1&article=223>
- Bawden, D. (2001). Information and digital literacies: A review of concepts. *Journal of Documentation*, 57(2), 218-259. <https://doi.org/10.1108/EUM0000000007083>
- British Educational Research Association [BERA] (2018). *Ethical Guidelines for Educational Research*. (Fourth ed.). London.
<https://www.bera.ac.uk/publication/ethicalguidelines-for-educational-research-2018>
- Buckingham, D. (2003). *Media education : Literacy, learning and contemporary culture*. Polity Press.
- Budur, T., Demir, A., & Cura, F. (2021). University readiness to online education during Covid-19 pandemic. *International Journal of Social Sciences and Educational Studies*, 8(1), 180-200. <https://doi.org/10.23918/ijsses.v8i1p180>
- Bundy, A. (1998). Information Literacy: The Key Competency for the 21st Century.
<http://educate.lib.chalmers.se/IATUL/proceedcontents/pretpap/bundy.html>
- Burns, D., Dagnall, N., & Holt, M. (2020). Assessing the impact of the Covid-19 pandemic on student wellbeing at universities in the UK: A conceptual analysis. *Frontiers in Education (Vol. 5)*. Frontiers Media. <https://doi.org/10.3389/educ.2020.582882>
- Calvani, A., Cartelli, A., Fini, A., & Ranieri, M. (2008). Models and instruments for assessing digital competence at school. *Journal of E-learning and Knowledge Society*, 4(3), 183-193. <https://www.learntechlib.org/p/43442/>
- Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*, 287, 112934.
<https://doi.org/10.1016/j.psychres.2020.112934>

- Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education / Louis Cohen, Lawrence Manion and Keith Morrison*. (Eighth ed.). Routledge.
- Covello, S., & Lei, J. (2010). A review of digital literacy assessment instruments. *Syracuse University, 1*, 31.
https://www.academia.edu/7935447/A_Review_of_Digital_Literacy_Assessment_Instruments?bulkDownload=thisPaper-topRelated-sameAuthor-citingThis-citedByThis-secondOrderCitations&from=cover_page
- Dahiru, T. (2008). P-value, a true test of statistical significance? A cautionary note. *Annals of Ibadan Postgraduate Medicine, 6*(1), 21-26. <https://doi.org/10.4314/aipm.v6i1.64038>
- Davies, R. S. (2011). Understanding technology literacy: A framework for evaluating educational technology integration. *TechTrends, 55*(5), 45-52.
<https://doi.org/10.1007/s11528-011-0527-3>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems, 49*(1), 5–22.
<https://doi.org/10.1177/0047239520934018>
- Edwards, R. (2015). Software and the hidden curriculum in digital education. *Pedagogy, Culture & Society, 23*(2), 265-279. <https://doi.org/10.1080/14681366.2014.977809>
- Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development, 68*(5), 2449-2472. <https://doi.org/10.1007/s11423-020-09767-4>
- Ferrari, A., & Punie, Y. (2013). DIGCOMP: A framework for developing and understanding digital competence in Europe. Luxembourg, Publications Office of the European Union, 2013. <https://doi.org/10.2788/52966>
- Ferrari, A., Punie, Y., & Redecker, C. (2012). Understanding digital competence in the 21st century: An analysis of current frameworks. In: Ravenscroft, A., Lindstaedt, S., Kloos, C.D., Hernández-Leo, D. (eds) 21st century learning for 21st century skills. EC-TEL 2012. Lecture notes in computer science, vol 7563. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-33263-0_7
- Geneva: World Health Organization. (2020). *Novel Coronavirus (2019-nCoV) Situation Report-11*. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200131-sitrep-11-ncov.pdf?sfvrsn=de7c0f7_4
- Geneva: World Health Organization. (2020). *Novel Coronavirus (2019-nCoV) Situation Report-51*. Available at: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200311-sitrep-51-covid-19.pdf?sfvrsn=1ba62e57_10
- Gervais, J. (2016). The operational definition of competency based education. *The Journal of Competency Based Education, 1*(2), 98-106. <https://doi.org/10.1002/cbe2.1011>

- Hafner, J., & Hafner, P. (2003). Quantitative analysis of the rubric as an assessment tool: An empirical study of student peer group rating. *International Journal of Science Education*, 25(12), 1509-1528. <https://doi.org/10.1080/0950069022000038268>
- Hattwig, D., Bussert, K., Medaille, A., & Burgess, J. (2013). Visual literacy standards in higher education: New opportunities for libraries and student learning. *Libraries and the Academy*, 13(1), 61-89. <https://doi.org/10.1353/pla.2013.0008>
- Helsper, E. (2008). *Digital inclusion: An analysis of social disadvantage and the information society*. Department for Communities and Local Government. <http://www.communities.gov.uk/>
- Hidayat, F. P. (2021). Media Literacy Education for Students During Learning Online the Covid-19 Pandemic. *Edunesia: Jurnal Ilmiah Pendidikan*, 2(3), 628-634. <https://doi.org/10.51276/edu.v2i3.182>
- Iannuzzi, P. (2000). Information literacy competency standards for higher education. *Community & Junior College Libraries*, 9(4), 63-67. https://doi.org/10.1300/J107v09n04_09
- Ilomäki, L., Kantosalo, A., & Lakkala, M. (2011). What is digital competence? In *Linked portal*. Brussels: European Schoolnet. <http://linked.eun.org/web/guest/in-depth3>
- Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., & Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Computers & Education*, 68, 473-481. <https://doi.org/10.1016/j.compedu.2013.06.008>
- Jenkins, H., Clinton, K., Purushotma, P., Robinson, A.J., & Weigel, M. (2006). *Confronting the challenges of participatory culture: Media education for the 21st century*, the John D and Catherine T MacArthur Foundation. http://www.digitalllearning.macfound.org/atf/cf/%7B7E45C7E0-A3E0-4B89-AC9C-E807E1B0AE4E%7D/JENKINS_WHITE_PAPER.PDF
- Karsenti, T., Poellhuber, B., Parent, S., & Michelot, F. (2020). What is the Digital Competency Framework?. *International Journal of Technologies in Higher Education*, 17(1), 11-14. <https://doi.org/10.18162/ritpu-2020-v17n1-04>
- Katz, I. R. (2005). Beyond Technical Competence: Literacy in Information and Communication Technology. *Educational Technology*, 45(6), 44-47. <http://www.jstor.org/stable/44429252>
- Kirschner, P. A., & De Bruyckere, P. (2017). The myths of the digital native and the multitasker. *Teaching and Teacher Education*, 67, 135-142. <https://doi.org/10.1016/j.tate.2017.06.001>
- Krumsvik, R. J. (2008). Situated learning and teachers' digital competence. *Education and Information Technologies*, 13(4), 279-290. <https://doi.org/10.1007/s10639-008-9069-5>

- Kyaw, B. M., Posadzki, P., Paddock, S., Car, J., Campbell, J., & Car, L. T. (2019). Effectiveness of digital education on communication skills among medical students: Systematic review and meta-analysis by the digital health education collaboration. *Journal of Medical Internet Research*, *21*(8), e12967. <https://doi.org/10.2196/12967>
- Laksana, D. N. L. (2021). Implementation of online learning in the pandemic covid-19: Student perception in areas with minimum internet access. *Journal of Education Technology*, *4*(4), 502-509. <https://doi.org/10.23887/jet.v4i4.29314>
- Lameras, P., & Moumoutzis, N. (2021). Towards the development of a digital competency framework for digital teaching and learning. *2021 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1226-1232). IEEE. <https://doi.org/10.1109/EDUCON46332.2021.9454027>
- Lee, S. J., Srinivasan, S., Trail, T., Lewis, D., & Lopez, S. (2011). Examining the relationship among student perception of support, course satisfaction, and learning outcomes in online learning. *The Internet and Higher Education*, *14*(3), 158-163. <https://doi.org/10.1016/j.iheduc.2011.04.001>
- Lloyd, S. A., Byrne, M. M., & McCoy, T. S. (2012). Faculty-perceived barriers of online education. *Journal of Online Learning and Teaching*, *8*(1).
- Martin, A., & Grudziecki, J. (2006). DigEuLit: Concepts and tools for digital literacy development. *Innovation in Teaching and Learning in Information and Computer Sciences*, *5*(4), 249-267. <https://doi.org/10.11120/ital.2006.05040249>
- Martin, F., Stamper, B., & Flowers, C. (2020). Examining Student Perception of Readiness for Online Learning: Importance and Confidence. *Online Learning*, *24*(2), 38-58. <https://doi.org/10.24059/olj.v24i2.2053>
- Medeiros, R. P., Ramalho, G. L., & Falcão, T. P. (2018). A systematic literature review on teaching and learning introductory programming in higher education. *IEEE Transactions on Education*, *62*(2), 77-90. <https://doi.org/10.1109/TE.2018.2864133>
- Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open*, *1*, 100012. <https://doi.org/10.1016/j.ijedro.2020.100012>
- Niederhauser, D. S., & Lindstrom, D. L. (2006). Addressing the nets for students through constructivist technology use in K–12 classrooms. *Journal of Educational Computing Research*, *34*(1), 91-128. <https://doi.org/10.2190/E0X3-9CH0-EE2B-PLXG>
- OECD (2005). The OECD Program Definition and Selection of Competencies (2005). *The definition and selection of key competencies*. Executive summary, 30 June 2005. Retrieved from: <http://www.oecd.org/dataoecd/47/61/35070367.pdf>
- OECD. (2010). Are the new millennium learners making the grade?: Technology use and educational performance in PISA 2006. *Educational Research and Innovation*. OECD Publishing, Paris. <https://doi.org/10.1787/9789264076044-en>

- Oliffe, J. L., Kelly, M. T., Gonzalez Montaner, G., & Yu Ko, W. F. (2021). Zoom interviews: Benefits and concessions. *International Journal of Qualitative Methods*, 20, 16094069211053522. <https://doi.org/10.1177/16094069211053522>
- Otieno, D. (2020). Integrating digital literacy in competency-based curriculum. In *Handbook of research on literacy and digital technology integration in teacher education* (pp. 142-155). IGI Global. <https://doi.org/10.4018/978-1-7998-1461-0.ch008>
- Paek, S., Um, T., & Kim, N. (2021). Exploring latent topics and international research trends in competency-based education using topic modeling. *Education Sciences*, 11(6), 303. <https://doi.org/10.3390/educsci11060303>
- Pichette, J., & Watkins, E. K. (2018). *Competency-Based Education: Driving the Skills-Measurement Agenda*. Toronto: Higher Education Quality Council of Ontario.
- Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, 8(1), 133–141. <https://doi.org/10.1177/2347631120983481>
- Posadzki, P., Bala, M. M., Kyaw, B. M., Semwal, M., Divakar, U., Koperny, M., Sliwka, A., & Car, J. (2019). Offline digital education for postregistration health professions: systematic review and meta-analysis by the Digital Health Education Collaboration. *Journal of medical Internet research*, 21(4), e12968. <https://doi.org/10.2196/12968>
- Rafiq, M., Batool, S. H., Ali, A. F., & Ullah, M. (2021). University libraries response to COVID-19 pandemic: A developing country perspective. *The Journal of Academic Librarianship*, 47(1), 102280. <https://doi.org/10.1016/j.acalib.2020.102280>
- Rashid, S., & Yadav, S. S. (2020). Impact of Covid-19 Pandemic on Higher Education and Research. *Indian Journal of Human Development*, 14(2), 340–343. <https://doi.org/10.1177/0973703020946700>
- Sá, M. J., & Serpa, S. (2020). COVID-19 and the promotion of digital competences in education. *Universal Journal of Educational Research*, 8(10), 4520-4528. <https://doi.org/10.13189/ujer.2020.081020>
- Shatto, B., & Erwin, K. (2016). Moving on from millennials: Preparing for generation Z. *The Journal of Continuing Education in Nursing*, 47(6), 253-254. <https://doi.org/10.3928/00220124-20160518-05>
- Sillat, L. H., Tammets, K., & Laanpere, M. (2021). Digital Competence Assessment Methods in Higher Education: A Systematic Literature Review. *Education Sciences*, 11(8), 402. <https://doi.org/10.3390/educsci11080402>

- Solove, D. J. (2007). I've got nothing to hide and other misunderstandings of privacy. *San Diego Law Review*, 44(4), 745-772.
https://heinonline.org/HOL/Page?handle=hein.journals/sanlr44&div=40&g_sent=1&casa_token=Cv_FaepFyBcAAAAA:r42Pc7E4rB9tgrjLyHO3nr0dFU-AGNXiQhoXlbnPun3BCpQ67toKQzHoexmSDDhH9fiKR_Olmg&collection=journals
- Spante, M., Hashemi, S. S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education*, 5(1), 1519143. <https://doi.org/10.1080/2331186X.2018.1519143>
- Sparks, J. R., Katz, I. R., & Beile, P. M. (2016). Assessing digital information literacy in higher education: A review of existing frameworks and assessments with recommendations for next generation assessment. *ETS Research Report Series*, 2016(2), 1-33. <https://doi.org/10.1002/ets2.12118>
- State Council of the People's Republic of China (PRC). (2021). 国务院关于印发全民科学素质行动规划纲要（2021—2035年）的通知 [Notice of the State Council on Issuing the Outline of the National Scientific Literacy Action Plan (2021-2035)]. State Council of the PRC. http://www.gov.cn/zhengce/content/2021-06/25/content_5620813.htm
- Tang, Y. M., Chen, P. C., Law, K. M., Wu, C. H., Lau, Y. Y., Guan, J., He, D. & Ho, G. T. (2021). Comparative analysis of Student's live online learning readiness during the coronavirus (COVID-19) pandemic in the higher education sector. *Computers & Education*, 168, 104211. <https://doi.org/10.1016/j.compedu.2021.104211>
- Tejedor, S., Cervi, L., Pérez-Escoda, A., & Jumbo, F. T. (2020). Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador. *Publications*, 8(4), 48. <https://doi.org/10.3390/publications8040048>
- Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge?. *Education and Information Technologies*, 26(5), 6401-6419. <https://doi.org/10.1007/s10639-021-10633-w>
- UNESCO (2020). COVID-19 Educational Disruption and Response. <https://en.unesco.org/covid19/educationresponse>
- United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. In *Resolution Adopted by the General Assembly. A/RES/70/1*. http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/70/1
shortcomings. *Poetics*, 34(4-5), 221-235. <https://doi.org/10.1016/j.poetic.2006.05.004>
- Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2020). Determinants of 21st-century skills and 21st-century digital skills for workers: A systematic literature review. *Sage Open*, 10(1), 2158244019900176. <https://doi.org/10.1177/2158244019900176>

- Vuorikari, R., Punie, Y., Carretero Gomez, S. & Van Den Brande, G. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens. Update Phase 1: the Conceptual Reference Model*. (EUR 27948 EN). Luxembourg (Luxembourg): Publications Office of the European Union. <https://doi.org/10.2791/607218>
- Xiao, J. (2019). Digital transformation in higher education: critiquing the five-year development plans (2016-2020) of 75 Chinese universities. *Distance Education*, 40(4), 515-533. <https://doi.org/10.1080/01587919.2019.1680272>
- Yu, A. Y., Tian, S. W., Vogel, D., & Kwok, R. C. W. (2010). Can learning be virtually boosted? An investigation of online social networking impacts. *Computers & education*, 55(4), 1494-1503. <https://doi.org/10.1016/j.compedu.2010.06.015>
- Zhao, Y., Llorente, A. M. P., & Gómez, M. C. S. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education*, 168, 104212. <https://doi.org/10.1016/j.compedu.2021.104212>