Chapter

Perspective Chapter: MOOCs to Bridge the Multilevel Digital Divide

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Abstract

Massive open online courses (MOOCs) play a significant role in proliferating universal online education regardless of learners' limitations and backgrounds. Regrettably, the MOOC movement has been challenged by the inequality in accessing essential digital technologies, known as the digital divide. Research has identified multiple forms of digital divide beyond the binary access difference. The evolving forms of the digital divide have been induced in MOOCs due to the access, skill, and outcomes gap, which drives a digital divide cycle. The concept of the multilevel digital divide in MOOCs is a rising concern that demands thoughtful actions by MOOCs stakeholders. This book chapter discusses the intertwined multilevel digital divide and MOOCs and proposes potential solutions to break the digital divide cycle and bridge the gap. Additionally, current MOOCs platforms have digital accessibility issues that hinder learners with disabilities from participating and can result in further inequalities. In order to address the accessibility issues, this chapter describes the application of web content accessibility guidelines and universal design for learning concepts that may assist associated people with MOOCs to bridge the digital divide and promote equitable MOOCs.

Keywords: digital divide, multilevel divide, bridging divide, MOOCs, educational equality, E-learning

1. Introduction

1.1 Equitable learning and MOOCs

The Massive Open Online Courses (MOOC) movement has the potential to bridge the global knowledge divide [1]. MOOCs have revolutionised the notion of accessing education through a wide range of open and distance (ODL) learning approaches [2]. Unlike typical institutional course enrolment, a large number of participants can access MOOCs basis on their demand for knowledge without strict entry requirements, which enables just-in-time knowledge opportunity and promote educational equality [2]. Educational equality has been an integral part of sustainable development that contributes to creating a civilisation that acknowledges social inclusion [3]. United Nations (UN) sustainable development goals (SDGs) incorporated education

as a priority objective defined in SDG goal 4, which aims to "ensure inclusive, equitable, and quality education and promote lifelong learning opportunities for all" (SDG-4). According to Sustainable Development Goal 2030, education is linked to socioeconomic mobility, which can play a crucial role in overcoming poverty [4]. Access to education enhances individuals' ability to escape from poverty. Since their origination, MOOCs have exhibited rapid growth and facilitated universal access to education for anyone from anywhere, regardless of their background [3]. Therefore, individuals can acquire the necessary knowledge and skill through MOOCs, resulting in economic mobility. Particularly, MOOCs widen educational access for all, including individuals with no prior access to education. Overall, MOOCs scaffold the efforts to achieve SDG-4, thus promoting gender equality, social inclusion, and special needs education [5].

1.2 Flexible and open learning opportunities

The core concept of MOOCs is to provide open access to education for all, which emerged from the open educational research (OER) movement [6]. MOOCs are developed adhering to a few fundamental characteristics, which are open, participatory, and distributed [7]. Access to MOOCs is often free of cost and open to individuals who can access the learning contents accommodating necessary devices and the Internet. Participation in MOOCs allows bidirectional interaction for learners to contribute and participate in learning and knowledge sharing. Due to the connective nature of MOOCs, knowledge is shared among the participants in a network. Participants can engage in the learning interaction and access course materials conveniently from anywhere [7]. The flexible characteristics and openness made MOOCs increasingly popular. As a result, MOOCs have grown exponentially in recent years. About a decade ago, more than 160 K registered learners were enrolled in three free Stanford courses, which was the Kickstarter of the modern MOOC movement [8]. According to recent census data, more than 220 million (excluding China) learners are enrolled in 3100 courses and 500 micro-credentials [8].

1.3 Growth of MOOCs

In recent days, many universities have adopted MOOCs, and several unicorn EdTech (Educational Technology) organisations (e.g. Edx, Coursera) revealed themselves with extensive online courses. Looking at the current proliferation of MOOCs may seem that this progress has a long history; however, the transformation of MOOCs happened in the last decade. In 2008, Dave Cormier from the University of Prince Edward Island and Bryan Alexander from the National Institute for Technology in Liberal Education coined the term massive open online course (MOOC) in response to an open online course designed and led by George Siemens of Athabasca University and Stephen Downes of The National Research Council [9]. Afterwards, in 2011, a few interactive teaching videos were created by Stanford University academics and disseminated through open Internet-based platforms supported by cost-free online resources [7]. The MOOCs explosion was initiated in 2011, and Stanford University played a significant role. Later in 2012, Coursera debuted as a commercial MOOCs platform. In the same year, separate non-profit organisations such as Udacity (founded by Sebastian Thrum) and Udemy were founded. MIT and Harvard subsequently combined their MITx platform into EdX [7]. They were followed by the European-based platforms Futurelearn and Iversity. Within

a decade, more than 900 universities have launched free online courses worldwide since Stanford's inception. Many national governments throughout the globe have developed their country-specific MOOC platforms in addition to the more prominent global MOOC platforms (Coursera, edX, FutureLearn), including India, Italy, Israel, Mexico, and Thailand [10]. Consequently, MOOCs opened the opportunity for everyone to choose from a wide range of courses that can contribute to global upskilling and the development of human resources.

1.4 MOOCs for upskilling

MOOCs can play a crucial role in upskilling human resources globally to address the global rise of enhanced employability demand. The world is experiencing high-paced digitalisation where job and career development needs are continuously transforming and require incessant upskilling for individuals to sustain the job market [11]. Due to the immense application of A.I., automation, and robotics, most of the existing workforce has to confront either migration of profession or acquiring new skills to accommodate the contemporary technological ecosystem. The employability characteristics in the workplace are shifting due to the ongoing change in technology, services, and markets, as well as demographic changes in the globe that demand lifelong skill development opportunities [11, 12]. Empirical evidence suggests that the opportunity for skill development influences employability improvement and career sustainability [11]. U.S. labour statistics shed light on this by demonstrating the strong relationship between skill-based education opportunities, employability, and career development [13].

Examples throughout the world demonstrate the need for upskilling to meet current employability requirements, particularly the need for technological skills. For instance, in 2016, there were technical skills shortages in 72% of major enterprises and 49% of Small and Medium Enterprises (SMEs) in the United Kingdom [14]. A similar tendency was also evident in other regions of the globe in a recent survey by the Manpower Group, which found that companies in India (83%), Japan (74%), Taiwan (88%), Hong Kong (83%), and Singapore (84%) were unable to acquire the necessary skilled manpower [15]. According to the survey, digital technology-relevant skills are the most required among the top five demanded job sectors (IT and Data, Sales and Marketing, Operation and Logistics, Manufacturing and Production, Customer service). Similar phenomena have been observed in Europe, a total of 26% of E.U. adult workers lacked the necessary job abilities in 2017, and by 2025, 49% of all job opportunities in the E.U. will need high-level qualifications [16]. Long-term unemployment was observed due to skills shortages and talent mismatch in Australia, which has been a rising concern [11]. In relation to the gap between upskilling and employment, tertiary educational institutions have limitations in adopting the changes swiftly and synchronising with the global economic climate and connecting industry demands [11]. The inadequacy of providing flexible and contemporary skill training can be overcome through MOOCs. According to the available evidence, MOOCs may be an effective way to upskill the workforce [11]. MOOCs can provide a simple, scalable, flexible, and cost-effective method for people and companies to acquire or update skills.

1.5 Equitable access debate in MOOCs

With the increasing Internet penetration and diffusion of information and communication technology (ICT) infrastructure, MOOCs are becoming worldwide

popular among people to participate in open education. Likewise, global evidence indicates that many organisations will widely adopt MOOCs as an applied educational framework [2]. Nonetheless, while being open and free, MOOCs tend to introduce hurdles to potential learners since they may not be available to everyone. In the early stage of the MOOC movement, access to ICT was a significant concern as MOOCs require access to the device and/or the Internet. There is always a concern that certain groups of people will not be able to attend MOOCs due to the access or skill gap.

Although physical access to ICT has significantly improved globally and nations are prioritising bridging the access gap, there is still a controversy that MOOCs are adopted mainly by educated people [5]. This phenomenon can be understood by the Knowledge Gap Theory [17], which suggests that the population with higher socio-economic status tend to access newly infused mass media and information faster than the lower-status group. Those with better educational attainment and adequate digital skills will naturally be ahead in taking advantage of MOOCs. A large number of individuals still need to acquire the fundamental digital competencies required to take advantage of this educational opportunity. Despite having access to ICT, they cannot take advantage of MOOCs or any other digital learning opportunity. Consequently, they cannot convert their digital/online capital to offline capital, which submerges them in a vicious cycle of the digital divide. Research has shown that delivering digital literacy training with the help of MOOCs can bridge the multilevel digital divide and unleash the potential of MOOCs to help the learner acquire the necessary skills for economic mobility [18].

Based on the information above, this chapter describes the challenges of the multilevel digital divide and digital accessibility associated with MOOCs. The chapter also synthesises a wide range of theoretical frameworks to shed light on the multilevel digital divide issues underpinned by MOOCs. In this technological realm, equity challenges in MOOCs cannot be addressed by the dichotomous digital divide concept; instead, MOOCs are emerging with a complex multilevel digital divide. This chapter provides a comprehensive understanding of the multilevel digital divide intertwined with MOOCs and devises how careful design of MOOCs can be used to overcome the multilevel digital divide. Additionally, the current chapter provides a brief guideline to design accessible MOOCs, which are crucial for inclusive practice.

2. Methodology

The methodology employed in this book chapter was a narrative compilation of credible qualitative and quantitative data, along with a comparison of well-established theoretical frameworks within the field of digital divide and MOOCs research. To ensure the credibility and accuracy of the information presented, multiple sources were consulted, including academic journals, government reports, and online databases. The sources were carefully evaluated for their relevance and reliability. The data from the selected sources were then analysed and synthesised, with a focus on identifying common themes and trends. The results of the analysis were used to form the basis of the narrative in this chapter, and the information was presented in a clear and concise manner, with appropriate references and citations provided for each piece of data. To validate the findings, the results were reviewed and checked by independent experts in the relevant field. The findings were then integrated into the narrative of the chapter. This method of data synthesis and integration was chosen to provide a comprehensive and in-depth analysis of the subject while maintaining the narrative structure of the chapter.

3. Challenges in MOOC

Although the proliferation of MOOCs is growing rapidly across the world, many challenges hinder participation in MOOCs based on learners' characteristics and their socioeconomic background [19]. The unavailability of sufficient resources and infrastructure has been seen as a significant barrier to MOOCs for learners from developing countries and least-developed countries (LDCs), as access to devices and the Internet is the mandatory prerequisite to access MOOCs. In developed countries, while Internet coverage has become almost universal to people, developing and least-developed countries are yet striving [20]. At the same time, maintaining quality Internet connection remains a challenge in developing countries and LDCs [21]. Incorporating rich interactive content with high-definition(HD) audiovisual in MOOCs has stressed the need for high-speed Internet connection and requires devices with adequate processing power. However, recent data shows that less than 25% of Internet users from LDCs have access to high-speed broadband Internet [21]. The access gap still seems a significant obstacle for participants from developing and least-developed countries. Nevertheless, there has been a linear increment in global Internet penetration over the past decade, with an average of 60% of the world's population now having access to the Internet and growing rapidly (see **Figure 1**).

When the access gap is closing, new tensions have been raised in the MOOC movement. Several studies claimed that the MOOC movement is challenged by the lack of financial and human resource support from stakeholders [23, 24]. Additionally, the open and cost-free characteristics demotivate stakeholders' intentions from a commercial lens and could induce fear of losing revenue. Due to the public benefit aspect of MOOCs, institutions anticipate income loss if prospective students choose MOOCs. Among many challenges, scholars and experts in this area identified the low completion rate of MOOCs as the notorious factor that strengthens the efficiency debate of MOOCs. The completion rate indicates the percentage of participants who

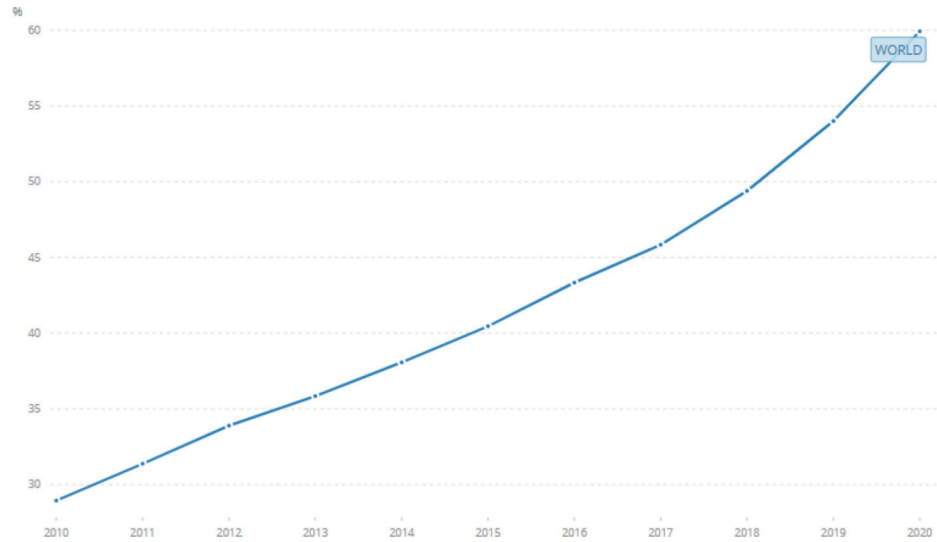


Figure 1.
Progress of internet penetration at the individual (% of the world population) level in the last decade. Source: Illustration from World Bank and ITU data [22].

satisfied the evaluation criteria of a specific course in order to be eligible for certification. Still, MOOCs have a significant dropout rate, with current completion rates ranging from 7 to 13%, depending on the platform [25]. However, scholars argue that considering completion rates as the indicator of MOOCs' overall success might not be an appropriate metric [26]. These completion rates may not take into account the diverse learning objectives of a variety of participants. For example, some participants may need to complete the course to acquire specific required knowledge from certain modules/content.

Before addressing any obstacles in the MOOC movement, it is crucial to address digital access challenges since access to the Internet and a device is a prerequisite for reaping the advantages of MOOCs, which is portrayed as the digital divide. Therefore, associated bodies with MOOCs development should comprehend the digital divide challenges at the outset of developing MOOCs.

4. The concept of a multilevel digital divide

Since the early 1990s, when Internet access and the usage of personal computers began rising, the "Digital Divide" has been a subject of attention, and it has continued to develop ever [27]. The most widespread definition of the digital divide is the gap between those who have access to and use digital technology(e.g. Internet, Devices) and those who do not [28]. Hilbert's descriptive framework describes the divide by differentiating how a person or organisation/community with distinct characteristics utilises various kinds of technology, how they access these technologies using different abilities, and how they achieve different results [29]. The term "Digital Divide" may seem like a technical issue; however, it is a social problem pertaining to the access and usage disparity in ICT, similar to other social inequality. The digital divide phenomena are far more complex and diversified than general dichotomous digital exclusion/inclusion [30]. In the twenty-first century, the digital divide notion is not limited to those with and without access to ICT. Multiple degrees of digital inequalities are extensively known and have been discovered through decades of intensive research [30–35].

Initially, the digital divide was studied as a binary difference between those connected to the Internet and those who were not [27]. This form of the digital divide is currently known as the first-level digital divide. Subsequently, Hargittai [36] emphasised that a distinction should be made between an Internet access gap and a skill divide, reflecting distinctions across groups of individuals in terms of the abilities required to utilise the Internet successfully. This idea also deviated from the deterministic notion that access to technology would inevitably bring all of its advantages. Several academics have highlighted concern about the approach to the digital divide that focuses only on differences in Internet access [37, 38]. Since the percentage of the population with an Internet connection is substantial in most Western nations, having an Internet connection is no longer regarded as the primary or sole barrier to benefiting from the Internet. When broadband Internet access and digital devices were more ubiquitous, the significance of an Internet access-based digital divide began to be questioned. Consequently, the focus of the digital divide discourse switched to the digital skills gap, which is the second-level digital divide [36], which also encompasses usage inequalities [38]. Several academics have proposed that digital disparities should be addressed more comprehensively, considering Internet access, skills, and the outcomes of Internet use [37, 38]. Consequently, the digital divide debate has

changed from binary Internet access to skills and usage of the Internet to an emphasis on the gain of Internet use, identified as the third-level digital divide in 2011 [39].

According to Robinson et al. [34], the legacy digital divide remains across various groups because of economic class, educational attainment, disability, and geographic location. They argue that emerging technologies of the fourth industrial revolution introduce more complex and growing digital divides. Consequently, there is the potential for a digital gap in various aspects. In addition, researchers found algorithm-driven inequalities in the intelligent algorithm-based smart environment [40]. In the information era, algorithms are the backbone of emerging technologies such as AI (Artificial Intelligence), IoT (Internet of Things), and Big data, which support the virtual labour market and virtual society. However, the algorithm-driven virtual world is forming a digital underclass and widening the digital gap unprecedentedly [34, 35]. Ragnedda [41] identifies "New Digital Inequalities" resulting from the algorithm-dependent virtual society. The notion of "New Digital Inequalities" encompasses three degrees of algorithm-based inequality: 1. Inequality in Knowledge, 2. Inequality in the Database, 3. Inequality in Treatment. Algorithms may acquire bias from their developers, resulting in "Inequalities in Knowledge" [41], if algorithms are trained using inaccurate reference data, referred to as "Inequalities in Database" [42]. As a result, algorithms may treat users differently depending on their gender or other attributes, resulting in "Inequalities of Treatment" owing to several deliberate or unintended shortcomings [43].

All associated bodies with MOOCs development need to comprehend the multilevel digital divides and the emerging forms of digital inequalities. Hence, they can develop strategies to reduce the impact of the digital divide. Otherwise, the MOOC movement may deviate from its originating characteristics of open and equitable learning for all.

5. Progress in access to ICT across the globe

Information and communication technologies (ICTs) provide a new framework and numerous opportunities for achieving social, economic, and political development goals. Over the decades, ICTs have become an increasingly important tool for development; their adoption can spur productivity, trade, and economic development. During the United Nations Conference on Sustainable Development, Rio + 20, Governments recognised the significance of ICTs facilitating the information flow between governments and the public, which is essential to bridge the digital divide and international corporations for providing equitable access to technologies. ICTs have completely revolutionised how people live, work, and communicate and have played an essential role in fulfilling the United Nations' Sustainable Development Goals (SDGs).

In 2015, Internet penetration grew from 6 to 43% of the world's population compared to 2000, according to International Telecommunication Union (ITU) 2015 ICTs figures [44]. Today there are more than 7 billion mobile subscriptions worldwide, significantly increasing from 738 million in 2000. Globally, around 3.2 billion people are using the Internet, of which 2 billion are from developing countries. Over the last decade, mobile broadband has enabled more areas to connect by overcoming infrastructure challenges worldwide. **Figure 2** shows global mobile network coverage covering most of the population in all regions. The share of the population lacking coverage does not exceed 7%, except for in Sub-Saharan Africa. Currently,

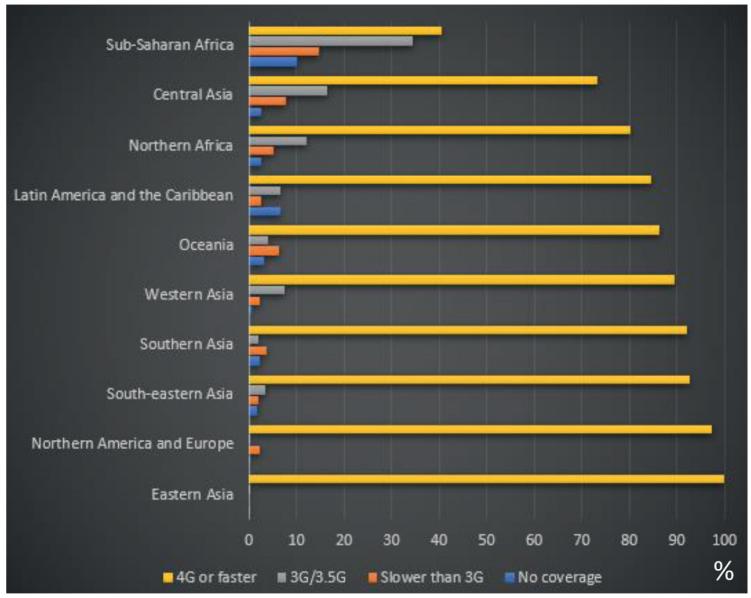


Figure 2.
Distribution of population by mobile network coverage, by technology, 2021 (source: UNCTAD calculations based on ITU [45]).

4G or newer wireless systems are the dominant technology in use around the world. Nevertheless, more than one-in-five people in Central Asia and Northern Africa have yet to gain 4G coverage.

Fixed-line technologies also play a crucial role in delivering Internet connectivity in many countries. These special connections are of the highest speeds, such as fibre broadband connections. As specified in SDG indicator 17.6.1, **Figure 3** presents the fixed broadband subscriptions relative to the population, disaggregated by speed. It is understood that Northern America, Europe, Oceania, and Eastern Asia are mostly enjoying high-speed fixed broadband, while other regions have much lower subscription rates. For instance, in 2021, Southern Asian countries had around two subscriptions per 100 inhabitants on average, whereas Sub-Saharan African countries had only one subscription. Network availability, access to electricity (e.g. for charging), and affordability in terms of network services and the devices needed to use them

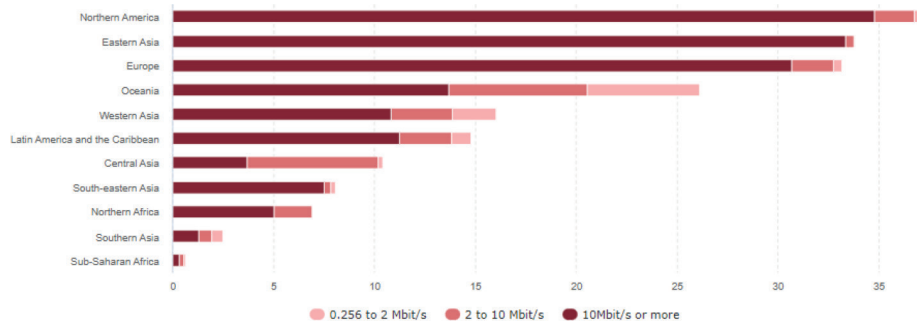


Figure 3.
Fixed broadband subscriptions by speed, calculations (source: UNCTAD calculations based on ITU [45]).

are the critical reasons for varying uptake across countries. Therefore, high-speed Internet access remains a luxury for most people in the least-developed countries. However, fixed-line or mobile networks are a pivotal fundamental requirement for Internet access.

6. Second-level digital divide challenges in MOOCs

While overall access to ICT is increasing around the globe, the adoption of MOOCs is hampered by the lack of ICT skills [1], as participants require minimum ICT skills to participate in MOOCs. Studies found that major beneficiaries of MOOCs hold prior ICT skills and have higher educational attainment [46, 47]. Therefore, people with affluent socioeconomic capital are likely to gain more benefits from MOOCs [5]. In contrast, the ICT skill gap and lack of elementary knowledge of MOOCs challenge disadvantaged groups to take part and reap the benefits of MOOCs. Empirical evidence indicates that people with higher educational status and ICT skills use MOOCs more, regardless of the course providers (University/Other Platforms) [5]. These common phenomena are derived from the MOOC platform that requires ICT skills and the design of the courses which offer content developed targeting educated participants, which are linked to the multilevel digital divide theories. The concept of the multilevel digital divide has identified the ICT skill gap as the second-level digital divide [30]. Therefore, despite having access to the Internet and devices, people can experience challenges in participating in MOOCs due to inadequate ICT skills.

When physical access is rapidly growing, and MOOCs are becoming increasingly popular, the lack of ICT skills is a significant challenge limiting the universal access and objective of MOOCs, which emerged from the multilevel digital divide. On the other hand, this will result in a further third-level digital divide. However, MOOCs can be carefully designed to reduce the skill gap, promote ICT skill training, and eventually scaffolds the needs of initial skill to reap the benefits from MOOCs.

7. Bridging second-level digital divide through MOOCs

Although the second-level digital divide or skill gap is considered as a barrier to participation in MOOCs, on the other hand, MOOCs have the potential to bridge the digital skills gap. Different types of competencies, such as "technical competence," "information literacy", "information navigation skill", "social skill", and "creative skill", have been highlighted by academics as necessary for closing the digital skills gap [48, 49]. Mossberger et al. [49] distinguished between technical competence, or "the skills required to operate hardware and software, such as typing, using a mouse, and instructing the computer to type records in a particular way", and information literacy, or "the ability to recognise when information can solve a problem or fulfil a need and to efficiently use information resources". Van Deursen et al. [48] categorised technical competence as "operational skills", or the fundamental Internet-use abilities. In addition, they identified 'information navigation skills' (the ability to identify, select, and evaluate sources of information on the Internet),' social skills (the ability to use online interactions and communication to understand and exchange meaning, as well as acquire social capital), and 'creative skills' (needed to create different types of quality content and to publish or share this with others on the Internet).

Studies found that the purposive application of MOOC can bridge the second-level digital divide (skill gap) [18, 50]. For example, in response to the European Commission's desire for more training options in digital competence, a MOOC on Basic Digital Competencies was launched in 2013 to assist bridge the digital skills gap in Spain by UNED (National Distance Education University; http://www.uned.es) in the Dominican Republic's UAPA (Open University for Adults; http://www.uapa.edu.do), and Spain's CSEV (Centre for Virtual Education; http://www.csev.org) [18]. This initiative, established in 2010 and included in the "Ibero-American Summit of Heads of State and Government", aims to promote social inclusion by enhancing remote education in Ibero-American nations. One of its primary goals is the development of abilities for distance education, including fundamental digital skills for instructors and students as well as the broader population.

The key aim of this MOOC represents an innovative recommendation that seeks to equip learners with the fundamental digital skills required to access the opportunities provided by the Knowledge Society and, in particular, to benefit from the new global effort based on social and open learning. The course included eight modules and 75 learning hours, leading to the awarding of badges and a final certificate upon completion. Each module had a wide variety of video material, supplemental materials, and links. Some were preparatory explanations, while others were video lectures filmed in a studio and by individual teachers. They were available for TV, polymedia, and screencast recordings, all open on YouTube. In response to the initial invitation issued by the Universia Miradax MOOC platform, over a thousand students were enrolled in the course. When the project's outcome was evaluated, the overall experience in MOOCs and the content were highly valued by learners [51]. The evaluation of this project identified a high level of learners' interest. However, the success and sustainability of such digital skill development MOOCs are linked with the participant-oriented design approach and matching learners' needs. The mentioned project depicts how MOOCs can be utilised to improve digital skills, which contribute to bridging the second-level digital divide.

Educated people are generally considered to have the fundamental digital skills to keep pace with the information era. However, people with higher educational attainment may require acquiring new digital skills or updating existing skill sets. For instance, university professors may require skill updates to cope with the gradual change in teaching and learning methods [50]. Basantes-Andrade et al. [50] studied the implementation of nano-MOOCs to improve the digital skills of university professors, who are the protagonists of their learning experience to innovate and apply teaching-learning techno-pedagogical proposals in the educational environment, in which technology is an integral part of teachers' professional activities. They employed a comparative quasi-experimental study (pre-test and post-test) with a sample of 297 university faculty members. The sampled faculty members exhibited optimal skill sets such as information literacy, problem-solving, and communication; however, they needed more content creation and digital security skills. Based on the pre-test result, a nano-MOOC was developed and implemented with faculty members. The post-test results revealed that online training through the nano-MOOC format is an effective option for university faculty training, and 83.84% of the participants increased their required digital competencies. These findings indicate that effective and individualised training may be accomplished in less time and tailored to the learners' requirements and characteristics.

The studies discussed above illustrate how MOOCs can be utilised to bridge the digital skill gap regardless of participants' educational attainment. However, to

address the lack of prior skill shortage, MOOC developers must be concerned with target participants' circumstances, understand their needs to navigate the course content, and apply strategies to retain participants until completion. Built-in course navigation guidelines, simplistic user experience (UX) design, multi-language support, and learner assistant system are some best practices to enhance MOOCs' success. Preplanned and comprehensive MOOCs design can help learners to acquire digital skills. Consequently, the escalation of digital skills will bridge the second-level digital divide and allow individuals to unleash the enormous potential of MOOCs and convert digital capital to offline capital.

8. MOOCs to ignite capital conversion cycle

The ownership of digital devices and access to the Internet does not ensure that individuals will gain equal outcomes and convert their online capital (i.e. digital assets) to offline capital. The degree of benefit from digital assets relies on the level of "technical competence", "information literacy", "information navigation skill", "social skill", and "creative skill". Possession of digital skill sets enables individuals to convert digital capital to offline capital.

The digital divide concept is intertwined with digital capital, described as a cumulative form of economic, social, and cultural capital [52]. However, Ragnedda and Laura [53] conceived digital capital as a specific isolatable capital instead of a mere subset of other capitals based on the Bourdieusian capital concept. They asserted that digital capital consists of two components: Digital Access (Equipment, Connectivity, Time spent, Support, and Training) and Digital Competencies (Information & Literacy, Communication, and Collaboration, Digital Content Creating, Safety, Problem Solving). Gómez [52] claimed that people with more offline capital (Social, Economic, and Cultural) are more likely to possess more digital capital, and people with sufficient digital capital can properly reap the advantages of their offline capital in the digital world and gain more offline capital. Conversely, people with less offline capital will possess less digital capital, consequently gaining less offline capital using digital capital. Gómez [52] explained this phenomenon as the bidirectional conversion of economic, social, and cultural capital to digital capital.

Initially, possession of material resources and income was identified as the key driver of the digital divide. However, contemporary studies conceptualised the ICT-related materialistic (device, Internet) and non-materialistic (motivation, skills) as the digital capital, which is the primary driver of the digital divide [53]. As explained earlier, individuals cannot benefit from digital capital without digital skill sets. Consequently, they cannot ignite the capital conversion cycle, which also sticks individuals in a digital divide cycle.

The MOOC movement can scaffold the upskilling process and ignite the capital conversion cycle, as illustrated in **Figure 4**. Individuals with access to ICT may leverage the advantage of ICT when they can overcome digital skill barriers. Consequently, individuals can transform their online capital into offline capital, enabling a self-reinforcing process and allowing them to gain more materialistic access and sophisticated skill sets. This cycle has the potential to bridge the multilevel digital divide. When individuals gain access to ICT, it does not ensure that the multiple forms of the digital divide would not impact them. Without ICT skills, individuals with rich materialistic access are subjected to stick in the first-level digital divide. Thus, MOOCs can assist in overcoming the divide. MOOCs intervention can reinforce both access to materialistic

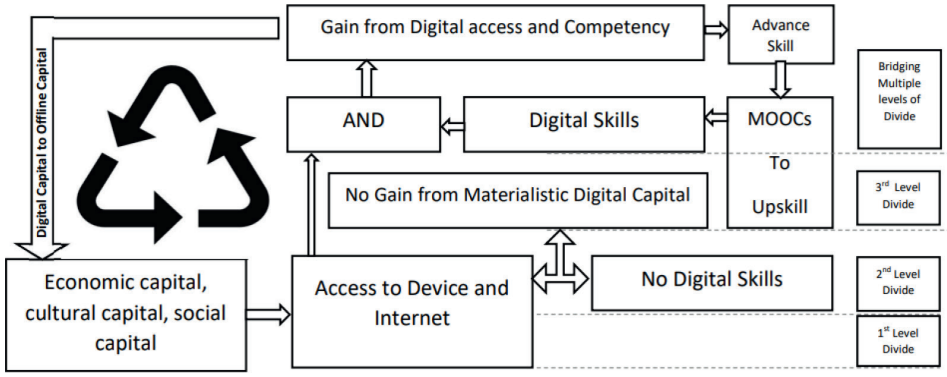


Figure 4.
MOOCs to convert digital capital to offline capital and bridge the multilevel digital divide. Source: Authors' elaboration using Gómez and Ragnedda & Laura Ruiu [52, 53].

access by converting online capital to offline capital. Also, MOOCs can enable the opportunity to overcome the second-level divide and exponentially enhance skills.

9. Digital accessibility challenges in MOOCs

Disability affects approximately 16% of the world's population, of which 2–4% have severe difficulty in functioning [54]. The worldwide prevalence of disability is increasing because of the ageing of the population, the fast spread of chronic illnesses, and advancements in the methodology used to quantify impairment [54]. Nevertheless, people with disabilities(PWD) are entitled to equal protection under the law and access to human rights [55]. Likewise, PWDs should have equal access to lifelong learning opportunities to enhance their living experience. MOOCs can provide online learning opportunities to all and allow and empower those who might be excluded due to disability.

The significant advantage of MOOCs is that they are accessible online to everyone. Nonetheless, this raises the question of the accessibility of MOOCs for PWD. Given that certain MOOCs depend largely on multimedia material, accessibility must be considered. Everyone must have access to videos, presentations, audio lectures, and rich content. Videos should have captioning to guarantee that all participants can interact with the topic. Accessibility issues and variable information literacy among students can raise challenges when participating in MOOCs. If participants cannot access, comprehend, or interact with course material, it will be impossible to evaluate their learning will result in social exclusion of PWD. Accessibility is a crucial dimension of the MOOC movement to accommodate people with different types of disabilities to open learning opportunities for PWD [56]. However, empirical evidence indicates that little progress has been made too far in generating universally accessible MOOCs or customising MOOCs to fit the requirements of PWD [57]. It is perceived that PWD can get equal benefits from MOOCs; hence, MOOCs should be utterly accessible to participants with disabilities [57]. There is a general consensus that the issues with MOOCs and PWD are not adequately monitored and understood. Along with that, the capacity of MOOCs providers to design completely accessible UX and develop accessibility policies has not matured [57]. Low stakeholder commitment and capacity levels might lead to difficulties for PWD that result in exclusion.

10. Web content accessibility guidelines for inclusive MOOCs

MOOCs are often delivered through websites where learning materials are presented to participants using web content. Therefore, inclusive MOOCs design should address the accessibility features of the broadcasting website. A website is accessible if its content is accessible to a wide variety of persons with disabilities, including those with visual impairment, hearing impairment, speech difficulties, restricted mobility, learning and cognitive limitation, photosensitivity, and various types of disability. Tim Berners-Lee, the World Wide Web inventor and director of the World Wide Web Consortium (W3C), states, "The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect" [58]. In order to ensure accessible MOOCs, the web content associated with the MOOCs should be developed following the Web Content Accessibility Guidelines. The Web Content Accessibility Guidelines (WCAG) are guidelines issued by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), the leading body for developing worldwide Internet standards [59]. WCAG is a collection of guidelines for making Web content more accessible for individuals with disabilities [59].

The WCAG is evaluated based on three conformance levels, ranging from A to AA and AAA. According to the guidelines, for users with disabilities, web content must be "Perceivable" & "Understandable" (covering necessary requirements for images (i.e. alternative text), audio, and visual design), "Operable" (outlining crucial practicalities like keyboard use and task completion time), and "Robust" (e.g. regarding cross-browser compatibility) [60]. Several versions of WCAG guidelines have been revealed over time, including WCAG 2.0 that was released in December 2008 and became an

Check point	**WCAG 2.1 criteria**
Skip links	WCAG 2.1-2.4.1
Alternative navigation	WCAG 2.1-2.4.5
Focus is visible	WCAG 2.1.-2.4.7
Keyboard operable	WCAG 2.1.-2.1.1,2.1.2,2.4.3
Page structure	WCAG 2.1.-1.3.1,1.3.2,2.4.6
Reflow and magnification	WCAG 2.1.-1.3.2., 1.4.4, 1.4.5, 1.4.10
Page titles	WCAG 2.1-2.4.2
Consistent navigation	WCAG 2.1-3.2.3
Consistent icons and labelling	WCAG 2.1-1.3.1, 3.2.4, 4.1.2
Image alternatives	WCAG 2.1-1.1.1
Link text	WCAG 2.1-2.4.4
Colour contrast and meaning	WCAG 2.1.-1.4.1,1.4.3.,1.4.11
Form field labels	WCAG 1.3.1,3.3.2
Error messages	WCAG 3.3.1,3.3.2
Alternative media	WCAG 1.2.2,1.2.3,1.2.5
Pause or stop motion	WCAG 2.1.-2.2.2

Table 1.
Essential WCAG 2.1 checklist to ensure web-based MOOCs accessibility, source: Authors' compilation following WCAG 2.1 [62].

ISO standard (ISO/IEC 40500:2012) in October 2012 [59]. In June 2018, W3C published WCAG 2.1; in December 2021, a draft of the extended guideline was published as WCAG 3.0, a successor to WCAG 2.2 and earlier versions [61]. However, it does not deprecate them. Before launching MOOCs, it is strongly recommended to at least check for the following 16 WCAG 2.1 criteria (See **Table 1**) and publish the contents for participants once they pass the evaluation [62]. Otherwise, inaccessible MOOCs can result in digital divides for PWD. In contrast, accessible MOOCs can work towards bridging digital inequalities by enabling access for every user across every device.

11. Following universal Design of Learning for MOOCs

Course designers and educators have adopted the Universal Design for Learning (UDL) concept for designing and delivering online courses from the perspective of meeting the requirements of diverse learner groups via purposeful planning [63]. UDL is a collection of concepts to develop learning curricula that provide equal learning opportunities for all participants [63]. UDL facilitates the development of accessible learning outcomes, resources, and evaluations. This method enhances the learning experience for all participants, including participants with disabilities [63]. With an emphasis on digital equality that transcends beyond enabling access to devices and reliable Internet, UDL provides principles to help learners via personalisation that acknowledges each learner's needs and skills. When using UDL in designing MOOCs, it is highly recommended to adhere to the following three key concepts (see **Figure 5**), which provide more flexibility to accommodate individual requirements, particularly PWD [64].

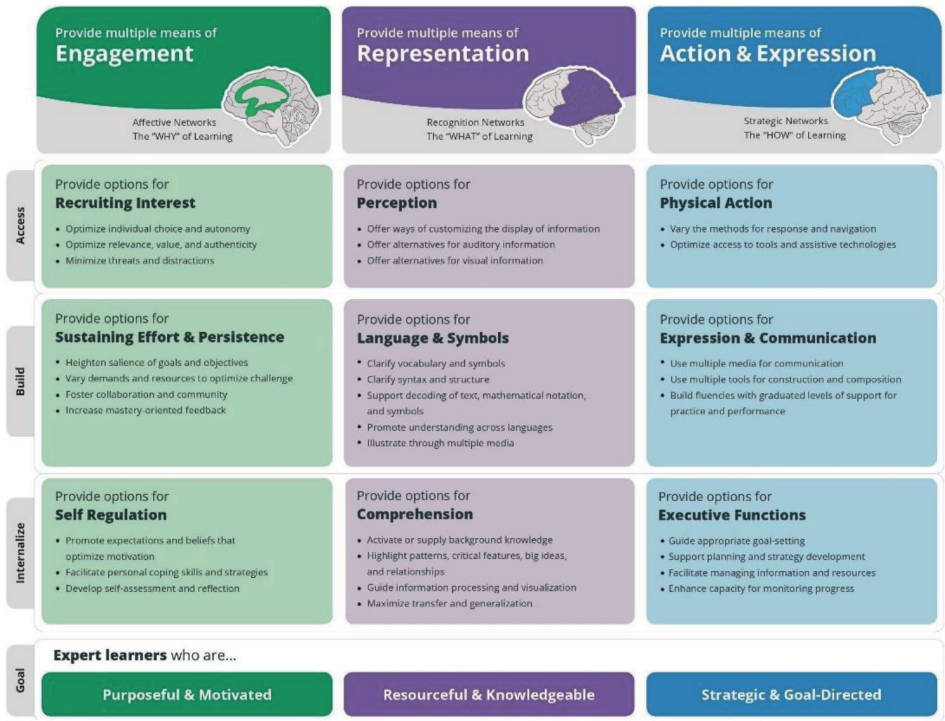


Figure 5.
Universal design for learning guidelines version 2.2 source: [64].

- **Multiple modes of student engagement** that engage learners' interests, suitably challenge them, and inspire them to learn.

- **Multiple methods of representation** that provide several approaches for students to obtain information and construct knowledge.

- **Multiple means of student action and expression** that provide alternative ways for learners to demonstrate what they have learnt.

When MOOCs are created utilising UDL, it implies that learners are given priority above educators' and providers' preferences, and institutional decisions reflect learners' circumstances and objectives. UDL also contributes to ensuring digital equality for all learners, including those with disabilities, by providing platforms and resources which are accessible and compatible with the software and hardware that is offered to students, such as assistive devices.

12. Conclusion

Massive open online courses are compelling, but stakeholders must consider their application thoughtfully. MOOCs have been criticised for their poor completion rates, limited teacher involvement, and inadequate evaluation methods. Remarkably, the access inequality phenomena have been raising concerns while MOOCs are being rapidly adopted. Nevertheless, the first level of the digital divide (access gap to ICT) has been found frequently discussed in the MOOC movement. However, the evolving nature of the digital divide concept suggests that MOOCs are challenged by multiple forms of digital divides. Therefore, mass adoption of MOOCs tends to develop a digital underclass and limit the opportunity to gain offline benefits from digital access and MOOCs. This chapter discusses the underlying multilevel digital divide concept linked with MOOCs. Also, the current chapter synthesises empirical evidence devising strategies to utilise MOOCs as a self-reinforcement tool to bridge the multilevel digital divide. Apart from multiple digital access inadequacies, PWDs are experiencing hurdles in accessing web-based MOOCs resulting in digital divides for learners with disabilities. This chapter discusses the strategies (i.e. WCAG, UDL) that may aid MOOC administrators in incorporating accessible MOOCs into existing learning programmes or developing new courses by carefully identifying the learners' needs using UDL and following WCAG.

The MOOC movement set off its journey acknowledging free and open education for all. Empirical evidence found that multiple forms of the digital divide and inaccessible MOOCs to diverse learner groups may deviate the MOOC movement from its pursuit. However, careful design and development approaches can overcome the digital divide challenges in MOOCs and foster digital equality in the digital learning paradigm.

Conflict of interest

The authors declare no conflict of interest.

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