MICRO-CREDENTIALING IN ADULT LEARNING: INTERNATIONAL CONSIDERATIONS

Billie McNamara, M.S.[1]
Qi Sun, EdD[1]

ABSTRACT: Micro-credentialing is unique because it spans epistemological paradigms, theoretical frameworks, and research methodologies in every academic discipline. Micro-credentialing and related technologies promote formal, non-formal, and informal learning among global adult learners through public-domain Open Educational Resources (OER) and other online courses that provide standalone enrichment or ancillary post-secondary knowledge and skills. Interests are rising in micro-credentialing as a verification tool. Yet, challenges to international standards, compatibility, language, validation, and efficacy require exploration to address technological issues, limitations, and implications for global adult learning. This paper introduces the foregoing concepts and relates them to concerns of the international adult education community. Educational researchers, instructional designers, administrators, and practitioners in academia, industry, and governments should understand historical details and current statuses to effectively prepare for sustainable creation, deployment, and storage of micro-credentials in the future. Likewise, consideration must be given to measuring and adapting to global adult learners' perceived value of micro-credentialing as an acceptable representation of knowledge and skills procurement through formal or informal, guided or self-directed, task-specific or generalized learning.

Keywords: micro-credentials, digital badges, online learning, global interoperability

Sometimes, *inter-national* does not mean *global* or even *worldwide*. This is the plight where one finds academic micro-credentialing, which Corbeil et al. (2021) define as "bite-sized learning and training in technology-enabled environments" (p. ii). Around the globe, leaders in adult education, the workforce, government agencies, and international nonprofit organizations are endeavoring to respond to rapid technology advancement while simultaneously advancing the recognition and sustainability of micro-credentials, with the implementation of globalized standards marked as a priority. Nonetheless, a plethora of challenges hinder the seamless universal integration of micro-credentialing in adult learning.

A UNESCO-UNEVOC Education Sector Report (2018), focused on cross-border recognition of learning credentials, describes the "new and dynamic landscape" (p. 5) of digital learning and open data sources for storing credentials in terms of pedagogical change, interoperable systems, and aligned standards for the credential and its repository. The world's united lens on lifelong learning requires methods for validating digital learning outcomes to be responsive, accessible, sustainable, and portable across national boundaries.

Global interest in higher education micro-credentialing is extensive. A UK-based strategic analysis consulting firm's 320-member Global Higher Education Executive consortium comprises 55% from North America, 18% East Asia and Pacific, 12% Europe and Central Asia, 7% Latin America, and 8% Middle East, South Asia, and Africa

[1]University of Tennessee, Knoxville, Department of Educational Psychology and Counseling, Educational Psychology & Research Program, Adult Learning Ph.D. Concentration. Corresponding author: bmcnamar@tennessee.edu.

combined (HolonIQ, 2021). A search of Google Scholar for the term *international adult education micro-credential* provided 120 relevant results published in the first six months of 2021. Three hundred twenty-four relevant results were published in the preceding four years. Yet, the titles listed span multiple continents and languages, comprising scholarly literature, government and quasi-governmental agency reports, international humanitarian nonprofit position papers, education industry-specific trade journals, corporate white papers, and dissertations.

Growing focus on micro-credentialing from many parts of the world indicates the need for researchers interested in global adult and higher education to better understand its historical details and current statuses. This paper introduces the foregoing concepts and addresses concerns of the international adult education community for effectively preparing future micro-credentials' sustainable creation, deployment, and storage.

Historical Context: Digital Credentials in Online Learning

Massive, Open, Online Courses

Digital credentials, often referred to as "badges," grew from recreational, electronic gaming and quickly were appropriated by massive, open, online courses (MOOCs) around the world as a method to denote achievement (Kato et al., 2020). Following the designation of 2012 as the "Year of the MOOC," the Global MOOC Survey results led to creation of the Quality Reference Framework for MOOC developers (Stracke, 2017). The MOOC format provides a platform for both instructor-driven and self-directed learning on almost any subject through public-domain or otherwise free, online delivery.

MOOC course offerings reflect an unfathomable number of subjects and levels. Instruction is delivered in formats ranging from short, serialized YouTube or TikTok how-to demonstrations to extended virtual, asynchronous or synchronous, multi-part courses that effectively develop a topic and provide opportunities for exploration and discussion among learners with similar interests worldwide. MOOCs are more popular internationally than in the US, where one finds hundreds of adult education MOOCs concentrated within leading providers Coursera®, EdX®, The Great Courses®, and numerous accredited universities (Shah, 2020). Internationally, distributed online learning is handled by a variety of providers.

Open Educational Resources

MOOCs are just one of many modalities deployed for transmitting open educational resources (OER) worldwide. OERs range from informal, single-subject discussions to semester-long, content-heavy courses similar to college curricula, to highly technical skills training. OER drawbacks include inconsistent definitions as to structure and administration, concerns about academic rigor and consistency, and exploiting informal learning to drive scholars toward formal learning. Because OER courses are usually loosely structured and self-directed, user satisfaction is high. However, a study of approximately 3,000 OER learners found users were generally satisfied but did not fully

understand the OER paradigm (Farrow et al., 2015). Alt (2021) likewise notes a dearth of empirical data regarding learners' motivation to utilize OERs. Interestingly, the existing higher education trend toward international acceptance of virtual learning resources made the transition to fully online courses in 2020 successful for many international colleges and universities. One study at an institution characterized as a "leading Chinese university" (Liu et al., 2020, p. 1) found responsive online learning sustainable, even in the midst of an unprecedented global pandemic.

OERs have not been as prevalent in the United States as in other nations, nor has the US benefited from multinational joint ventures and government schemes such as the European Union's Erasmus+ Programme (Fundaţia, n.d.). In 2016, Erasmus+ established the PARADIGMS and e-VALUATE projects focused on assessing online learning platforms (Finocchietti & Lokhoff, 2021). The Open Textbook Initiative, funded by the Libraries of the Australasian Network, increased awareness of OERs in that Pacific region (Ponte & Hurley, 2021). The 58th volume of Springer's series, *Education in the Asia-Pacific Region: Issues, Concerns and Prospects*, is replete with chapters covering OERs, digital credentialing, and similar technology-related learning subjects (Ra et al., 2021).

Micro-Credentialing and Digital Badges

While the concept of OER courses fits modern learning interests, few OER products mesh together to provide a framework for a degree or certification that is recognizable worldwide. Rather, most online courses that provide artefactual proof of completion do so in the form of a micro-credential or digital badge that "acknowledges the achievement of skills and competencies through explicit evidence" (Alt, 2021, p. 1). Oliver (2019) describes micro-credentials as "granular" (p. 1), defining a micro-credential more precisely as "a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification" (p. 19).

The terms *micro-credential* and *digital badge* are essentially interchangeable today. Traditional educational institutions, however, generally consider the term *micro-credentialing* connotes a higher standard of learning. SUNY (n.d.) offers micro-credentials to show its "commitment to each student's success and the value of individualized learning" (par. 2), describing its "high-quality micro-credentials" thus:

> At the most basic level, micro-credentials verify, validate, and attest that specific skills and/or competencies have been achieved. They differ from traditional degrees and certificates in that they are generally offered in shorter or more flexible timespans and tend to be more narrowly focused. Micro-credentials can be offered online, in the classroom, or via a hybrid of both. (par. 1)

Nonprofit EDUCAUSE (n.d.) uses parallel language in its marketing of courses. OER learning micro-credentials and digital badges are less likely to be awarded by an educational institution than by a MOOC, a proprietary credentialing consolidator such as

Digital Promise, or even corporations such as Disney and government agencies such as US-based NASA (R. Gibson, 2015).

Researchers have recorded a general sense of success among all stakeholders, noting badges provide a common language between industry and education. Soenen and Finocchietti (2021) maintain learner-centered micro-credentials "are not a goal in themselves but are important for the full educational and professional development of individuals" (par. 25). D. Gibson et al. (2013) observe digital badges for learners provide incentives, measures of progress, and visible recognition of accomplishments. Glover and Latif (2013) report an early study at City University of London found learners' enthusiasm for badges projected a positive effect on lifelong learning. Multiple subsequent studies in academia, industry, and government across the globe concur.

Like merit badges earned in scouting and other organizations, digital badges represent the completion of a learning activity. Unlike merit badges, digital badges do not necessarily represent mastery. Fennelly-Atkinson and Dyer (2021) maintain deficiencies in specific knowledge and skills competencies discovered through learning assessment are surmountable through deployment of "tried-and-true processes of instructional design" (p. 96) when developing a micro-credentialing program.

Professional organizations, such as the National Education Association (NEA, n.d.), offer micro-credentials aimed at industry-specific practitioners. NEA describes its micro-credentials as "grounded in research and best practice and designed to be personalized, flexible, and performance-based" (par. 4). Heggart and Dickson-Deane (2021) reiterate the importance of flexibility in their discussion of Australia's implementation of micro-credentials in learning design, providing for breaking courses into smaller components, allowing more course offerings and accommodating the need for "multiple entry and exit points" in curricular structure (pp. 10-11).

Citing Rose (2017) and others, Laughlin (2021) argues in favor of individual agency and personalized instruction, rather than standardization in micro-credentialing, to meet learners' needs for the future workforce. Rossiter and Tynan (2019) promote their "Learner-and-Earner Micro-credential Journey" to underscore learner agency resulting from "stacking desired credentials through lifelong learning" (p. 8). Additionally, individuals can "stack badges onto a core certification to represent a specialization or an advanced designation" (Leaser, 2016, p. 48).

Digital Badges' Roots in Gamification

Digital badges as representations of skill and knowledge proficiency grew from gaming, which was accepted as a reputable method for eLearning about the year 2000 (Sawyer, 2002). Kapp (2016) describes gamification as: "...an emergent approach to instruction that facilitates learning and encourages motivation through the use of game elements, game mechanics, and gamebased thinking" (p. 356). Game-based education has expanded far beyond the 1980s and 1990s' *The Oregon Trail*, *Carmen Sandiego* series, and *LeapFrog*. In fact, "gamification of learning" has grown into a separate instructional

category with standards, dedicated publications, and professional conferences (Ostashewski & Reid, 2015). Gamified learning is assessment-driven, providing simplified measurements for compliance monitoring. Gamified curricula are suitable for everyone and nearly every learning environment, adaptable to users' special needs, and easily portable between instructor-led and self-directed schema transversing languages and cultures, so all learners acquire skills and knowledge in personalized learning spaces.

Storage and Display of Micro-Credentials and Digital Badges

The MOOC badge concept initially fizzled, likely because there was no permanent way to connect a graphic image with the resource it represented (Pastore, 2019). Those who received a badge from a free course on widget-making in the early MOOC years likely asked, "So what?" What did that badge mean to the rest of the world, and how would its earner display the badge to connote its worth? Did the earner print badges and create a quasi-scouting sash on a bulletin board? Social media profiles were not prevalent, so how would learners share their accomplishment, imparting its meaning to all who saw the badge? MacKinnon (2021) posits micro-credentials and digital badges "are a 21st-century solution to the shortcomings of paper certificates in the age of digital, online identity management" (p. 57).

Micro-credentials and digital badges clearly continue to be important in internationalization of adult and higher education because they ostensibly provide a verifiable representation of skills and knowledge acquired by a learner. Traditionally, such representations have been printed documents such as a diploma from an established and accredited institution. Often, however, the granting institution or governing body has ceased existence. Thus, a method for validating learning represented by the certificate may be unavailable. Other credentials, such as a college degree or professional certification, are usually widely recognized and accepted within academia or professions because the rigor and qualification methods are well-established.

Individuals traditionally have maintained a portfolio of certificates to produce if asked by a potential employer or other inquirer. Modern digital backpacks, or eportfolios, are replacing those books and files of physical documents. The Open Badge Passport provides international users free, open storage and display, plus a directory of registered badges for which users can apply. Social media supplies options for badge-earners to display their digital credentials. The professional social media site LinkedIn provides badge display space on users' profiles. Institutional learning management systems usually include optional badge capabilities for courses. Buchem (2016) provides an indepth discussion of digital portfolio collections containing "badges as records or representations of learning pathways" (p. 346) that can ostensibly reflect an individual's lifelong learning.

Standardized Digital Badge Specifications

The digital learning badges movement floundered until late 2011, when Mozilla launched its global Open Badges initiative (Seitzinger, 2015; Pastore, 2019). Mozilla provided

infrastructure, including standardized specifications and programming API's for developers. Mozilla showcased images and provided a repository for storing details about the badges. The MacArthur Foundation simultaneously granted a few million dollars to Mozilla and a "badges for learning" competition (Surman, 2011). How are transcript data transmitted with a badge, and how does a digital badge convey the necessary information in a globally recognizable form? The Open Badges standard requires digital badges to contain metadata "bound" in the image: badge name, description, criteria for earning, issuer, evidence of earning, date issued, standards and endorsements, and tags (keywords) (Clements et al., 2020). Digital badges "serve as a proxy transcript for the [learning] activity" (Leaser, 2020, par. 29).

In 2017, IMS Global took over administering the Open Badges "ecosystem" (IMS, n.d.). The organization reports as of 2018, 24.1 million Open Badges had been issued worldwide under the Mozilla/IMS platform. Mozilla badges migrated to the Badgr system (IMS, n.d.). International technology giant IBM credits its success implementing digital credentialing to adoption of Mozilla/IMS Global Open Badges specifications, which provided a conduit for seamless communication between higher education and industry, especially in technology (Leaser, 2020).

Blockchain Technology and Digital Badges

Blockchain technology is another interesting, trending consideration for the future of digital badges. While most individuals associate blockchain with cryptocurrency, *blockchain* simply refers to a public ledger of database transactions (Belshaw, 2015). A key is required to view transaction details, and that key is held by parties engaged in the transaction – in this case, the badge issuer and earner. Through a fascinating case study, Mikroyannidis et al. (2020) provide an excellent analysis of blockchain technology and its implications for the future of lifelong learning by decentralizing resources ("peer-to-peer infrastructure") and adopting standards for data publication, storage, and retrieval via the World Wide Web. The authors argue the answer lies in their proposed "Semantic Blockchain," pairing blockchain technology with the Semantic Web, which is built on technologies and standards derived from models such as Linked Data, promulgated by World Wide Web creator Tim Berners-Lee.

A digital badge is a commodity with intrinsic value to the issuer and the earner in the blockchain context. BadgeChain was derived as a solution for long-term storage and verifiability of badge information. Affiliating with the global nonprofit W3C consortium that establishes standards for the World Wide Web, BadgeChain supports decentralized distribution of the verification details associated with badges (Lemoie, n.d.). Universities or other public-trust agencies could host blockchains to ensure the data are properly handled (Lemoie & Soares, 2016). As with all international transactions of items of value, the concept of blockchains in conjunction with digital badges provides innumerable opportunities for future exploration.

Verification of Micro-Credentials and Digital Badges

Verifying the legitimacy of a micro-credential or digital badge and specific details such as date, grantor, and course content is crucial to academic and workforce leadership; however, "digital learning records support and challenge the usual credential evaluation systems" worldwide (UNESCO-UNEVOC, n.d., par. 4). Commercial, institutional, and government-affiliated badge data aggregators compete globally for preeminence. Europe, North Africa, and the Middle East embrace the UNICollaboration-administered Open Badge Factory (MacKinnon, 2021). Both New Zealand's and Australia's Qualifications Frameworks provide a foundational method in the Australasian region (Selvaratnam & Sankey, 2020). In the US, for-profit and nonprofit members of the Learning Credential Network compete for acquisition of storable data based on a blockchain platform (Patton, 2019).

Selvaratnam and Sankey (2020) propose a simplified structure for interoperability among micro-credentialing storage systems. The learner completes a desired module in a virtual learning environment and receives a micro-credential (badge) that can be downloaded, posted on social media, or placed in an electronic portfolio online. Often, the instruction is delivered through a Learning Management System where badges can be stored. Institutions with sufficient infrastructure may have internal methods for storing digital credentials connected to each student. Credentialing management systems, both for-profit and nonprofit, provide public-facing third-party storage options. Employers can then access stored, verified credentials when considering a potential hire. Employers may have participated in creation of the credentials, providing instant recognition.

The Future of Micro-Credentialing and Digital Badges

The future of micro-credentialing is nebulous because no one can predict the technological future with confidence. An OECD Working Paper (Kato et al., 2020) encourages policymakers worldwide to address persistent "great uncertainty" despite "an increasing volume of these new credentials" (p. 4). Konert et al. (2017) present an indepth exploration of the requirement for, and methods to accomplish, global alignment of badges from the standpoint of structural standards and matching existing badges to achieve homogeneity. Lemoine and Richardson's (2015) discussion of micro-credentials, nano degrees, and digital badges in global higher education provides an engaging synopsis.

The European Union (EU) is leading globally with its Open Badges Platform (OBP), funded under the Erasmus+ Programme. The OBP's charter is to "assess, develop and promote the common EU platform for digital badges, targeted at adult education organizations, adult educators and adult learners that also represent the main target groups" (Fundația, n.d., emphasis added). The OBP targets seven EU nations' technology advancement for adult educators and standardized development of "soft skills" training in the workplace (Colibaba et al., 2020). The EU's European Higher Education Area comparative analysis of 35 member countries reports several "transversal issues," beginning with "the need for further discussion at national and international levels to

reach a common understanding of micro-credentials" through a "clear and transparent common framework" that balances "standardisation and flexibility" (Soenen & Finocchietti, 2021, pars. 20-22).

Findings from a May 2021 online conference sponsored by the United Nations' International Labour Organization (ILO) focused on adult learners in the Philippines reveal "'an explosion' of online and micro-credential programmes during the COVID-19 pandemic highlights the importance of lifelong learning to upskilling, reskilling and the economic recovery" (ILO, 2021, par. 1). Citing research performed in Malaysian higher education, Soon and Ismail (2021) argue convincingly micro-credentialing can be a "missing bridge" between unemployment and reemployment in the post-SARS-CoV-2 pandemic world.

In the United States, workplace implementation of digital badges is fragmented. Multinational technology corporations, such as Microsoft and IBM, were quick to embrace digital badges, probably because of existing industry certification schemes. In August 2020, IBM awarded its 3,000,000th digital badge since its program began in 2015. The company's announcement reports benchmarks: personalized, portable learning; scaffolded progression of competencies; identifiable pool of skilled employees; workforce democratization; a positive correlation between badges and employee performance and retention; and a common language between industry and education (Leaser, 2020).

HolonIQ (2021) surveyed its expert panel and determined, "There is little evidence that employers are willing to accept micro-credentials as a replacement for the college degree," chiefly a result of "lack of agreed standards and trust in micro-credentials, inability of the institution to keep up with the pace of change, internal resistance and lack of employer demand" (p. 8). Selvaratnam and Sankey (2020) argue learning institutions shoulder a significant responsibility for streamlining micro-credentialing creation, validation, storage, and verification for all parties.

A report from the United Nations through the UNEVOC section of UNESCO (Chakroun & Keevy, 2018) suggests digital credentials are critical for successful advancement of transnational education by providing methods to track skills proficiencies and learning systems across an individual's lifetime:

> There is increasing evidence that the use of digital technologies in education and training is supporting the development of learning materials and close monitoring of teaching and learning processes, changing pedagogies and forms of assessment and certification. Digital learning records and open data sources are complementing traditional qualifications repositories, while challenging the conventional models of credential evaluation... These changes trigger many questions about the trustworthiness of data, interoperability of systems, and most critically the ubiquity of the standards—both learning standards and technology standards—that govern the new and dynamic landscape. (p. 5)

Observing the vast number of countries that lack educational policies in general, Soenen and Finocchietti (2021) maintain, "Internationalisation is a key topic, together with discussions at the national level: the aspect of co-constructing micro-credentials with a transnational approach must be kept in view and taken into account" (par. 24). Ongoing efforts, such as the EU's Erasmus+ DIGI-HE project, which aims to "enhance universities' digitally enhanced learning and teaching strategies," will engage higher education administrators and practitioners (Gaebel et al., 2021, p. 5); however, worldwide industry leaders and workforce training providers' engagement is essential.

Conclusion

The world of learning is bounded by precepts such as a need to respond—or, preferably, predict—the rapid advancement of technology and the increased focus on self-directed learning as learners seek knowledge outside the traditional classroom (Beaven, 2021). Meanwhile, public policy and the workforce require efficacy, veracity, and sustainability of evidence of learning and competencies.

Eventually, truly global agreement must be reached on standards for recognition, definition, creation, validation, and distribution of micro-credentials and digital badges. Otherwise, adult education's present-day goal of a future filled with lifelong learners, whose eportfolios are overflowing with micro-credentials, will not be achieved.

References

Alt, D. (2021). Who benefits from digital badges? Motivational precursors of digital badge usages in higher education. *Current Psychology*. https://doi.org/10.1007/s12144-021-02002-0

Beaven, A. (2021). Learning without a teacher: Self-directed language learning in the digital wilds. In T. Beaven & F. Rosell-Aguilar (Eds.), *Innovative language pedagogy report* (pp. 43–47). Research-publishing.net. https://doi.org/10.14705/rpnet.2021.50.1234

Belshaw, D. (2015, March 30). Peering deep into future of educational credentialing. *Badgechain*. Retrieved July 23, 2021, from http://badgechain.com/2015/03/

Buchem, I. (2016). Digital badges as (parts of) digital portfolios: Design patterns for educational and personal learning practice. In D. Ifenthaler, N. Bellin-Mularski, & D.-K. Mah (Eds.), *Foundation of digital badges and micro-credentials: Demonstrating and recognizing knowledge and competencies* (pp. 343–367). Springer International Publishing. https://doi.org/10.1007/978-3-319-15425-1_19

Chakroun, B., & Keevy, J. (2018). *Digital credentialing: Implications for the recognition of learning across borders*. https://unesdoc.unesco.org/ark:/48223/pf0000264428

Clements, K., West, R. E., & Hunsaker, E. (2020). Getting started with open badges and open microcredentials. *International Review of Research in Open and Distributed Learning, 21*(1), 153–171. https://doi.org/10.19173/irrodl.v21i1.4529

Colibaba, A., Gheorghiu, I., Colibaba, A., Antonita, C., Cirsmari, R., & Constantin, A. (2020). The recognition of "soft skills" through the European Open Badges Platform Project. In Pixel (Ed.), *Conference proceedings 13th international conference innovation in language learning virtual edition*, 92–96.

Corbeil, J. R., Khan, B. H., & Corbeil, M. E. (Eds.). (2021). *Microlearning in the digital age*. Routledge. https://doi.org/10.4324/9780367821623

EDUCAUSE (n.d.) *Earn and display your microcredentials*. Retrieved July 23, 2021, from https://www.educause.edu/microcredentialing/earn-and-display-your-microcredentials

Farrow, R., de los Arcos, B., Pitt, R., & Weller, M. (2015). Who are the open learners? A comparative study profiling non-formal users of open educational resources. *EURODL (European Journal of Open, Distance and E-Learning), 18*(2), 50–74.

Fennelly-Atkinson, R., & Dyer, R. (2021). Assessing the learning in microlearning. In J. R. Corbeil, B. H. Khan, and M. E. Corbeil (Eds.), *Microlearning in the digital age* (pp. 95–107). Routledge. https://doi.org/10.4324/9780367821623-8

Finocchietti, C., & Lokhoff, J. (2021, February 27). The promise of micro-credentials? The road to recognition. *University World News*. https://www.universityworldnews.com/post.php?story=20210224114309588

Fundaţia Euroed Iaşi. (n.d.). *EU-OBP*. Retrieved July 23, 2021, from https://eu-obp.eu/

Gaebel, M., Zhang, T., Stoeber, H., & Morrisroe, A. (2021). *Digitally enhanced learning and teaching in European higher education institutions*. European University Association absl.

Gibson, D. C., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. B. (2013). Digital badges in education. *Education and Information Technologies, 20*(2), 1–8. https://doi.org/10.1007/s10639-013-9291-7

Gibson, R. (2015). Four strategies for remote workforce training, development, and certification. In Information Resources Management Association (USA) (Eds.), *Gamification: Concepts, methodologies, tools, and applications* (pp. 770–785). IGI Global. https://doi.org/10.4018/978-1-4666-8200-9.ch038

Glover, I., & Latif, F. (2013). Investigating perceptions and potential of open badges in formal higher education. In J. Herrington, A. Couros, & V. Irvine (Eds.), *Proceedings, EdMedia 2013 – world conference on educational multimedia, hypermedia and telecommunications*. Association for the Advancement of Computing in Education, Chesapeake, VA, 1398–1402.

Heggart, K., & Dickson-Deane, C. (2021). What should learning designers learn? *Journal of Computing in Higher Education*. https://doi.org/10.1007/s12528-021-09286-y

HolonIQ. (2021). Micro credentials executive panel survey. https://www.holoniq.com/wp-content/uploads/2021/03/HolonIQ-Micro-Credentials-Exec-Panel- March-2021-1.pdf

International Labour Organization (2021, May 19). “Explosion” of micro-credential courses proves lifelong learning vital. [Press release]. Retrieved July 23, 2021, from http://www.ilo.org/asia/media-centre/news/WCMS_793064/lang--en/

IMS Global Learning Consortium. (n.d.). *History*. https://openbadges.org/about/history

Kapp, K. M. (2016). Gamification designs for instruction. In C. M. Reigeluth, B. J. Beatty, & R. D. Myers (Eds.), *Instructional-design theories and models, volume iv: The learner-centered paradigm of education* (pp. 351–384). Routledge. https://doi.org/10.4324/9781315795478

Kato, S., Galán-Muros, V., & Weko, T. (2020, March 10). The emergence of alternative credentials. [Policy brief]. *Education working paper No. 216; OECD Working Papers Series*. OECD – Organisation for Economic Co-operation and Development.

https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/WKP(2020)4&docLanguage=En

Konert, J., Open Badge Network, & Mufeed, O. (n.d.). OER decision nodes. https://www.assignmenthelp.net/blog/new-edtech-trends/oer-decision-nodes/

Laughlin, T. (2021). A vision for deeper agency and personalization in micro-credentials. In P. Northrup, K. Rasmussen, & R. Colson (Eds.), *Career ready education through experiential learning*, (pp. 19–45). IGI Global. https://doi.org/10.4018/978-1-7998-1928-8.ch002

Leaser, D. (2016). Open badges: Reimagining the credential space with significant, unintended benefits. *Training Industry Magazine, (9)*4, 48–49.

Leaser, D. (2020, August 3). IBM awards its three millionth digital badge (and disrupts the labor market in five big ways). *IBM Training and Skills Blog*. https://www.ibm.com/blogs/ibm-training/ibm-issues- its-three-millionth-digital-badge-and-disrupts-the-labor-market-in-the-process/

Lemoie, K. (n.d.). The opportunity space for open badges + blockchain. Retrieved July 23, 2021, from https://www.w3.org/2016/04/blockchain-workshop/interest/lemoie.html

Lemoie, K., & Soares, L. (2016). Connected impact: Unlocking education and workforce opportunity through blockchain. ACE American Council on Education Office of Educational Technology. https://www.acenet.edu/Documents/ACE-Education-Blockchain-Initiative-Connected-Impact-June2020.pdf

Lemoine, P. A., & Richardson, M. D. (2015). Micro-Credentials, nano degrees, and digital badges: New credentials for global higher education. *International Journal of Technology and Educational Marketing, 5*(1), 36–49. https://doi.org/10.4018/ijtem.2015010104

Liu, Y., Zhang, Y., Qiao, W., Zhou, L., & Coates, H. (2020). Ensuring the sustainability of university learning: Case study of a leading Chinese university. *Sustainability, 12*(17), 6929. MDPI AG. https://doi.org/10.3390/su12176929

MacKinnon, T. (2021). Open badges: Recognising learning through digital micro-credentials. In T. Beaven & F. Rosell-Aguilar (Eds), *Innovative language pedagogy report* (pp. 57-61). Research-publishing.net. https://doi.org/10.14705/rpnet.2021.50.1236

Mikroyannidis, A., Third, A., & Domingue, J. (2020). A case study on the decentralisation of lifelong learning using blockchain technology. *Journal of Interactive Media in Education, 2020*(1), 23, 1-10. https://doi.org/10.5334/jime.591

National Education Association (NEA). (n.d.). *Micro-Credentials*. Retrieved July 23, 2021, from https://www.nea.org/professional-excellence/professional-learning/micro-credentials

Oliver, B. (2019). *Making micro-credentials work for learners, employers and providers*. Deakin University.

Ostashewski, N., & Reid, D. (2015). A history and frameworks of digital badges in education. In T. Reiners & L. C. Wood (Eds.), *Gamification in Education and Business* (pp. 187–200). Springer International Publishing. https://doi.org/10.1007/978-3-319-10208-5_10

Pastore, R. (2019, August 13). What's the deal with digital badges?. [Video]. YouTube. https://www.youtube.com/watch?v=ifkY67Tioo8

Patton, C. (2019, November 25). Why IBM and others are building a global database for employee credentials. *Human Resource Executive*. https://hrexecutive.com/why-ibm-and-others-are-building-a-global-database-for-employee-credentials/

Ponte, F., Lennox, A., & Hurley, J. (2021). The evolution of the Open Textbook Initiative. *Journal of the Australian Library and Information Association, 70*(2), 194–212. https://doi.org/10.1080/24750158.2021.1883819

Ra, S., Jagannathan, S., & Maclean, R. (Eds.). (2021). Powering a learning society during an age of disruption. Springer. https://doi.org/10.1007/978-981-16-0983-1

Rossiter, D., & Tynan, B. (2019). *Designing and implementing micro-credentials: A guide for practitioners*. Commonwealth of Learning.

Sawyer, B. (2002). *Executive summary of serious games: Improving public policy through game-based learning and simulation.* Wilson Center.

Seitzinger, J. (2015, April). Open badges [Video]. TED Conferences. https://www.youtube.com/watch?v=DiTHIuqA0cc

Selvaratnam, R.M., & Sankey, M.D. (2020). An integrative literature review of the implementation of micro-credentials in higher education: Implications for practice in Australasia. *Journal of Teaching and Learning for Graduate Employability, 12*(1), 1–17.

Shah, D. (2020, January 12). From MOOCs to TikTok: The unexpected impact of the MOOC hype. *The Report by Class Central*. https://www.classcentral.com/report/moocs-tiktok/

Soenen, M., & Finocchietti, C. (2021, March 6). Starting points for recognition of micro-credentials. *University World News*. https://www.universityworldnews.com/post.php?story=20210302104300698

Soon, J., & Ismail, R. (2021). Unemployment in the post-pandemic world: Is micro-credentialing the missing bridge? In A. K. Dey & H. Chaturvedi (Eds.), *The new normal: Reinventing professional life and familial bonding in the post Covid-19 era*. Bloomsbury Publishing. https://www.ebooks.com/en-us/book/210241735/the-new-normal/h-chaturvedi/

Stracke, C. M. (2017). The quality of open online education and learning: A quality reference framework for MOOCs. In *Smart universities: Education's digital future. Official Proceedings of the International WLS and LINQ Conference* (pp. 97–105).

SUNY The State University of New York. (n.d.). *Micro-credentials at SUNY*. Retrieved July 23, 2021, from https://system.suny.edu/academic-affairs/microcredentials/

Surman, M. (2011, September 15). *Mozilla launches Open Badges Project*. https://blog.mozilla.org/blog/2011/09/15/openbadges/

UNESCO-UNEVOC Education Sector, Division for Policies and Lifelong Learning. (2018). *Digital credentialing and a new learning landscape is examined in recent UNESCO report*. https://unevoc.unesco.org/home/Digital%20Cred%20Report