

Towards a Future of Qualifications: A Systematic Review of Micro-Credentials

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Abstract

Micro-credentials are bite-sized collections of skills or knowledge, complementing formal, informal, or non-formal degrees or certificates. Clarifying the role of micro-credentials in open and distance learning, a comprehensive review of the existing literature is essential. This study presents the results of a systematic literature review employing the PRISMA method to analyze the integration of micro-credentialing systems, stakeholder perceptions of their value, the impact of emerging technologies on their recognition, and future trends. A total of 205 publications, encompassing as specified terms of micro-credentials in their title, were retrieved from the Web of Science and Scopus databases. The results were discussed in five principle impact areas including the strategies in higher education and lifelong learning, sector-specific upskilling and reskilling, the digital proof of competency, challenges in design and implementation, and critiques on micro-credentials. The study reveals the evolution of micro-credentials and provides a roadmap for their future advancement.

Keywords: Micro-credentials; Qualifications; Lifelong learning; Upskilling and reskilling; Digital badges; Higher education

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Introduction

The higher education system has been criticized for confining education within the campus walls, failing to respond to current needs in today's world where the flow of information is faster than in the past, not allowing learners to upskill or reskill themselves and not supporting lifelong learning processes sufficiently. In such a scene, what would it be like if there was a model that could counter these criticisms, link education with more flexible and lifelong learning processes, and provide different entry and exit points in our learning journey? As a response to this query, micro-credentials—stackable, combinable, or transferable qualifications—are emerging as a promising solution to the above-mentioned criticism. In this regard, the main purpose of this study explores the scholarly landscape of micro-credentials and provides a broader perspective by adopting systematic review and data mining and analytics approaches. This review aimed to answer the following research questions: (1) How are micro-credentials conceptualized and strategically positioned within the context of higher education and lifelong learning? (2) What roles do micro-credentials play in addressing sectoral needs for upskilling and reskilling, particularly through flexible curriculum solutions? (3) How are micro-credentials being implemented and validated as digital proofs of skills and competencies through emerging technologies such as blockchain and AI? (4) What frameworks and strategies are proposed for the design, development, and implementation of micro-credentialing systems? (5) What are the critiques and challenges associated with the adaptation, accreditation, and standardization of micro-credentials in online and distance learning environments?

Literature and Background

What are micro-credentials?

Micro-credentials, as an umbrella term (UNESCO, 2018), encourage inclusive learning pathways for everyone while also serving as a professional development strategy and addressing the workforce's demands for upskilling and reskilling. Since micro-credentials have characteristics including transparency, portability, and flexibility, learner-centered brief training programs may now match the rapidly changing learning demands of formal, informal, and nonformal learning environments. Micro-credentials are short, targeted learning certifications that formally recognize specific skills, knowledge, or competencies acquired through various learning modalities (Oliver, 2019; UNESCO, 2022). Unlike traditional qualifications, micro-credentials offer flexibility, stackability, and alignment with labor market needs, often verified through digital means such as badges or digital certificates.

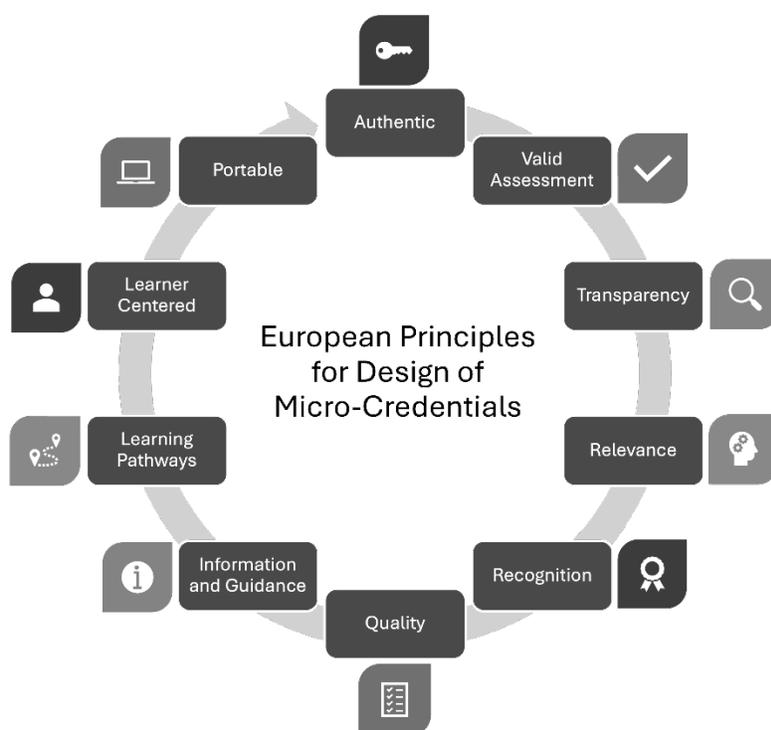
Even though there are various definitions for this term, they generally refer to identical ideas. As “learning opportunities of smaller volume than for traditional qualifications,” micro-credentials, according to the European Commission (2021, p. 1), “enable the targeted, flexible acquisition and recognition of knowledge, skills, and competencies to meet new and emerging needs.” Furthermore, they state that “micro-credentials are not a substitute for regular qualifications. Rather, they can enhance traditional credentials and provide a chance for lifelong learning for anyone.” In addition to the definitions being comparable, what distinguishes McGreal and Olcott's (2022) definition from the European Commission's is the potential that micro-credentials could substitute for traditional education. One of the most commonly used definitions of micro-credentials highlights that they are an additional, alternative,

complementary, or part of a formal certification that belongs to an assessed learning process (Oliver, 2019). Micro-credentials, as a potential way for people outside of higher education to acquire competencies and expertise and confirm their competence (Bozkurt & Brown, 2022; Kır et al., 2025), present novel opportunities for lifelong, life-wide, and life-deep learning. Micro-credentials, with bundled or unbundled characteristics, enable personalized learning adventures for learners on their lifelong learning path (Pelletier et al., 2021). Because of their flexible nature, micro-credentials offer an opportunity to incorporate them into the formal educational process in the future. Besides, micro-credential programs that align with the Bologna process are more effortlessly integrated into undergraduate and graduate degrees (Şenocak & Kır, 2022).

The Council of the European Union has set certain standards on the niche and nature of micro-credentials, advising Member States and micro-credential providers on the principles that the designs should incorporate in 2022. It is highlighted that these principles are universal and serve as a basis for micro-credentials excellence in all areas of practice. Figure 1 depicts these ten fundamental principles that have several distinctive characteristics within their main subjects.

Figure 1

European Principles Design and Issuance of Micro-Credentials



The increasing interest in micro-credentials is not merely an innovation within higher education, but a response to longstanding concerns raised by employers over the past four decades regarding the misalignment between university qualifications and workforce needs. The

diminishing perceived value of traditional degrees in securing sustainable employment has significantly contributed to the emergence of alternative credentialing systems aimed at validating job-relevant skills.

Why has the concept of micro-credentials grown so popular in research?

With the development of more adaptable and accessible learning environments, more innovative applications and alternative platforms are created to address the personal learning needs and objectives of individuals. Micro-credentials are gaining some traction in higher education (Pelletier et al., 2021) to enhance alternatives to traditional degrees, diplomas, and certifications. As a result, higher education institutions have increasingly promoted micro-credentials programs and frameworks, and they have also built organizations around institutional or national initiatives (Resei et al., 2019).

Micro-credentialing programs can be a solution for upskilling in industry-recognized skills and employability competencies, which has been a worry for the workforce sector and employers that have anticipated a rapid learning of skills to boost productivity (Gauthier, 2020). Universities and colleges are tasked with addressing the market's demand for increasing expertise in relevant subjects at this time. As employers and job seekers become more aware of employment-enhancing micro-credentials programs, demand for such short-term upskilling opportunities is expected to increase. Ward et al. (2024) discusses the Universal Micro-Credential Framework, which incorporates badges and skills profiling to create interdisciplinary learning and assessment paths. Such frameworks not only validate the competencies acquired through micro-credentials but also enhance their credibility in the eyes of employers. Employers are increasingly recognizing the value of micro-credentials, particularly in relation to soft skills, which are often seen as essential for workplace success (Bruguera et al., 2024). All stakeholders, including governments, skills agencies, and higher education institutions, as well as accrediting associations, independent training providers, and global consortia, are able to strengthen their competitiveness by planning, marketing, and developing institutional strategies for incorporating micro-credentials into their current programs (McGreal et al., 2022). In an additional instance, the Canadian Higher Education system and labor market have taken the initiative to adopt micro-credentials. In the interest of upskilling and reskilling the workforce, the Ontario government recognized the value of micro-credentials and allocated \$60 million in funding through 2020. Researchers from the Higher Education Quality Council of Ontario subsequently defined micro-credentials and evaluated the value they provided to Canadian companies and students to figure out the most efficient manner to utilize the funds (Pichette et al., 2021).

The rise of micro-credentials and skills-based training is empowering companies to hire individuals with specific skills, while universities are scrambling to catch up by offering new programs and qualifications. While universities all over the world (e.g., Athabasca University and PowerED, Open University and FutureLearn, Deakin University, Royal Melbourne Institute of Technology, MIT, eCampusOntario, Udacity, Coursera, and edX) are currently creating training and new programs in this area, the demand for micro-credentials and skills-competency-based training has provided many private companies a chance to recruit employees. While industrialized countries with robust economies have been paving the way in addressing micro-credentials, other countries have also made advancements in this field as well.

Related Studies

Very few studies have been reported that fully explore the potential of micro-credentials by analyzing published works in an academic context. For instance, Selveratnam and Sankey's literature review study (2021) is focused on certain research gaps in the literature, spots on core concerns to model key strategies for researchers and concludes with an overview of micro-credentials' practical uses and industrial cases, more specifically in the context of higher education in Australasia. Another study by Wolz et al. (2021) addresses weak areas related to digital credentials and lacks a comprehensive grasp of digital credentials by carrying out a systematic literature review. The majority of these studies have emphasized the conceptual background of the micro-credentials, or one particular component in a single setting. Although the literature on this topic has benefited considerably through conceptual frameworks, contextual examinations, and new perspectives on micro-credentials (Mhichil et al., 2023), much more research must be conducted to enhance the adoption and implementation process by institutions. Researchers disagree, meanwhile, on whether micro-credentialing in higher education will be adopted as an ongoing strategy (Ralston, 2021), though this could change according to adoption approaches and institutional and national situations.

Diverse research studies have investigated the micro-credential acceptance process, quality standards, design and development aspects, recognition methods, and employers' viewpoints (Gauthier, 2020), in addition to evaluating perspectives from various settings (Mischewski & Christie, 2018; Young et al., 2019). Thi Ngoc Ha et al. (2023) conducted an in-depth evaluation of research papers published between 2012 and 2022, underlining the potential benefits of integrating micro-credentials into the higher education system. Researchers point out that micro-credentials are still in their initial stages of growth and development, and that, despite increased interest and awareness in the sector, implementation issues remain. Ahsan et al. (2023) analyzed 56 articles on digital badges and micro-credentials that were published between 2015 and 2021 in the Scopus database of research for their systematic review. This study, similar to previous study (Thi Ngoc Ha et al., 2023), highlights the impact on higher education and provides a framework for the applicability of micro-credentials in higher education. Brown et al. (2023) concentrates on how to structure an institutional transformation strategy, which business models would be required, how to shepherd the process, and how to identify any possible risks. Those in charge of supervising the implementation of micro-credentials may need to consider through risks that might arise, create strategies that best advance the objectives of the institution, and demonstrate confidence through executing strong initiatives (Brown et al., 2023). Similarly, Varadarajan et al.'s (2023) systematic research primarily focused on the positive aspects and challenges of implementing micro-credentials and developed a framework for them for different stakeholders. In contrast to previous research, this study addresses the worries that an uptick in the use of micro-credentials would have a detrimental effect on higher education. Nevertheless, it was additionally noted that in spite of all of these challenges, higher education institutions' position with regard to micro-credentials is the center for every stakeholder involved and would undoubtedly affect the sequence of events in the near future (Varadarajan, Koh, & Daniel, 2023).

Tamoliune et al. (2023) carried out a systematic review to examine the consequences of micro-credentials on social and economic aspects of the post-COVID-19 recovery process. The review consisted of 32 studies which were undertaken in the field of higher education between 2015 and 2022. Consequently, it was demonstrated that micro-credentials improved learners'

employability skills in addition to their life skills, such as their psychosocial and interpersonal skills (Tamoliune et al., 2023). From a complementary perspective, Alsobhi et al.'s (2023) systematic review study provides a glimpse into how blockchain technology could potentially be used in higher education for verifying micro-credentials. To accomplish this, the review comprised 15 studies that offered blockchain-based micro-credentials in higher education between 2016 and 2022, illustrating an urgent need for additional research on this topic (Alsobhi et al., 2023).

As a result, it is necessary to investigate which elements and points were most prominent in all past studies that carried out a specific threshold. Therefore, the purpose of this article is to contribute to the field by exploring the whole potential and use of micro-credentials, as well as to outline the current state and overall picture. Another goal of this research is to create a future vision for strengthening the uptake of micro-credentials. In this regard, this study aims to explore and identify emerging research themes and patterns on micro-credentials in the educational landscape.

Methods

Research Design

For a comprehensive exploration of emerging research trends and patterns surrounding micro-credentials in education, this study employed a systematic literature review (Gough et al., 2012) alongside bibliometric analysis methods (Donthu et al., 2021). Complementing these approaches, the study used data mining and analytical techniques (Fayyad et al., 2002), incorporating t-SNE analysis of the titles (van der Maaten & Hinton, 2008), text mining of the abstracts (Feldman & Sanger, 2007) and social network analysis (SNA) of the keywords. The rationale behind employing a diverse array of analytical methods was to ensure the triangulation of data, thereby augmenting the reliability and validity of the analytics (Thurmond, 2001). This multifaceted approach enabled the investigation of various layers within the research corpus, facilitating a comprehensive understanding and addressing the research questions effectively. The study employed three complementary bibliometric and text-mining techniques—t-SNE visualization, co-word network analysis, and abstract keyword frequency analysis—to uncover thematic structures within the selected corpus. These approaches are well suited for identifying latent research trends in a manageable dataset ($N < 250$), allowing for interpretative synthesis consistent with the aims of a systematic review.

To enhance the trustworthiness of findings, a methodological triangulation approach was employed. By integrating t-SNE-based title mapping, abstract-level text mining, and keyword co-occurrence analysis, the study cross-validates thematic patterns across different lexical layers. This triangulation strengthens the internal validity of the review and enables a more comprehensive identification of emergent research directions.

Inclusion Criteria and Sampling of Research Corpus

The study focused on publications indexed in the Scopus and Web of Science (WoS) databases, accessible through library services or open access, which contained specified search strings in their titles (see Table 1). Scopus and WoS were chosen as the academic databases for

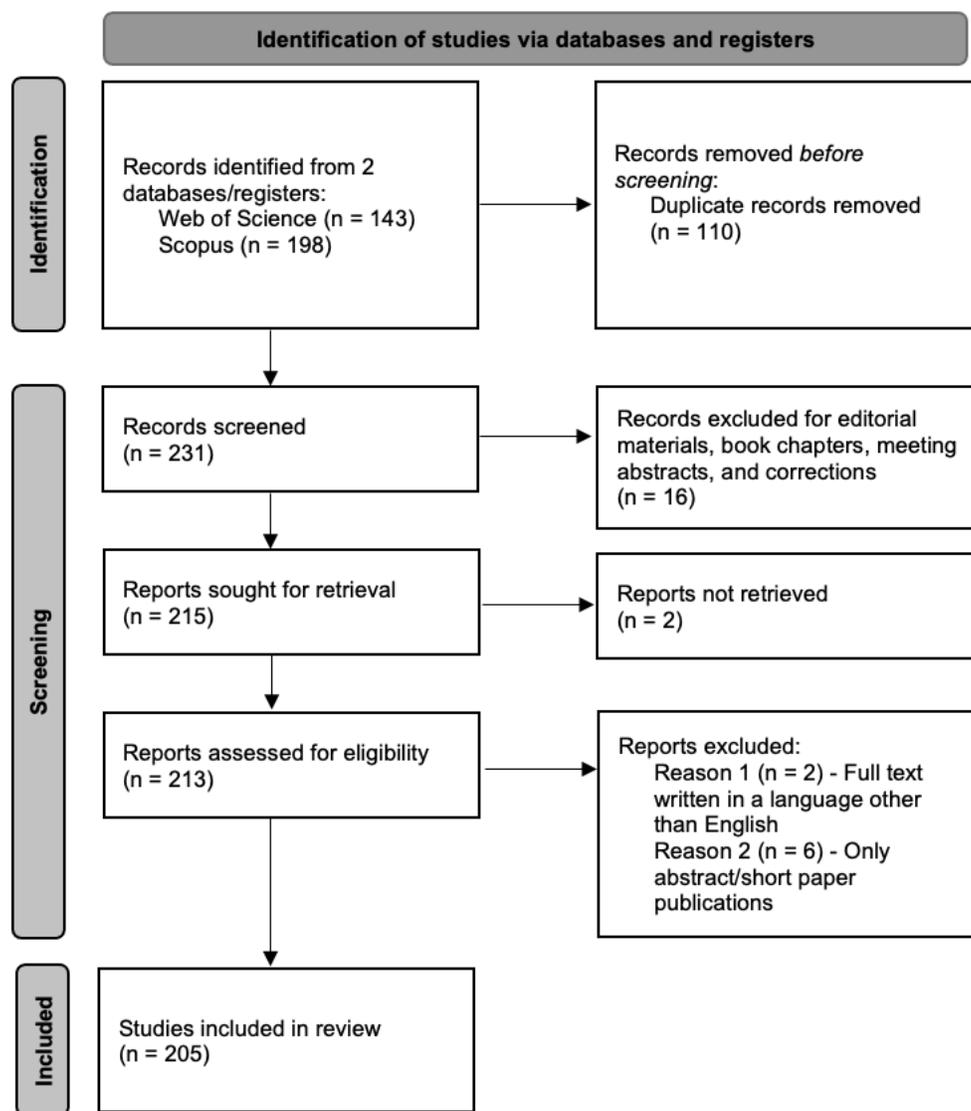
data retrieval due to their extensive coverage of publications, facilitating an inclusive approach. The construction of our research corpus involved the use of search strings related to micro-credentials in the educational landscape (see Table 1). Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Page et al., 2021). Figure 2 illustrates the comprehensive process and measures undertaken in compliance with the PRISMA statement guidelines and principles. Initially, a total of 341 relevant documents were identified across two databases (198 in Scopus, and 143 in WoS) as of January 15, 2025. Among these documents, 110 were found to be duplicates and subsequently excluded. Consequently, 231 documents underwent screening. The final research corpus comprised 205 publications.

The search algorithm was meticulously designed to capture a broad spectrum of pertinent literature, using variations of the term “micro-credentials” within the titles of potential articles. This was achieved by including both “micro-creden*” and “microcreden*” as search terms, the asterisk (*) serving as a wildcard character to encompass any extensions of the root word in publication titles. This approach was predicated on the assumption that the inclusion of these specific terms in article titles would yield a focused yet expansive collection of literature pertinent to the subject matter of interest. To align with the scope of online learning, only studies explicitly referring to online, digital, or technology-enhanced micro-credentialing systems were included. Publications focusing solely on face-to-face or workplace-based implementations without an online learning component were excluded.

Table 1

Search Strings

Databases	Search Strings	Years Covered
Scopus	TITLE (micro-creden*) OR TITLE (microcreden*)	2014-2024
WoS	(TI=(micro-creden*) OR TI=(microcreden*))	2015-2024

Figure 2*Flow Diagram of the PRISMA Statement****Data Analysis Procedures***

This study adopts a three-phased approach to investigate research trends, patterns, and themes in openness in education research. In the initial phase, bibliometric techniques (Donthu et al., 2021) are used to acquire descriptive findings. Moving to the second phase, the study employs lexical analytical approaches involving “two stages of co-occurrence, information extraction—semantic and relational—using a different algorithm for each stage” (Smith & Humphreys, 2006, p. 262). Finally, in the third phase, to gain a complementary perspective, the study uses Social Network Analysis (SNA) for keyword analysis. SNA “offers powerful ways to summarize networks and identify key people, [entities], or other objects that occupy strategic locations and positions within a matrix of links” (Hansen et al., 2010, p. 6). Within this context, lexical semantic relationships in titles and abstracts are identified through text mining.

Keywords related to openness in education studies are treated as nodes and analyzed based on their co-occurrence relationships, with the resulting patterns visualized on a network map.

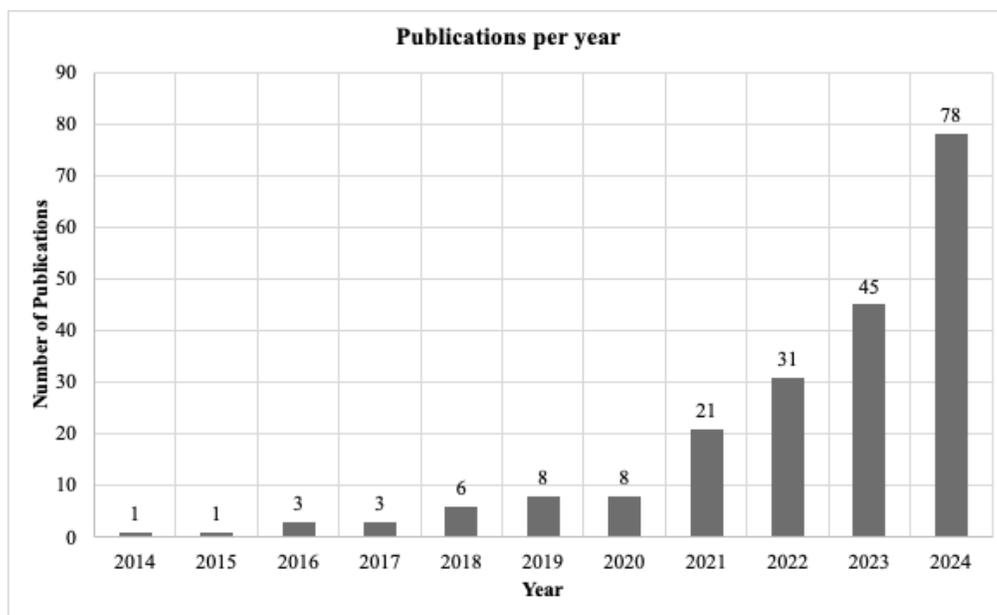
Limitations

This paper acknowledges several limitations in interpreting the study's findings. Primarily, while Scopus and WoS represent the largest databases for peer-reviewed publications, this study's findings are based on data obtained solely from these two scholarly sources. Despite the establishment of a substantial research corpus through this search, it is important to recognize that articles on micro-credentials may also exist in other databases, sources, and formats, including the grey literature. The study is limited to publications explicitly containing "micro-credentials" in their titles, which may have excluded relevant studies using synonymous or related terms. Furthermore, the reliance on Scopus and Web of Science databases may have led to language and publication bias. Finally, while efforts were made to ensure relevance to online learning, the interpretation of platform usage was dependent on how explicitly the source described the learning modality. As a result, this study offers only a partial perspective.

Findings and Discussion

Research Trends

The annual publication count throughout the studied period is presented in Figure 3. A modest increase in publication volume from 2014 to 2020 precedes a significant surge in 2021, with the number of publications in that year tripling compared to the prior year. This upward trend continues in the following years, reaching 45 publications in 2023, which is approximately six times higher than that of 2020. It is important to note that this study accounts for publications up to January 2025. Our analysis up until 2024 revealed an increasing trend in the number of publications, which continued in 2024. Based on this trend, we anticipate a continued increase in publications in the coming years.

Figure 3*Annual Number of Publications****Research Themes***

Within each investigation, the meta-components encompassing titles, abstracts, and keywords serve as an optimal representation of the articles at a granular but representational level. These elements encapsulate the fundamental essence of the articles, providing key insights in a succinct, concise, and well-structured manner. As a result, this segment meticulously examines the titles and abstracts of the studies using t-SNE analysis (Figure 4) a text-mining methodology, which evaluates the lexical associations to uncover evolving themes (Figure 5). Furthermore, this analysis delves into keywords to complement the text-mining examination (Figure 6), aiming to attain a clearer understanding and identify research patterns.

institutions can offer students, learners, and teachers' pathways that emphasize personalized learning, skill acquisition, and, more importantly, the agility to adapt to changing job market demands. These credentials can serve as critical nodes connecting higher education with lifelong learning, highlighting their potential to transform both pedagogy and curriculum design. This strategic approach not only enhances the training and educational experience but also aligns with the broader goal of fostering a culture of continuous learning and adaptation in an ever-evolving global landscape.

The abovementioned theme is also echoed in the related literature. Accordingly, micro-credentials, which have grown to be an increasingly popular subject, have been acknowledged to promote lifelong learning by bridging the gap between industry and higher education (Pawilen et al., 2024). The unbundling of educational practices and higher education itself may be impacted by micro-credentials, which are considered a possible alternative to higher education (Ehlers, 2018). Leading higher education institutions are required to create micro-credential programs and more open, accessible learning environments for learners in order to become qualified in this field provided their potential long-term impact (McGreal et al., 2022) and higher education institutions are anticipated to incorporate these innovations into the curriculum they offer. In their research of the relationship between micro-credentials and employability and lifelong learning, Brown et al. (2021) presented the argument that within the next five years, a well-established and advanced system of micro-credentials practices will have developed. Bayly-Castaneda et al. (2024) emphasize the necessity of adapting learning experiences to meet the evolving demands of the workforce, highlighting the importance of continuous skill acquisition through micro-credentials. This adaptability is essential in addressing the rapid changes in job markets and the skills required for future employment.

As reported in a Delphi study on the potential for micro-credential adoption in higher education, strategies, and policies need to be developed at the national and international levels, there is no one approach that is effective for all stakeholders, and the eventual outcome of this process is unpredictable (Pirkkalainen et al., 2023). Likewise, a study conducted for higher education administrators addressed whether micro-credentials are appropriate for the institution, potential challenges, and strategies that can be developed, and suggested that all stakeholders should come together on an agreement that minimizes risks and shares expenses associated with the easy implementation of micro-credential programs (McGreal & Olcott, 2022). Building collaborations with such stakeholders and promoting university-industry collaboration will provide an acceleration to learners' lifelong educational pathways (Fitzgerald & Huijser, 2021). According to this study, the use of micro-credentials in higher education proposes disruptive advantages in learning environments and provides alternative opportunities for both learners and the workforce demanding improvement in skills in lifelong learning processes.

Flexible Curriculum Solutions for Reskilling and Upskilling Requests from the Sector

This theme addresses the use of micro-credentials to provide flexible curriculum solutions essential for reskilling and upskilling the workforce, thereby meeting the needs of employers and various sectors. The theme is supported by the following insights from the following analysis:

- Figure 4 (t-SNE of Titles): Strategic nodes include micro-credentials, higher education, work, workforce, vocational, and skill.
- Figure 5 (Text-Mining of Abstracts): Connected paths link micro-credentials, employers, sector, workforce, upskilling, reskilling, need, and design, development, professional, knowledge, competency.
- Figure 6 (SNA of Keywords): Connected nodes show 21st-century skills, workforce development, employment, industry, and professional development.

This theme implies that flexible curriculum solutions involving micro-credentials are increasingly recognized as essential for reskilling and upskilling within the workforce, responding directly to the needs of employers and various sectors. These solutions bridge the gap between higher education and the workforce by aligning educational offerings with vocational skills and competencies that are in high demand. By focusing on the development of 21st-century skills, micro-credentials offer a tailored approach to professional development, allowing for the workforce to adapt to rapid changes in industry requirements and technological advancements. This strategic alignment between micro-credentials, employers, and higher education institutions ensures that the curriculum is not only responsive to the immediate needs of the sector but also encourages a culture of lifelong learning and continuous professional growth.

These ideas are also supported by the relevant literature. Accordingly, employers are able to use micro-credentials as a benchmark for shaping the upcoming workforce (Kohler et al., 2021) and assist currently employed workers in improving their abilities (Selvaratnam & Sankey, 2021). Employers' struggle to hire adequately qualified employees with the expertise they require, as well as fresh graduates' challenges to find jobs after graduating from the traditional education system, are driving up the demand for micro-credentialing (Olcott Jr., 2022) and fostering competitive rivalry. In addition, micro-credentials, which are available online, are considered by employers as a practical and flexible alternative to improve the soft skills of those already working in the sector (Bruguera et al., 2024).

The idea of lifelong learning should be supported by higher education institutions, and they need to evolve by facilitating the reskilling and upskilling processes and leading the way in the micro-credentialing process (Romero Llop et al., 2022). Furthermore, to serve as an advantageous resource for upskilling employees (Calonge & Shah, 2016), MOOC platforms give organizations straightforward scalable solutions to refresh and improve workforce-specific skills and offer credentials that result in formal certifications (Calonge et al., 2019). Micro-credentials as a career path are anticipated to be documented, and the industry will recognize and encourage the skills gained. Nevertheless, learners may not comprehend how to accomplish this (Healy, 2021), which could have perplexing effects in unstructured processes (Gauthier, 2020). Che Ahmat et al. (2021), who advise higher education and employers regarding how to strengthen graduate employability, suggest that the portability and independent verification of obtained credentials and micro-credentials are directly related to their international competitiveness. Government support for skill transformation processes in institutions and planning of micro-credentials according to workforce needs can contribute to developing different collaborations (Pachler, 2023).

Micro-Credentials and Digital Proofs for Skills, Qualifications, and Competencies

This theme explores how micro-credentials, along with digital badges and blockchain technology, are revolutionizing the way skills, qualifications, and competencies are recognized and verified in the digital age. The theme is supported by the following insights from the following analysis:

- Figure 4 (t-SNE of Titles): Strategic nodes include micro-credentials, micro-credentialing, digital, credentials, and badge.
- Figure 5 (Text-Mining of Abstracts): Connected paths link blockchain, adoption, higher education, technology, and micro-credentials, digital, badges, skills.
- Figure 6 (SNA of Keywords): Connected nodes highlight micro-credentials, badge, digital badge, competence, and blockchain.

According to this theme, micro-credentials, along with digital badges and blockchain technology, are revolutionizing the way skills, qualifications, and competencies are recognized and verified in the digital age. These digital proofs offer a granular, flexible, and transparent method of credentialing that aligns closely with the evolving needs of both individuals and organizations. The adoption of blockchain technology in the issuance and verification of micro-credentials ensures the security, portability, and authenticity of these digital badges, facilitating their acceptance across various sectors. By enabling learners to accumulate and showcase a portfolio of verified competencies, micro-credentials, and digital badges empowers individuals with the tools to navigate the complex landscape of 21st-century employment.

The ideas supporting this emerging theme were also discussed in the related literature. For example, Clements et al. (2020) explored the reasons for the growing acceptance of alternative credentials, blaming changes in the educational, demographic, and economic spheres. They highlighted open badges as a practical way to recognize a wide range of learning and achievements, highlighting how open badges may connect formal and informal learning contexts and meet the demands of the workforce in real-time. Kayyali et al. (2023), similarly, highlight that micro-credentials are seen as valuable for acquiring skills and competencies, with students motivated by both intrinsic and extrinsic factors. Likewise, Gregg et al. (2022) find that engineering students are motivated to participate in micro-credential program offerings due to both intrinsic interest in the topic and the professional value attributed to the digital badge. This suggests that while students see the inherent value in the learning process, the tangible outcomes (in the form of digital badges) also play a significant role in their decision to engage with micro-credentials.

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From the technological infrastructure perspective, Alsobhi et al. (2023), shed light on how micro-credential systems with blockchain can become more reliable and easier to verify. They point out that blockchain technology, known for its secure and unchangeable record-keeping, can be used to safely store academic records. This means that employers and academic institutions can quickly check someone's qualifications without having to go through a middleman. This approach doesn't just make the verification process smoother; it also makes it harder for people to fake their qualifications (Hölbl et al., 2018). Moreover, Shanmughan et al. (2024) explore how artificial intelligence (AI) can facilitate personalized learning paths, thereby enhancing the relevance and applicability of micro-credentials in diverse educational contexts. AI may play a crucial role in the development and personalization of micro-credentials. Even with these encouraging advancements, it is anticipated that AI will not be enough to fully evaluate complicated competencies, particularly in micro-credentials assessment procedures (Galindo et al., 2024). While AI can be an effective tool to increase efficiency in many operational processes, it may be limited in comprehensive competency assessment and credentialing.

Designing, Development, Adaptation, and Implementation of Micro-Credentials

(See strategic nodes in Figure 4: micro-credentials, readiness, design, development, implementation; see connected paths in Figure 5: micro-credentials, micro-credentialing, research, implementation, framework; see connected nodes in Figure 6: accreditation, design, development, implementation, credentials adoption.) This theme suggests that the design, development, adaptation, and implementation of micro-credentials involve a comprehensive approach that encompasses readiness assessment, research-based framework development, and strategic implementation processes. Such an approach ensures that micro-credentials are not only designed to meet the specific needs of learners and industries but are also developed with a clear framework that considers accreditation standards and the broader ecosystem of credential adoption. The integration of research into the micro-credentialing process is crucial for the formulation of effective and adaptable frameworks that support the seamless implementation and recognition of these credentials. Through careful design and development, followed by thoughtful adaptation to changing educational and workforce demands, the implementation of micro-credentials can significantly enhance the value and relevance of educational offerings, promoting a more agile and responsive accreditation and learning landscape.

Similar ideas were also articulated in the related literature. For instance, it is argued that micro-credentials can attest to online course completions and apply in face-to-face or blended formats. They are validated by a range of authorities, including universities, colleges, professional associations, and companies, and can be aligned or mapped to existing qualifications and/or standards frameworks. Types of micro-credentials include certificates, certifications, MOOCs, apprenticeships, coding boot camps, badges, MicroMasters, and Nano-degrees, each certifying learning or skill attainments or competencies based on some form of accepted assessment (McGreal & Olcott Jr., 2022). On the other hand, Clements et al. (2020)

and Mashford-Pringle et al. (2023) both underline the need for a clear framework for the accreditation of micro-credentials, ensuring that they are valued and recognized as legitimate evidence of professional development and competency. Platforms for issuing, viewing, and storing these digital credentials have proliferated, but there's still a gap in understanding their features and benefits fully (Kiiskilä et al., 2022).

Critiques and Challenges of Implementation and Adaptation of Micro-credentials

(See strategic nodes in Figure 4: micro-credentials, challenges; see connected paths in Figure 5: micro-credentials, challenges, value, qualifications, standards; see connected nodes in Figure 6: micro-credentials, accreditation.) According to the final theme focusing on issues to pay attention and suggesting being proactive, the implementation and adaptation of micro-credentials face several critiques and challenges, central to which are concerns about value, qualifications, and standards. A primary critique is the varying standards and definitions of micro-credentials, which can lead to confusion about their value and how they compare to traditional qualifications. This inconsistency poses challenges for accreditation bodies tasked with ensuring that these new forms of credentials meet rigorous educational standards. Furthermore, the adaptation of micro-credentials into existing educational and professional ecosystems necessitates a re-evaluation of how achievements and competencies are recognized and validated. Addressing these challenges requires collaborative efforts among educators, industry leaders, and accreditation organizations to establish clear guidelines and frameworks that uphold the integrity and value of micro-credentials.

In line with the scope of the aforementioned theme, Wheelahan and Moodie (2022) highlight the complexities of integrating micro-credentials into the education system and labor market. While micro-credentials offer potential benefits in terms of flexibility and responsiveness to changing skill demands, their implementation must be carefully considered to ensure they complement rather than undermine comprehensive educational experiences and support equitable access to meaningful employment opportunities. Likewise, McGreal and Olcott Jr. (2022) caution that micro-credentials should not be viewed as a panacea for institutional challenges or as a major revenue source, but rather as part of a broader strategic approach to education and training. The development of accreditation and quality standards may be a further challenge for microcredentials. In their research on quality assurance in the OECD countries, Brown and Duarte (2024) voiced concerns about the quality processes of micro-credentials, characterizing them as largely invisible and relatively immature. In the North American context—particularly in the U.S. and Canada—the lack of a unified national qualifications framework poses challenges for the consistent design, assessment, and policy alignment of micro-credentials. This variability across institutions and jurisdictions can influence both the development process and the level of trust and recognition afforded to these credentials by learners and employers.

Conclusions, Implications, and Suggestions

As a consequence of an expanding skills gap in the labor market, micro-credentials programs are becoming more and more common, and they have begun to establish a partnership between industry and higher education. A variety of organizations in this field have taken action in reaction to the increasing interest and demand for micro-credentials, opening up possibilities

for efforts and projects involving micro-credential recognition, verification, stackability, and the development of different uses. This study aimed to explore the evolving role of micro-credentials in education, summarize how they are currently perceived by major stakeholders, and outline potential future directions grounded in current research. Studies from the Web of Science and Scopus databases have been included in the study for this purpose, and the PRISMA protocol was employed to carry out a systematic analysis. The research findings were divided into five predominant impact areas. These are: the strategies in higher education and lifelong learning, sector-specific upskilling and reskilling programs, micro-credentials that provide digital proof of competency, challenges in designing and implementing micro-credentials, and critiques are among the most noteworthy characteristics in these areas.

Based on the findings of this study and insights gained through the reviewed papers, this study has some suggestions and implications for future research directions. Since the subject of micro-credentials is constantly evolving and dynamic, higher education institutions need to carefully figure out the way they will differentiate themselves. Higher education institutions should enact the necessary regulations, and the curriculum may need to adopt a skill-focused instructional design for this process to move forward in a flexible and all-inclusive approach.

Future studies may concentrate more specifically on one or more of the five impacts, which are based on the five significant impact areas outlined in the research's findings. The sector's skill in research and development can be evaluated through current programs across various dimensions or settings, particularly those driven by blockchain technology, which will verify and disseminate. Another crucial issue is that future research may investigate at the phases of creating policies and procedures that hasten the recognition of micro-credentials on a national or international level. Institutions aiming to adopt micro-credentialing systems should consider integrating them with existing LMS platforms to ensure smoother learner experience and recognition. Additionally, clear frameworks for skill validation and alignment with workforce needs are essential for increasing stakeholder trust. While the study focuses on peer-reviewed academic literature, it is important to note that practical implementations of micro-credentials by corporations and intergovernmental organizations (e.g., Microsoft, Boeing, NATO) may offer further insights. However, such industry-level data typically exists in grey literature and case-based reports, which were beyond the scope of this academic synthesis.

Looking ahead, the adoption of micro-credentials may catalyze a structural transformation in higher education. As traditional degrees face scrutiny regarding their labor market value, universities could increasingly adopt hybrid credentialing models—potentially balancing degree programs with modular, skill-focused micro-credentials. This shift could enable more flexible learning pathways, responsive curriculum design, and stronger alignment with lifelong learning and workforce development priorities. However, such transformation would require active engagement from faculty, accreditation bodies, and policy-making agencies to ensure coherence, quality assurance, and recognition across sectors.

Data Availability Statement

To enhance transparency and replicability, the full list of the 205 publications included in this systematic review, along with the processed dataset and analysis workflow, has been

made publicly available via the Open Science Framework (OSF). The data can be accessed using the following Digital Object Identifier (DOI): <https://doi.org/10.17605/OSF.IO/B9PQT>

Competing Interests

The authors have no competing interests to declare.

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