Exploring the potential of micro-credentials: A systematic literature review

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Micro-credentials have recently become a huge research interest, as they play an important role in the social, economic, and higher education sectors. Mindful of growing critique in some circles and recent publications, this paper offers an informed analysis of the potential of micro-credentials to foster post-COVID-19 pandemic recovery across a spectrum of dimensions, including supporting innovation in higher education institutions (HEIs). It reports a systematic literature review analysis of scientific articles published between 2015 and January 2022 on micro-credential research in the field of higher education. Results of a bibliometric and qualitative content analysis from 32 scientific articles provided insights into the potential of micro-credentials to foster post-pandemic recovery through social, economic, and higher education innovations. The findings suggest that the potential can be unfolded through multiple dimensions, like offering more possibilities for individuals to up-skill, re-skill and enter the labor market (economic context), enhancing lifelong learning by developing flexible personal learning pathways (social context), extending services in assessment and recognition of non-formal and informal learning, and introducing stackable credits and previous qualifications (higher education context). Even though the paper analyses scientific articles from the pre-pandemic and pandemic period, this study aim to systematize the results of other researchers and to offer sound insights into how further development in micro-credentials could contribute to the post-pandemic recovery.

1. Introduction

The World Economic Forum (2020) predicts that after the COVID-19 pandemic, half of all jobs will change substantially due to automation within the next 10 years. If this prediction is accurate, the current workforce, regardless of their current qualifications, will need to quickly re-skill and/or up-skill. According to the European Approach to Micro-credentials report (European Commission, 2020a), the demand for short learning options and their recognition and validation are likely to increase further as a means to achieve a sustainable recovery from the COVID-19 crisis in the social and economic context, as well as foster higher education innovations. Since the start of the pandemic, there has been an unprecedented surge in demand for online learning (CEDEFOP, 2020), which has been met by an expansion of online learning possibilities and micro-credentials (Orr et al., 2020). These changes brought challenges and resulted in new demands for the higher education sector, as conventional degree programs could no longer meet labor market demands (Gauthier, 2020) and respond to the needs of those requiring professional development. Researchers have confirmed that the pandemic has stimulated the need for the development of new competencies (Dirani et al., 2020; Reedy et al., 2021; Walpola and Lucas, 2021) and professional development that is "...personalized, competency-based, flexible, and collaborative" (Hunt et al., 2020, p. 34). The improvement in skills to meet the dynamically changing economic environment and the process of switching to learning online have become integral strategies for global recovery and economic resilience in the post-COVID period (Davidson, 2020). Consequently, higher education institutions (HEIs) worldwide have been challenged to respond to this change urgently.

Micro-credentials provide a perspective on and a targeted way to clearly validate competencies and facilitate employability, while HEIs have good opportunities to develop this area as both a provider (Porter and Perris, 2021) and an innovator. However, the most recent research raises concerns that micro-credentials might focus on changing traditional full-course curriculum into a more competence-based and work-related curriculum just to respond to the emerging need for more skilled workers (Ralston, 2021; Desmarchelier and Cary, 2022). Critical commentators alert that such transformation might lead to the commercialization of higher education which would bring a "moral hazard" (Ralston, 2021, p. 95). Although being aware of the potential risks and challenges that micro-credentials might bring to higher education, this paper seeks to emphasize the potential that micro-credentials may bring to foster social, economic, and higher education innovations. It is important to note, that within the scope of this paper, the higher education sector refers to universities and universities of applied sciences.

A growing number of studies have been conducted to investigate the emerging capacity of micro-credentials from the social (Desmarchelier and Cary, 2022; Msweli et al., 2022),

economic (Gauthier, 2020; Wheelahan and Moodie, 2021), higher or professional development perspectives (Hunt et al., 2020; Zhang and West, 2020). It is noted that in the current research literature, there is a thin line between the implications of micro-credentials for social and economic recovery, because the two contexts are closely interrelated (Davidson, 2020; Oliver, 2021), meaning that these aspects should be considered equally important. Despite a growing number of publications, this paper contends that a more integrative approach to research is required that looks more holistically at the key drivers and multiple dimensions of micro-credentials. A systematic literature review was chosen as an appropriate method for reviewing and summarizing this body of knowledge.

The aim of this research is to investigate from an integrative perspective the potential of micro-credentials to foster social, economic, and higher education innovations.

The research question: What is the potential of micro-credentials to foster the post-COVID-19 pandemic recovery through social, economic, and higher education innovations?

2. Theoretical rationale for micro-credentials

The concept of micro-credentials is relatively new, formed by the joint efforts of researchers, practitioners, and policy makers. As noted by Brown and Mhichil (2022) the use of the definition mainly depends on "who is using the term and in what context." While most of the time definitions of micro-credentials are based on a theoretical and scientific point of view, most of the existing models, prototypes, and practices are mainly explored and developed within the frameworks of different educational applied projects (e.g., MICROBOL, MICROHE). In this research, micro-credentials are considered a small volume of learning certified by a credential. Oliver (2022) provides a more detailed explanation of what constitutes a micro-credential by defining it as:

- A record of focused learning achievement verifying what the learner knows, understands or can do.
- Includes an assessment based on clearly defined standards and is awarded by a trusted provider.
- Has standalone value and may also contribute to or complement other micro-credentials or macro-credentials, including through recognition of prior learning.
- Meets the standards required by relevant quality assurance (p. 20).

In the context of the European Higher Education Area (EHEA), micro-credentials can be offered by HEIs or recognized by the institutions applying recognition procedures in line with the Lisbon Recognition Convention or recognition of previous learning, where applicable. Multiple initiatives aim to suggest

a set of constituting elements that need to be addressed to issue a micro-credential (MICROBOL, 2020; Oliver, 2022) so it would provide information on what specific knowledge, skills or competencies learners have achieved. Therefore, experts emphasize the importance of defining learning outcomes that might appear to be even more important than the volume of learning (Oliver, 2022). Moreover, for micro-credentials to respond to labor market needs, they are expected to be linked to the Framework of Qualifications of the European Higher Education Area and National Qualifications Framework (QF-EHEA/NQF) and, among other elements, indicate assessment methods, criteria, and be compliant with quality assurance requirements in line with the Standards and Guidelines for Quality Assurance in the European Higher Education Area [ESG] (MICROBOL, 2020, p. 7). All the above-mentioned aspects emerge to be very important when discussing how to define and deliver micro-credentials so they would serve the needs of different stakeholders (e.g., employers, learners, representatives of HEIs or policy makers) and serve as a tool to foster post-pandemic recovery through social, economic, and higher education innovations.

Micro-credentials build on discourses about the changing role of higher education in the 21st Century. They respond to the need of labor market by offering new skills, and extended services for assessment and recognition of previous learning (Lang and Giglietta, 2022), moreover, employers are eager to invest in human capital. Human Capital Theory argues that humans can increase their productive capacity through more education and increased skills training (Becker, 1964), and there is a direct link between increased investment in education and increasing economic output. Wheelahan and Moodie (2021) argue that micro-credentials "are based on a human capital perspective in which individuals invest in themselves by second guessing the requirements of the labor market" (p. 224). However, more recent interpretations of HCT recognize that learning is not just about financial well-being and earning but also about the quality improvement of an individual and their social life (Brown et al., 2020).

Set against this theoretical backdrop, European Union Skills agenda (European Commission, 2020b) introduces micro-credentials as a tool supporting lifelong learning through the development of work-related competencies, active citizenship, and personal development. It is believed that by introducing new approaches for professional development, career planning, and transformed learning design solutions, micro-credentials may contribute to the post-COVID-19 pandemic recovery (CEDEFOP, 2022). Research prior to the pandemic suggests that most learners pursue micro-credentials for work-related purposes (Kato et al., 2020), which leads to increasing expectations for higher education institutions to offer a more competence-based and work-related teaching and learning curriculum. Therefore, it is necessary to further investigate micro-credentials to better determine

their long-term viability and potential contribution from an integrative perspective that offers insights not only from the higher education sector, but wider social and economic viewpoint. However, to be implemented in practice, micro-credentials need to be understood as an innovation. According to Diffusion of Innovation Theory (Rogers, 2003), every innovation goes through five phases: awareness, persuasion, decision, implementation, and confirmation. Importantly, Brennan et al. (2014) note that:

> many innovation practices do not radically modify the traditional higher education institutions' functions; rather, they provide new ways of doing traditional things that respond more efficiently to changing requirements in higher education (p. 8).

From this perspective, micro-credentials, respectively, do not aim to change the traditional approach to higher education but to introduce an innovative approach to professional development, recognition, assessment of prior learning, etc. Educational institutions are now given a new role of micro-credential issuers in the education ecosystem (Acree, 2018). Brown et al. (2021), p. 238) draw attention that "micro-credentials have many different faces and should not be treated or generalized as a single uniform entity." Considering this, it is important not to oversimplify micro-credentialing and be aware not only of the capacity that they can bring but also of the challenges and risks they can pose. Therefore, it is seen, that the process of micro-credentialization has now entered a persuasion phase, where stakeholders reconsider both, the benefits and challenges that this process might bring.

As already noted, there is consensus that a sustainable European approach to micro-credentials also encompasses the public mission of universities, which is the provision of high-quality, learner-centered, and innovative education and training (Futures et al., 2020). Short-term open learning opportunities leading to micro-credentials may help widen the scope of learning and skills development opportunities and form the lifelong learning dimension in higher education. By providing learners with flexibility in choosing the time, location, teaching, and access methods at a lower cost, more social groups of different ages can be reached (European Commission, 2020a). However, while the assessment and recognition of micro-credentials are confined by employers and policy makers (Oliver, 2022), more discussions are needed to provide a more consistent approach and understanding of the their potential.

To sum up, micro-credentials, as a novel fast-developing type of credential in Europe and other parts of the world, are a response to the fast-changing skill needs of the labor market. They allow for the targeted acquisition of skills and competencies while not replacing traditional qualifications, offer HEIs new opportunities, and introduce possibilities

for quick learner-centered and competence-based professional development. Moreover, they highlight the importance of transparent recognition and assessment processes that, among other factors, would help to increase the trust in micro-credentials globally (Oliver, 2022). As the above theoretical analysis illustrates, micro-credentials from an integrative perspective have the capacity to positively affect social, economic, and higher education sectors and contribute to a sustainable post-pandemic recovery by widening learning opportunities.

3. Research methodology

A systematic literature review is characterized by a criteria-based, structured, reproducible, and methodical design for collecting existing evidence on the researched topic and uncovering areas where further research is needed (Xiao and Watson, 2019).

In this section, the process of selecting articles is explained. Figure 1 provides a visualization of the identification, screening, and eligibility procedures. To conduct this review, researchers followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Checklist, which includes

27 items (Rethlefsen et al., 2021). Additionally, the researchers developed a systematic literature review protocol that ensured a consistent and quality-assured process.

3.1. Identification of articles

Two researchers conducted electronic searches for eligible research articles in the following databases: EBSCOhost, Taylor&Francis, and SpringerLink. These are highly recognized databases that index journals in the fields of social sciences and education. The initial search phase took place on December 20, 2021. Following the systematic literature review principles, a team of researchers determined the inclusion and exclusion criteria for data collection. The criteria for identifying the articles included the following:

- The article had to be published during the time period from January 1, 2015, to January 5, 2022.
- The article had to be published in peer-reviewed journals.
- The article had to be in English.
- The article had to be available in full-text format (with a university library membership).
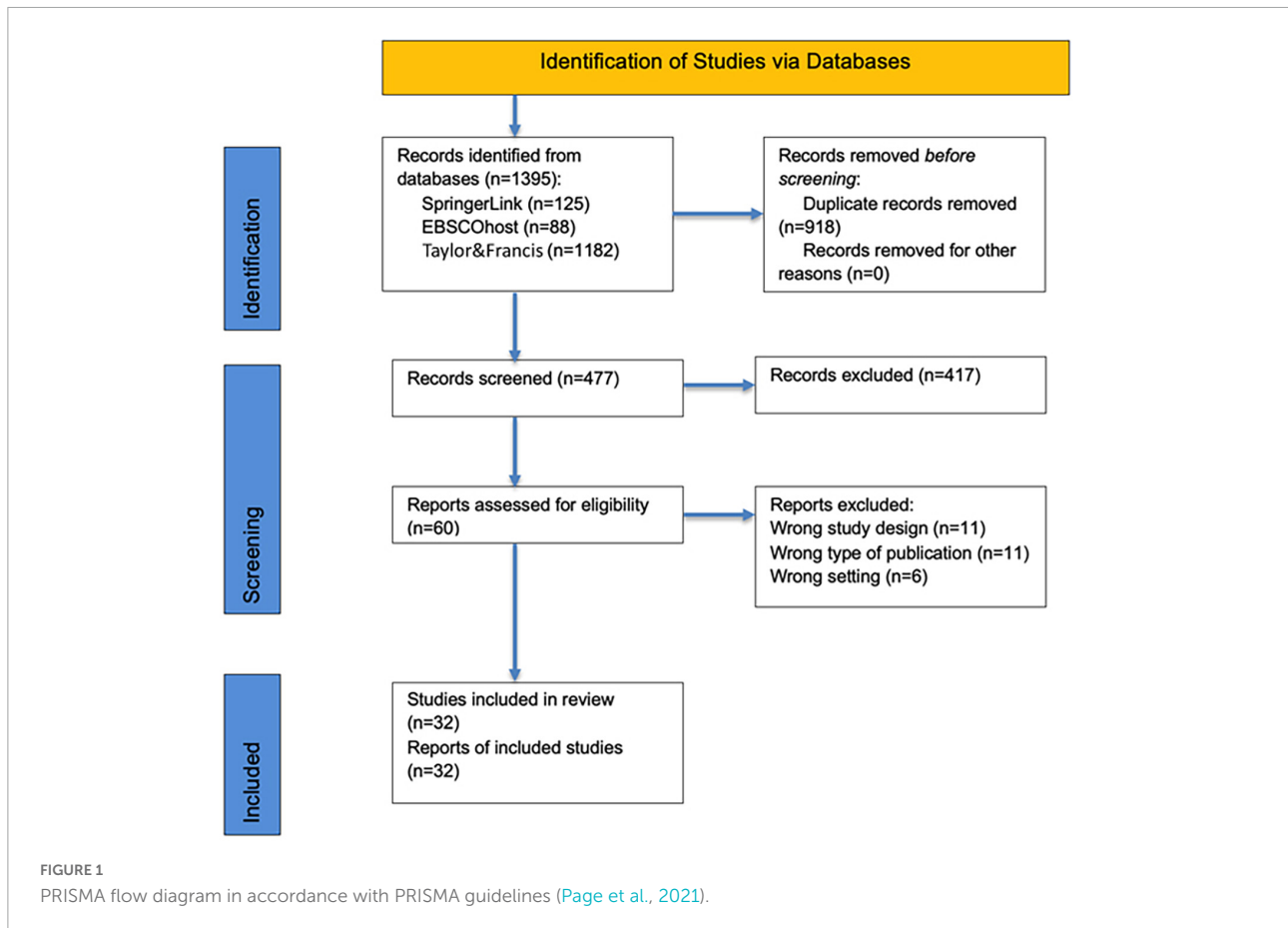

FIGURE 1
PRISMA flow diagram in accordance with PRISMA guidelines (Page et al., 2021).

TABLE 1 Inclusion and exclusion criteria used for screening.

Inclusion criteria	Exclusion criteria
• Studies published in peer-reviewed academic journals	• Publications that refer to digital badges when they are not considered as micro-credentials
• Keywords mentioned in the title or abstract	• Publications included in gray literature and non-peer-reviewed journals

TABLE 2 Distribution of articles included in the data extraction process per database.

Database	Number of articles	%
EBSCOhost	7	22
Taylor&Francis	10	31
SpringerLink	15	47
Total	**32**	**100**

The researchers discussed and defined the main concepts used for the keyword search to ensure the inclusiveness of the most relevant articles. As a result, two keyword phrases were included in the Boolean operator search: *micro-credential** or *microcredential AND higher education or university or college.*

The researchers identified the articles using the keywords and evaluated whether the criteria had been met. A total of 1,395 studies were identified. All articles were imported into EndNote, where duplicates were removed ($n = 918$), resulting in 477 studies to be screened. References of the articles were exported to the systematic review management software Covidence, which ensured systematic and collaborative screening and full-text review processes.

3.2. Screening procedure

During the second stage, two researchers independently screened titles and abstracts by applying the inclusion and exclusion criteria, which are presented in Table 1.

As the researchers screened the studies independently, in case of disagreements or conflict, they discussed the conflicting decision until consensus was achieved. As a result of this meticulous procedure, 417 articles were excluded; thus, 60 articles remained for the full-text review.

3.3. Eligibility

Two researchers reviewed the full texts of all 60 articles eligible for full-text screening. When needed, the researchers discussed and resolved discrepancies. Twenty-eight articles were excluded for the following reasons: wrong study design ($n = 11$); wrong type of publication, meaning it was a non-academic article ($n = 11$); and wrong setting ($n = 6$). A total of 32 articles remained for data extraction for the final analysis.

3.4. Data extraction

A data extraction form was built on the Covidence platform, which allowed extraction of the main characteristics of the articles, such as the region where the study was conducted,

research aim, research questions, study design, topics covered, and research focus. In addition, there was a box for notes in the form in which the reviewers could note their main insights, questions, or doubts.

3.5. Study characteristics

Overall, 32 articles from all three databases were included (Table 2). As can be seen, most studies are indexed in the SpringerLink database.

3.6. Data analysis

The bibliometric data analysis was followed by a descriptive content analysis to obtain information about the content of the articles. In this study, descriptive content analysis was used to review the research design, research focus, and predetermined sub-topics. Overall, 10 sub-topics were predetermined that focused on the dimensions that would lead to uncovering social, economic, and higher education innovations.

The following guiding questions were used to support the main research question throughout the data analysis process:

- What is the distribution over time of research articles that examined micro-credentials in the higher education context?
- What is the research focus of the research articles?
- What is the distribution of the research articles by country/region?

3.7. Reliability and validity

To ensure the reliability and validity of the findings, two researchers worked together throughout the entire process. The initial screening of the articles was performed strictly following the systematic literature review protocol. Then, both researchers reviewed the same article, and if any discrepancies were found, the researchers had to discuss to reach consensus; this ensured the reliability and validity of the findings. In addition, once the first draft of the analysis was completed, it was sent to four

independent experts who were asked to evaluate and review the findings. Once feedback from the experts was received, it was noted that there was consistency among all four experts' opinions. This process allowed us to check whether all stages of the research, including research item identification, screening procedures, and data extraction, were conducted properly; thus, the findings can be considered reliable and valid.

3.8. Limitations

As the systematic review took place during the end of 2021 and the beginning of 2022, articles published later than January 5, 2022, were not included. As a result, there is a chance that more publications will be relevant to this research and complement the findings.

Taking into consideration the scope and focus of the research, only databases in the social sciences and education fields were used to identify articles. Therefore, other relevant articles on micro-credentials from different fields, such as medicine, were not included.

The search followed very strict procedural requirements for the systematic literature review. As the initial screening for the articles was conducted using concrete keywords, e.g., *micro-credential** or *microcredential AND higher education or university or college*, in either the title or the abstract. This resulted in the immediate elimination of a significant portion of research articles that were on the topic of micro-credentials, but their title or abstract did not include the keywords.

4. Findings

In this section, the findings of the systematic literature review and the qualitative content analysis are presented. The articles were analyzed in terms of the topics and the sub-topics covered, as well as the research focus. However, the distribution by research design, geographic region, and year of publication was considered, as it may have some influence on the research results.

4.1. Distribution by year of publication

The articles were categorized in terms of their publication year.

An increase in publications during the pandemic period can be seen in Figure 2. Interest in micro-credentials grew significantly from 2019 to 2021, and many educational institutions had to switch to emergency online teaching and learning. Due to a pandemic that brought challenges when various social and economic restrictions were imposed, employees had to look for alternative ways to requalify to remain

competitive in the labor market. While there were 12 articles published in 2021, in contrast, there were no publications in 2016 that fit the inclusion criteria. Most of the articles published during the pandemic focused on the potential of micro-credentials to address pandemic-introduced challenges.

4.2. Distribution by country/region

The articles were grouped in accordance with their geographic region. The distribution of the articles by geographic region is presented in Table 3.

Categorization highlighted the common trends in what regions and countries are leading in the research on micro-credentialization. Moreover, it is noted that micro-credentials are defined differently in different regions. In the Australian region (five articles; 16%; e.g., Ruddy and Ponte, 2019; Cook, 2021; Ralston, 2021; Selvaratnam and Sankey, 2021) micro-credentials are understood as individual courses that can be stacked up to a higher-value credential, whereas in the European region, micro-credentials are seen as a type of credential in the digital format (Egloffstein and Ifenthaler, 2017; Jirgensons and Kapenieks, 2018). Articles (15 articles; 47%) written by American authors (e.g., Copenhaver and Pritchard, 2017; Ippoliti and Baeza, 2017; Cheng et al., 2018; Santandreu Calonge et al., 2019; Stefaniak and Carey, 2019; Newby and Cheng, 2020) refer to micro-credentials as digital badges, which in the European context are often seen only as one type of micro-credential.

4.3. Distribution by study design

The analysis of the study design offered the opportunity to determine the most frequently used research methods, which may provide a comprehensive view of micro-credentialing in the context of higher education. The distribution of research articles by study design is presented in Table 4.

Because micro-credentials as a phenomenon are still relatively new, the articles implemented unconventional research methods and designs. Many articles (47%) on micro-credentials employed various study methods, including document analysis, systematic analysis, and research-based design. Moreover, it was observed that the articles used more rigorous and explicit research designs, such as a mixed-method design, in order to analyze micro-credentials. Aiming to depict the overall image of micro-credentials and their implications for social and economic processes, and higher education innovations, 19% of the articles implemented a mixed-method design. Among the other popular conventional research methods and designs, 16% of the articles employed quantitative approaches, and 9% presented case studies that allowed analysis of micro-credentials. Although due to its nature, the
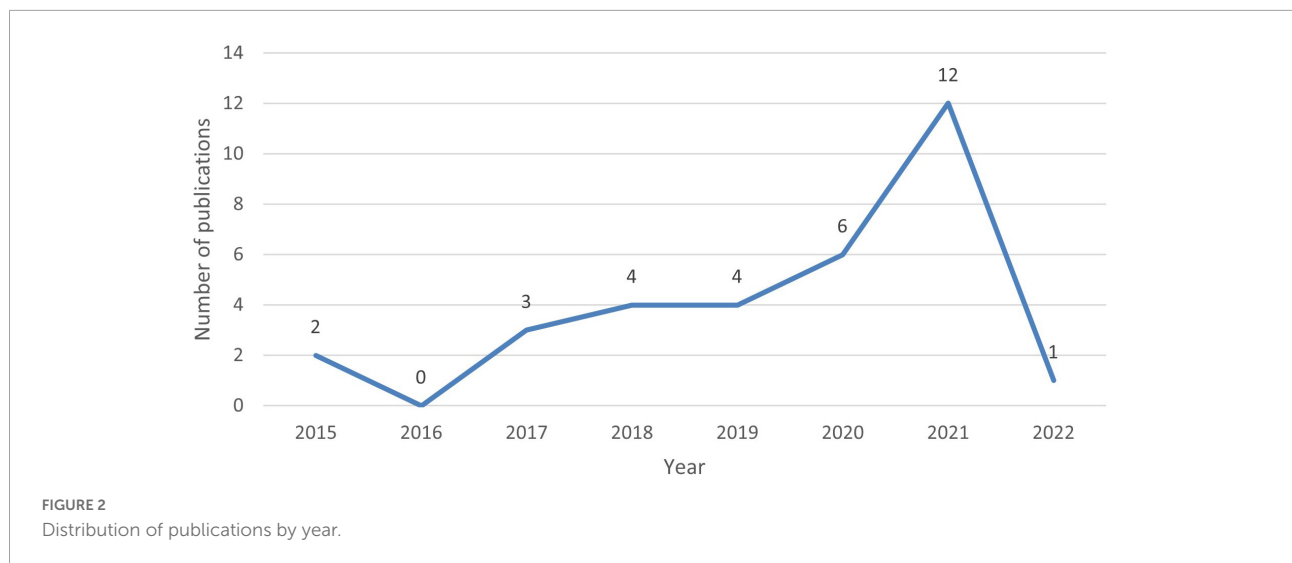
FIGURE 2
Distribution of publications by year.

TABLE 3   Distribution by country/region.

Country/Region	Number of articles	%
United States	15	47
Australia	5	16
Canada	3	9
Europe	5	16
Other	4	12
Total	**32**	**100**

TABLE 4   Distribution by study design.

Study design	Number of articles	%
Mixed method research	6	19
Quantitative research	5	16
Qualitative research	3	9
Case study	3	9
Other	15	47
Total	**32**	**100**

quantitative research on micro-credentials presented the main tendencies, the case studies analyzed micro-credentials in real-life contexts, thus providing a hands-on approach to the reader. Finally, 9% of the articles employed qualitative methods. It can be concluded that qualitative and case study approaches are seen to be the least popular study designs for researching micro-credentials, and this is presumably because the topic is relatively new and there are not yet enough actual long-standing practices to analyse.

4.4. Distribution by research focus

The articles were also analyzed in terms of their research focus. The analysis showed that research on micro-credentials usually focuses on the following: barriers to successful integration of micro-credentials, success factors and enablers that facilitate implementation of micro-credentialization, and the potential of micro-credentials to support various processes within the social, economic, and higher education sectors.

The analysis revealed that the vast majority of the articles (70%) focused on the potential of micro-credentials to facilitate various social and economic processes and explored micro-credentials as higher education innovations. However, 18% of

the articles examined the main barriers to efficient micro-credentialization integration into the social, economic, and higher education contexts. Such factors as stakeholders' attitudes toward new types of credentials, some intrinsic barriers, lack of policy guidelines and regulations that would determine the use of micro-credentialing within certain contexts, insufficient technical infrastructure, procedures for recognition of micro-credentials, issues with program designs, and lack of teacher digital competence have been indicated as the main barriers to efficient integration of micro-credentials (Stefaniak and Carey, 2019; Clausen, 2022). In addition, 7% of the articles discussed the success factors of micro-credentialization. Finally, a minority of the articles (5%) investigated micro-credentials as mechanisms for fostering social and economic progress and higher education innovations, demonstrating the existing gap in the literature.

4.5. Distribution by sub-topics covered

The analysis indicated that research on micro-credentials has focused on the following topics: social, economic, and higher education innovations. The analysis suggested that these main topics are communicated through sub-topics, including

re-and up-skilling, employers' needs, employability, lifelong learning, career guidance, well-being/welfare, assessment, and recognition, stackability of credits and qualifications, integration into curriculum, and learning design solutions (see Table 5).

4.6. The potential of micro-credentials in social and economic contexts

Results of analyzed publications confirm that micro-credentials are frequently discussed in the economic context. To illustrate, 18 out of the 32 articles discuss the integration of micro-credentials for the purpose of re-and up-skilling to open up possibilities for employees in the labor market. To illustrate, Copenhaver and Pritchard (2017) stress that the integration of micro-credentials can facilitate such processes as professional development, contribute documentation of employees' learning achievements, and assist with far-reaching learning programs. In addition, 14 articles investigated the potential and main barriers to micro-credentialization for career guidance. Eighteen articles analyze the importance and the potential of micro-credentialing for increasing employability. In fact, micro-credentials can often be treated as a means for facilitating the hiring process; however, problems arise if employers are unfamiliar with the concept and doubt its validity and reliability compared to traditional types of credentials (Devedžić and Jovanović, 2015). Nonetheless, the potential of micro-credentials is undeniable in identifying potential candidates' actual skills and competencies needed for a position (Gauthier, 2020). Consequently, micro-credentials can contribute significantly to global recovery and economic resilience in the post-COVID-19 period (Davidson, 2020).

Fourteen articles discuss what employers expect from higher education graduates and how the implementation of micro-credentials may help address employers' need to create a more flexible and competitive labor force. The labor market constantly places new demands on potential employees, as the vast majority of jobs are expected to change significantly due to automation processes (World Economic Forum, 2020). The research suggests that higher education graduates are often ill-prepared to successfully integrate within the labor market, as they lack essential practical skills, qualifications, and competencies (Gauthier, 2020). Often, formal degree qualifications are criticized by employers, as higher education graduates fail to demonstrate practical skills, and degree programs equip students with theoretical knowledge that is not desired by the labor market. There is a tendency to underestimate the importance of formal qualification, the labor market dictates demand for new skill sets and qualifications (Gauthier, 2020; Ralston, 2021). Therefore, micro-credentials may be advantageous for employers trying to determine the most suitable candidates for positions (Devedžić and Jovanović,

2015; Gauthier, 2020). While employers are exploring ways to equip their workforces with the skill sets needed to increase overall efficiency, higher education students and graduates seek easier integration within the labor market. Micro-credentialing can assist by addressing the needs of all the stakeholders involved (Gauthier, 2020).

In addition, micro-credentials have been analyzed in the social context, as a large number of the articles (22) explored micro-credentials and their potential in the context of lifelong learning. The contribution of micro-credentials to lifelong learning has been observed from two different perspectives: fostering the development of certain skills in learners and the ability of micro-credentials to document learning achievements. The feature of micro-credentials, tracking and documenting learning achievements, is praised, as it advocates lifelong learning (Woods and Woods, 2021). The potential of micro-credentials to facilitate the development of lifelong learners equipped with skills that would be easily reconciled with the specific demands of the labor market (Gauthier, 2020; Ashcroft et al., 2021) and to document the acquisition of these skills (Fisher and Leder, 2022) is undeniable.

4.7. The potential of micro-credentials in the context of higher education

The research underscores the importance of an integrative perspective as the role of micro-credentials in supporting higher education innovations was also evident throughout the literature. As shown in Table 5, most of the articles (24) focus on the integration of micro-credentials into the curriculum. This has become extremely relevant since the start of the pandemic, when digitalization of education became a dominant trend globally (Davidson, 2020). Most of the articles explored the main barriers to and the potential of micro-credentials within the context of higher education. The main emphasis is on micro-credentials as facilitators in the process of developing a competence-based curriculum, which is related to job requirements and responsibilities (Wheelahan and Moodie, 2021). The research also suggests that micro-credentials can bring flexibility into curriculum design (Cook, 2021), as students can choose topics that are interesting to and beneficial for them.

Seventeen articles focus on the features of micro-credentials, such as the stackability of credits and prior qualifications. This feature has been of great interest in the context of employability and the labor market. The findings also revealed that the topic of assessment and recognition of previous learning, documented through the use of micro-credentials, is very common in the research literature. To illustrate this point, Carey and Stefaniak (2018) explored open digital badges as substitutions for traditional credentials and diploma supplements. Moreover, McCullough and Buch (2020) recognize micro-credentials as an innovative solution in the context of higher education to record

TABLE 5 Distribution by sub-topics covered.

	Subtopics covered	Total (out of 32)	Authors
Economic context	Re-skilling and/or up-skilling	18	Copenhaver and Pritchard, 2017; Egloffstein and Ifenthaler, 2017; Carey and Stefaniak, 2018; Jirgensons and Kapenieks, 2018; Ruddy and Ponte, 2019; Santandreu Calonge et al., 2019; Gauthier, 2020; McCullough and Buch, 2020; Zhang and West, 2020; Ashcroft et al., 2021; Gamrat and Zimmerman, 2021; Olcott, 2021; Ralston, 2021; Wheelahan and Moodie, 2021; White, 2021; Woods and Woods, 2021; Clausen, 2022; Fisher and Leder, 2022
	Employers' needs	14	Devedžić and Jovanović, 2015; Copenhaver and Pritchard, 2017; Egloffstein and Ifenthaler, 2017; Ruddy and Ponte, 2019; Santandreu Calonge et al., 2019; Gauthier, 2020; Ashcroft et al., 2021; Cook, 2021; Olcott, 2021; Ralston, 2021; Wheelahan and Moodie, 2021; Woods and Woods, 2021; Fisher and Leder, 2022; Wheelahan and Moodie, 2022
	Employability	18	Devedžić and Jovanović, 2015; Law, 2015; Copenhaver and Pritchard, 2017; Egloffstein and Ifenthaler, 2017; Ghasia et al., 2019; Ruddy and Ponte, 2019; Santandreu Calonge et al., 2019; Stefaniak and Carey, 2019; Gauthier, 2020; Zhang and West, 2020; Ashcroft et al., 2021; Olcott, 2021; Ralston, 2021; Wheelahan and Moodie, 2021; Woods and Woods, 2021; Wheelahan and Moodie, 2022; Clausen, 2022; Fisher and Leder, 2022
Social context	Lifelong learning	23	Devedžić and Jovanović, 2015; Law, 2015; Copenhaver and Pritchard, 2017; Egloffstein and Ifenthaler, 2017; Carey and Stefaniak, 2018; Jirgensons and Kapenieks, 2018; Ghasia et al., 2019; Ruddy and Ponte, 2019; Santandreu Calonge et al., 2019; Stefaniak and Carey, 2019; Gauthier, 2020; McCullough and Buch, 2020; Peacock et al., 2020; Zhang and West, 2020; Ashcroft et al., 2021; Gamrat and Zimmerman, 2021; Olcott, 2021; Ralston, 2021; Selvaratnam and Sankey, 2021; Wheelahan and Moodie, 2021; White, 2021; Woods and Woods, 2021; Wheelahan and Moodie, 2022
	Career guidance	14	Egloffstein and Ifenthaler, 2017; Ghasia et al., 2019; Santandreu Calonge et al., 2019; Cheng et al., 2020; Gauthier, 2020; McCullough and Buch, 2020; Zhang and West, 2020; Ashcroft et al., 2021; Gamrat and Zimmerman, 2021; Olcott, 2021; Ralston, 2021; Wheelahan and Moodie, 2021; White, 2021; Wheelahan and Moodie, 2022
	Well-being/welfare	2	Olcott, 2021; Ralston, 2021
Higher education context	Assessment and recognition of prior learning	16	Devedžić and Jovanović, 2015; Law, 2015; Copenhaver and Pritchard, 2017; Ippoliti and Baeza, 2017; Coleman, 2018; Jirgensons and Kapenieks, 2018; Ghasia et al., 2019; Ruddy and Ponte, 2019; Stefaniak and Carey, 2019; Gauthier, 2020; McCullough and Buch, 2020; Ashcroft et al., 2021; Olcott, 2021; Selvaratnam and Sankey, 2021; White, 2021; Woods and Woods, 2021
	Stackability of credits and qualifications	17	Carey and Stefaniak, 2018; Jirgensons and Kapenieks, 2018; Ghasia et al., 2019; Ruddy and Ponte, 2019; Stefaniak and Carey, 2019; McCullough and Buch, 2020; Zhang and West, 2020; Ashcroft et al., 2021; Cook, 2021; Olcott, 2021; Ralston, 2021; Selvaratnam and Sankey, 2021; Wheelahan and Moodie, 2021; White, 2021; Woods and Woods, 2021; Clausen, 2022; Fisher and Leder, 2022
	Integration into curriculum	24	Devedžić and Jovanović, 2015; Law, 2015; Copenhaver and Pritchard, 2017; Ippoliti and Baeza, 2017; Carey and Stefaniak, 2018; Cheng et al., 2018; Coleman, 2018; Ghasia et al., 2019; Ruddy and Ponte, 2019; Stefaniak and Carey, 2019; Cheng et al., 2020; McCullough and Buch, 2020; Newby and Cheng, 2020; Peacock et al., 2020; Alt, 2021; Ashcroft et al., 2021; Cook, 2021; Gamrat and Zimmerman, 2021; Olcott, 2021; Ralston, 2021; Selvaratnam and Sankey, 2021; Wheelahan and Moodie, 2021; Woods and Woods, 2021; Clausen, 2022
	Learning design solutions	16	Devedžić and Jovanović, 2015; Copenhaver and Pritchard, 2017; Cheng et al., 2018; Coleman, 2018; Ghasia et al., 2019; Cheng et al., 2020; Gauthier, 2020; McCullough and Buch, 2020; Newby and Cheng, 2020; Peacock et al., 2020; Zhang and West, 2020; Alt, 2021; Ashcroft et al., 2021; Cook, 2021; Gamrat and Zimmerman, 2021; Wheelahan and Moodie, 2021

learning achievements, acquire skills, and track professional development. Finally, the analysis showed that the potential of micro-credentials as innovative learning design solutions has been frequently explored (16 articles). Articles examined existing policies and guidelines that encourage HEIs to explore and implement micro-credentials in course design to increase learner engagement and motivation to study (Ghasia et al., 2019; Ruddy and Ponte, 2019).

5. Discussion and conclusion

It is important to acknowledge that since the time this literature review was undertaken, several new publications have emerged, including other literature reviews (e.g., Brown et al., 2021; Brown and Mhichil, 2022; Fisher and Leder, 2022; McGreal et al., 2022; Nguyen et al., 2022). This work both confirms some of the findings of this study and introduces new

developments in the micro-credentialing area. Several of the key findings of these new publications are integrated into the discussion below reflecting on the main themes emerging from the literature review. Next to theoretical observations, insights about the development of micro-credentials infrastructure are presented at the end of this section.

This systematic literature review aimed to answer the following question: What is the potential of micro-credentials to foster the post-pandemic recovery through social, economic, and higher education innovations? The bibliometric analysis revealed an increasing interest in micro-credentials from the perspective of different stakeholders, including policy developers, higher education representatives, learners, and employers. The number of studies on micro-credentials in higher education has increased significantly since 2020. This result can be explained by the emerging need to respond to the global pandemic, which "created the opportunity for strategic reset and change" (Olcott, 2021, p. 14) and "serve[d] as one catalyst for shifting directions and navigating post-pandemic higher education" (Olcott, 2021, p. 14). The systematic literature review revealed that micro-credentials provide new opportunities for learners to acquire additional and co-curricular skills, such as information and digital literacies, critical thinking, and teamwork (Ruddy and Ponte, 2019), and at the same time, support employers' need for "an alternative, cheaper, more flexible, and at scale continuing professional development" (Santandreu Calonge et al., 2019). Micro-credentials may help employers identify an applicant's actual skills needed for a job (Gauthier, 2020). In addition, micro-credentials, offering learners a quicker and more cost-effective mechanism for acquiring specific industry-recognized competencies and skills that are necessary for successful work performance and/or employability, are valued and recognized by employers.

McGreal et al. (2022) suggest multiple different factors have forced the growth of interest in micro-credentials at the higher education level including:

- the pandemic,
- the growing costs of education,
- employers' concerns about insufficient learners' level of skills and competencies to successfully integrate into labor markets,
- difficulties regarding the accessibility of education,
- students' fears about limited job opportunities.

Micro-credentials offer a lot of advantages, however, most importantly, they enable learners to develop desired professional skills and competencies and support knowledge and skills acquisition processes (Nguyen et al., 2022). Micro-credentials allow the integration of innovative teaching and learning design solutions by focusing more on learner-centered learning where students can support their own learning by planning and monitoring it (Nguyen et al., 2022).

5.1. Micro-credentials as social and economic innovations

The process of micro-credentialization involves a wide range of social stakeholders, such as employers, employees, corporate and private companies, and educational institutions with an emphasis on quality assurance processes (Olcott, 2021). Consequently, the awareness of micro-credentials should be expanded, while its potential for economic and workforce development should not be doubted. To illustrate this point, from an employer's perspective, the essence of micro-credentials is economics and competition. In the contemporary post-pandemic labor market, employers face a challenge in finding a well-equipped workforce that could respond to work-related challenges and demonstrate a high level of expertise upon recruitment (Gauthier, 2020), since "the majority of the employers and admission officers ignore any credits that are not recognized as a formal credentialing system" (Ghasia et al., 2019, p. 225). From the other point of view, micro-credentials can help narrow down the pool of potential candidates and select those who demonstrate the specific skills needed for a job.

However, in the context of the Human Capital Theory, micro-credentials should be seen from a wider perspective. It does not necessarily mean that having the right credential or qualification can ensure one's success in overcoming social disruptions and finding a job one is qualified for Brown et al. (2020). It is one's personal investment in professional identity and social life that can be seen as the basis for the congested labor market, fostering employers to transmit internal training and learning to individuals (Wheelahan and Moodie, 2022). To respond to this change, HEIs are expected to provide more learning services, micro-credentials being one of them.

Following on this point, Fisher and Leder (2022) highlight the potential of micro-credentials to create a more immediate educational supply to capture new skills and update competencies quickly, offering methods that suit employees' individual needs as well as allowing them to stack micro-credentials up toward the desired qualifications. For example, there have been attempts to motivate employees to learn with micro-credentials, exploring them as a low-cost way to assess and promote learning, track achievement, encourage professional development (Copenhaver and Pritchard, 2017), and increase employability (Maina et al., 2022). In addition, employers seek professional development through online learning and the credentialing of that learning, which can later be recognized as formal qualifications. This claim appears in some of the more recent literature that has been published since the review was undertaken. For example,

McGreal et al. (2022) state that micro-credentials offer the possibility to stack the credentials issued by different educational providers, in meantime, ensuring that the potential employers will receive a permanent digital record of the applicant's level of proficiencies and skills acquired that are vital for the applicants to successfully perform the tasks in the workplace.

From the employees' and learners' perspective, micro-credentials can be highly valued for those who are not able to find a job that fits their qualifications, as they can provide an alternative pathway for re-skilling and/or up-skilling, which can then be seen as a cheaper, more flexible option to foster professional development (Santandreu Calonge et al., 2019). They allow the development of learning pathways when learners can plan their learning by selecting courses or subjects that they need and when they need them. Working professionals are more likely to participate in the targeted learning offered by micro-credentials, which breaks down conventional degree programs, meaning that traditional programs have been subdivided and separate components are offered as separate micro-credentials so learners can choose only a few skills to learn. In such a way the idea of lifelong learning is supported, demonstrating the acquired competencies and skills, contributing to the recognition of the qualifications and competencies, increasing employability, and providing future career guidance (Cheng et al., 2020). Woods and Woods (2021) note, that for working adults, micro-credentials offer flexibility that cannot be provided by conventional degree programs.

While the literature shows clear benefits for employers, employees and learners, it also reveals several concerns and strong criticisms about the growing micro-credentialing movement. Two main criticisms have been leveled at micro-credentials. First, Ralston (2021) claims the "micro-credentialing craze" is contributing to the "decline of the traditional degree. It paves the way for the total substitution of degree programs with micro-credentials..." (p. 95). This perspective expresses a concern that micro-credentials may boost the commercialization of higher education when HEIs will focus on financial interests more than serving the needs of lifelong learning or personal professional development (Desmarchelier and Cary, 2022; Nguyen et al., 2022; Wheelahan and Moodie, 2022). Next to this, Ralston (2021) raises a second concern, claiming that most of the discussions on micro-credentialization are carried by the top-level (i.e., policy makers, higher education management, employers, etc.), while the bottom level (including students, teachers, and communities) is yet not heard (Reynoldson, 2022). Therefore, Reynoldson (2022) predicts that the general attitudes toward micro-credentialization and its possible effects on social, economic, and higher education would be rather different from what is being depicted.

5.2. Micro-credentials as higher education innovations

Decisions on the implementation of micro-credentials affect every HEI. This research shows that some HEIs see micro-credentials as a tool for lifelong learning (Ghasia et al., 2019) and for the development and consolidation of innovations. The integration of micro-credentials enables HEIs to extend their services and functions in assessing and recognizing non-formal and informal learning. In alignment with the Diffusion of Innovation theory, there is evidence in the literature that the process of implementing micro-credentials takes place over a period of time, with actions and decisions that involve all stakeholders.

Olcott (2021) emphasized the recognition of non-formal and informal learning in which the benefits of micro-credentials can be exploited, such as non-certificate courses for volunteer work, academic skills and integrity, staff training, and technological competence. Moreover, professional courses for staff development could be assessed as micro-credentials and cover areas such as teaching-/learning-related subjects, technology, and professional skills (Selvaratnam and Sankey, 2021).

Micro-credentialization allows for a rich variety of motivations and opportunities for students (Coleman, 2018). They are portrayed as a more advantageous option when comparing them with traditional degree studies, as they offer a greater level of flexibility and accessibility of learning, and make education affordable, especially for learners who come from disadvantaged settings (Oliver, 2021). Micro-credentials connect students' activities and experiences to learning and development in a meaningful way, engaging them through a combination of intrinsic and extrinsic motivators involved in self-regulated learning. Gish-Lieberman et al. (2021) support this idea indicating that up to now, the common trend in micro-credentials is that they are better suited for active, self-regulated, and autonomous learners. Even though it may sound rather positive, another recently published literature review (Nguyen et al., 2022) shows that many students shared their fears that they may not have vital learning skills to undertake micro-credentials and, in that way, acquire needed professional skills and competencies.

In such a way, the critique of micro-credentials extends to higher education innovations. For example, Wheelahan and Moodie (2022) claim that micro-credentials may boost the privatization and commercialization of education, and put more demands on learners, whose main goal becomes to enter the rigorous labor market. Moreover, even though students demand an affordable way to combine their studies and preparation for entering the labor market (McGreal et al., 2022), many of them express concern about the quality of micro-credentials as the design and content often do not meet the standards (Nguyen et al., 2022; Wheelahan and Moodie, 2022). In fact, this student

concern is supported by the findings of the recently conducted international survey within higher education and industrial sectors, which demonstrated that there is still a lack of common standards for and quality assurance of micro-credentialization process, thus, micro-credentials are still not widely accepted (Holon IQ, 2021).

Micro-credentials can also be beneficial for higher education institutions, as these credentials are usually offered in a digital format; they may increase the accessibility of education and ensure higher enrollment rates. Indeed, micro-credentials enable higher education institutions to remain attentive and respond to rigorous industry needs and at the same time carry on with their business, i.e., providing education to the masses (Reynoldson, 2022). However, the critique expressed in some of the recent publications raises awareness "whether micro-credentialing, with its constituent processes of unbundling and servitization, is an acceptable long-term strategy for institutions concerned to survive and thrive in a highly competitive education marketplace" (Ralston, 2021, p. 98). Ralston (2021) postdigital-Deweyan critique points out that the tendencies are rather worrying as the traditional role of education providers is disturbed and the entire sector becomes more and more commercialized. Moreover, this critical approach is supported by Reynoldson (2022) claiming that with the increased need for more industry-oriented education, learners are forced to undertake new roles as they are often pictured as flexible and hard-working workers, who are devoted and ready to acquire the demanded skills and competencies to boost the economy. The entire existence of a learner in education is defined in terms of employment perspectives and the potential to make profits, respond to labor market demands and second guess what competencies or requirements will be needed in a near future (Wheelahan and Moodie, 2021). Therefore, micro-credentials become a way to track capital, by pointing out the value of a holder in the labor market (Reynoldson, 2022), rather than a mechanism to provide a deep and quality learning experience.

The ideas presented above should be reconsidered from a critical perspective understanding that "there is more to the micro-credentials story than we have revealed thus far" (Brown et al., 2021, p. 238) so they should be discussed in a wider context. For example, while a single micro-credential may not support and ensure professional development or demonstrate proficiency in specific competencies fully, the possibility to stack them through lifelong learning may benefit learners and employees a lot (Desmarchelier and Cary, 2022).

While the integration of micro-credentials into higher education is seen as an innovative practice, it requires rethinking operating structures to offer micro-credentials in different formats (Selvaratnam and Sankey, 2021). As observed in the Australian context, attempts to turn traditional courses into micro-credentials or integrate them into the currently existing courses have failed (Boud et al., 2021). It is noted that the process of change may be slow and build over time, and at the same

time, it may go through the phases described by the diffusion of innovations theory. Therefore, a broader understanding of the implementation processes and infrastructure of micro-credentials is needed, taking into consideration institutional regulations, infrastructure, faculty members' incentives, and curriculum changes.

Considering this, some important issues of platforms and infrastructure need to be observed. Clausen (2022) examined the adoption of micro-credentials and highlighted structural and technical challenges in the higher education system as well as identified challenges for support and professional development staff members. For instance, if higher education institutions seek to implement digital badges as micro-credentials, they need to evaluate their scalability capabilities, "consider the degree of transferability" (Carey and Stefaniak, 2018, p. 1225), and consider that the digital badge application process should be standardized in order to function successfully in a given system that would act as currency between the educational institution and the industry. The same rule applies to the introduction of micro-credentials in higher education. On the other hand, Carey and Stefaniak (2018) concluded that adaptation requires complex changes, while the main factors that negatively affect the use of micro-credentials include an increased workload for professors and a lack of understanding of the purpose and value of micro-credentials.

Processes for the digitalization of learners' data and elements in the recognition process of micro-credentials should be seen as part of a wider digital infrastructure. When discussing the role of blockchain and the future of digital learning, Jirgensons and Kapenieks (2018) distinguished multiple elements that are required for the platform where micro-credentials are documented and stored, including security assertion, recipient, issuer, criteria applied, and evidence of accomplishment. One of the initiatives and developments in this domain within the European Union context is the Europass Digital Credentials Infrastructure (EDCI) which allows standardized metadata and interoperability of different tools (Council of the European Union, 2022). However, the capacity and development of Europass in the context of the micro-credentialing process are not much featured in the literature. This demonstrates the efforts of individual institutions to promote the development of micro-credentials by offering innovative solutions in a context that might be different from other universities. Implementation of the infrastructure may help to ensure the successful development of the integration of micro-credentials in different types of institutions and provide support for all the stakeholders of this process.

6. Implications of the study

The research demonstrates that the diffusion of micro-credentials as an innovation in higher education is likely to

continue in response to the constantly changing requirements for this sector. Therefore, HEIs could be seen both as providers and innovators in the micro-credentialization process. As with any other innovations, before being fully adopted and implemented, micro-credentials need to go through different innovation phases (Acree, 2018) and therefore it might take more time to realize their potential (Oliver, 2021). Higher education institutions need to recognize micro-credentials as innovative practices that require changes and flexibility in competence-based curriculum design. Next to this, there is a need for close cooperation with the labor market, the extension of services and functions in the assessment and recognition of non-and informal learning, stackability of credits and previous qualifications, and reconstruction of operating structures, such as institutional regulations, faculty staff incentives, and infrastructure (Egloffstein and Ifenthaler, 2017; Clausen, 2022). Consequently, it is crucial for HEIs to implement micro-credentials for learning improvement and to increase the employability of higher education graduates. Considering the potential that micro-credentials bring and how they may foster post-pandemic recovery at different levels, this research supports the idea that "the development of micro-credentials needs to be in the service of these big ideas, not as a big idea in itself" (Brown et al., 2021, p. 250). Although there is very little research on the implementation of micro-credentials into higher education institutions in the post-pandemic period, the findings suggest that the implementation of micro-credentials in higher education may foster life skills (e.g., interpersonal and psychosocial) and employability skills among university graduates. Even though the research shows a lot of potential in micro-credentialization, the criticisms should not be ignored as micro-credentialization may accelerate the inflation and commercialization of education.

From an economic point of view, micro-credentials, especially those for the purpose of re-and up-skilling, and personalized and competence-based professional development (Hunt et al., 2020; Gamrat and Zimmerman, 2021) may open up possibilities for individuals to enter the labor market (Kato et al., 2020). Transferable skills (e.g., communication skills, critical thinking, and teamwork) tend to be the skills most appreciated by individuals in their long-term careers, while specific technical skills or specialized knowledge have limited validity but are highly valued by employers.

From the social perspective, micro-credentials encourage learners to engage in lifelong learning by allowing them to create flexible personal learning pathways (Hunt et al., 2020), learn at their own pace, recognize the acquired skills and competencies, and increase their career prospects. Moreover, in the long-term perspective, the value to individuals in their careers of acquiring transferable and specific skills through micro-credentialing is undeniable, because they allow individuals to remain competitive in the labor market (Gauthier, 2020) and improve themselves as individuals.

Research, presented in this article, carries significant implications for further research in the field of micro-credentials. Considering the fact that the research on micro-credentials is still in the early stages and most of the articles have been published during and pre-pandemic period, it is necessary to further investigate micro-credentials to better determine their viability and usefulness in the long-time perspective. Also, the analysis has shown that the topic of micro-credentials in the social, economic, and higher education sectors is mostly analyzed from a single stakeholder perspective. Thus, explicit research studies that would examine the micro-credentials in the above-mentioned areas from multiple stakeholders' perspectives would be highly appreciated. Additionally, the research has indicated that micro-credentials may have considerable benefits and potential to contribute to a sustainable recovery in the post-pandemic world, however, the latest research literature elaborates further, by highlighting some major criticisms of micro-credentials. Thus, it is rather recommended to conduct further investigations in different sectors to determine the capacity and the risks that micro-credentials may bring to the process of micro-credentialization. As the research has demonstrated, the vast majority of studies conducted on the topic of micro-credentials are limited to specific, mostly descriptive research methods, therefore, further research which incorporates a qualitative approach and methods that could provide rich insights would be highly appreciated to enrich the field.

Finally, the rapid growth of published scientific papers on micro-credentials since this review was undertaken, and the launch of several new policy frameworks developed by governments around the world, confirms the relevance and significance of this study and the need for further research.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

and give consent to submit this article for publication in this journal, made a substantial contribution to the manuscript, read, and approved the final manuscript.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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