



Mapping the Evolving Landscape of Micro-Credentials: Research Trends, Lifelong Learning, and Employability

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Abstract: Micro-credentials have gained increasing attention as flexible forms of learning recognition within the changing landscape of lifelong learning and employability. This study maps the development, conceptual structure, thematic evolution, and international collaboration of micro-credentials research. A bibliometric analysis examined 135 English-language journal articles indexed in Scopus and published between 2015 and 2026. The analysis combined scientific performance indicators with keyword co-occurrence, thematic mapping, thematic evolution, trend topics, and international collaboration analysis. The findings reveal rapid growth in the field, with 77.8% of publications appearing between 2023 and 2026. Micro-credentials, higher education, lifelong learning, and employability emerge as central concepts in the research network. The thematic structure identifies micro-credentials, higher education, and lifelong learning as basic themes, while professional development, accreditation, e-learning, workforce development, equity, and personalized learning represent more developed themes. Temporal patterns also show growing connections between micro-credentials, lifelong learning, and employability, alongside increasing attention to workforce development and equity. International collaboration remains uneven across countries and does not necessarily correspond with publication productivity. Overall, the findings indicate an expanding and increasingly interconnected research landscape in which micro-credentials extend beyond alternative credentialing toward broader discussions of lifelong learning, employability, professional development, and workforce needs. This study systematically maps the field and highlights directions for future research on the long-term outcomes, recognition, quality, and equitable development of micro-credentials.

Keywords: Micro-credentials; Lifelong Learning; Employability; Bibliometric Analysis

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INTRODUCTION

Changing competency needs, driven by digital transformation, technological developments, and the dynamics of the world of work, have created a need for more flexible, adaptive, and lifelong accessible learning systems. Educational models that rely on long-term formal qualifications cannot always meet individuals' needs to acquire, update, or develop specific competencies in a relatively short period. In this context, micro-credentials have emerged as a form of recognition for more specific, focused learning outcomes, achieved through learning experiences with a smaller scope than conventional qualification programs. This flexibility makes micro-credentials increasingly relevant in educational discourses, professional development, and lifelong learning.

The development of micro-credentials is not only related to the diversification of credential forms, but also to a shift in learning orientation toward skills that better meet the needs of individuals and society. Various micro-credential programs support upskilling, reskilling, professional development, increased employability, and mastery of specific competencies needed in work and life. Their modular, relatively short, and competency-oriented characteristics allow learners to acquire skills without always having to follow a formal education program for a long duration (Moore et al., 2025; Sargent et al., 2023; Varadarajan et al., 2025). . Thus, micro-credentials can be understood not only as an alternative certification mechanism, but also as part of a learning ecosystem that links competency development with changing learning needs throughout life.

This linkage places micro-credentials in a broader discourse on lifelong learning. Lifelong learning emphasizes the sustainability of the learning process across different stages of life and across formal,

nonformal, and informal contexts. In this perspective, micro-credentials have the potential to provide a more flexible learning path for individuals to update knowledge and skills according to changing personal, professional, and social needs (Bruguera et al., 2025; Desmarchelier & Cary, 2022; Guest, 2024; Narong, 2025; Pirkkalainen et al., 2023; Venaruzzo & Diaz, 2025; Zdunek et al., 2024). Its relevance grows as learning needs extend beyond early-life qualification acquisition to ongoing upskilling and reskilling. The relationship between micro-credentials, skill development, and lifelong learning thus suggests a shift from credentials as proof of educational completion to credentials as part of a more sustainable and flexible competency development process (Brown & Nic-Giolla-Mhichil, 2022; McGreal et al., 2022).

In line with these developments, research on micro-credentials shows a growing concern in various contexts of education and workforce development. Previous studies have discussed micro-credentials in higher education, digital credentials, employability, professional development, upskilling and reskilling, competency recognition, and implementation and quality assurance. These developments show that micro-credentials have developed into a multidimensional field of study that brings together issues of education, competence, technology, and the needs of the world of work (Alenezi et al., 2024; Celik & Toprak, 2026; Surono & Jusuf, 2025; Thi Ngoc Ha et al., 2023; Wihendro et al., 2024). However, this breadth also causes knowledge about micro-credentials to be spread across various research orientations, so that the conceptual relationship between micro-credentials, skills development, and lifelong learning is not easily understood as an integrated research landscape.

Several studies have attempted to map the development of micro-credential studies through literature reviews and bibliometric analyses. These studies make an important contribution in showing the growth of publications, implementation contexts, credential characteristics, and the development of micro-credential research, especially at the higher education level (Alsobhi et al., 2023; Johan et al., 2025; Tamoliune et al., 2023; Yüksel, 2025). However, mapping that specifically places skills development and lifelong learning as a common point in the development of knowledge about micro-credentials still requires further attention. As a result, it is not entirely clear how this field's intellectual structure is formed, which themes dominate, how themes interconnect, and where research on micro-credentials for skills development and lifelong learning is moving.

This gap matters because increased publications do not automatically clarify a field's structure and developmental direction. Bibliometric analysis systematically analyzes scientific literature through performance analysis and science mapping to identify scientific productivity, the influence of sources and documents, collaboration patterns, conceptual structure, and the development of research themes. This approach maps relationships between concepts scattered across the micro-credentials literature through keyword co-occurrence, thematic mapping, and thematic evolution. Thus, bibliometric analysis not only shows how the field is evolving, but can also reveal how research orientation is shifting and which themes are gaining attention as the field develops.

Based on these gaps, this study aims to map the development and structure of research knowledge regarding micro-credentials for skills development and lifelong learning through bibliometric analysis of Scopus-indexed publications. In particular, the research is directed to answer three questions: (1) how research on micro-credentials for skills development and lifelong learning develops based on scientific production, publication sources, geographical contributions, and scientific impacts; (2) how the conceptual and thematic structures shape the field of research; and (3) how the main themes develop over time and what new themes indicate the direction of future research. The analysis used Biblioshiny to integrate performance analysis and science mapping, particularly through scientific production analysis, citations, keyword co-occurrence, trend topics, thematic maps, and thematic evolution.

This research contributes by shifting the mapping of micro-credentials from a general or dominant discussion to a specific educational context, and by clarifying the position of micro-credentials at the intersection of skill development and lifelong learning. Through mapping conceptual structures and thematic evolution, this research is expected to identify themes that have developed strongly, themes that remain peripheral or are still developing, and the relationships among credential orientation, competency development, and learning sustainability. These findings can then form the basis for a research agenda on micro-credentials that better responds to the needs of skills development and lifelong learning.

METHODS

This study uses a bibliometric analysis design to map the development of research on micro-credentials in the context of skills development and lifelong learning. Bibliometric analysis was chosen because it allows the identification of publication development, scientific contributions, patterns of inter-concepts, thematic structure, and the direction of development of a research field systematically and can be replicated (Aleskerov

et al., 2026; Oliveira, 2024). The research procedure is carried out through several stages, which include data collection, document filtering, data extraction and cleaning, bibliometric analysis, and visualization of results. These stages align with the bibliometric analysis procedure, which includes data collection, filtering, extraction, analysis, and visualization.

Bibliographic data were obtained from Scopus, which was chosen because it provides broad coverage of peer-reviewed scientific publications and sufficient bibliographic metadata for bibliometric analysis. The search was conducted in September 2026 through the title, abstract, and keywords fields (TITLE-ABS-KEY) using a combination of Boolean operators. The search strategy combines terms that represent micro-credentials with terms related to skill development and lifelong learning. Search terms include "micro-credential" OR "microcredential" OR "micro credential" combined with "lifelong learning", "life-long learning", "continuing education", "continuing professional development", "professional development", "adult learning", "adult education", "skills development", "skill development", "skills training", "skill training", "upskilling", "reskilling", "employability", "workforce development", and "workforce training". Searches are limited to publications for the period 2015-2026 without geographical restrictions. The initial search returned 430 documents, which were then selected based on predetermined criteria. This reporting component follows a reference article that describes the database, keyword combinations, search time, and year range before describing the document screening process.

Table 1. Document Screening Process

Stages	Description	Number of Documents
Initial search results	All documents obtained from Scopus with a period of	718
Filter period	Publication year 2015-2026	430
Filter fields of science	Social Sciences	305
Document type filters	Article	151
Language filters	English	147
Relevance screening	Relevant based on title and abstract checks	135
Final Dataset	Documents that meet all criteria	135

As shown in Table 1, the screening process is carried out in stages to obtain a collection of documents aligned with the research focus. Of the 718 documents obtained in the initial search, the publication period is first limited to 2015-2026. Next, documents are selected by field of knowledge, document type, and language. Documents that meet all these filters are then examined by title and abstract to ensure their relevance to micro-credentials in the context of skills development and lifelong learning. This gradual screening process aims to exclude documents outside the research scope while retaining publications relevant to the conceptual structure to be mapped. Reference articles also use sequential filtering by period, field of knowledge, document type, and language before assigning datasets for analysis.

The inclusion criteria in this study include publications that are (1) indexed in Scopus; (2) published in the period 2015-2026; (3) included in the field of Social Sciences; (4) journal articles; (5) written in English; and (6) have a substantive relevance to micro-credentials in the context of skills development, lifelong learning, upskilling, reskilling, professional development, employability, or relevant forms of competency development. The exclusion criteria include publications outside the research period, outside the established field of knowledge, written in languages other than English, and in the form of conference papers, reviews, book chapters, editorials, notes, or other document types other than journal articles. Publications that only mention search terms but do not substantively discuss micro-credentials in the context of skill development or lifelong learning are also excluded after examination of titles and abstracts. The study also applies explicit inclusion and exclusion criteria to reference articles to ensure the document's suitability for the bibliometric focus being analyzed.

The final dataset is then exported from Scopus in BibTeX format for analysis using Biblioshiny. Before analysis, the data is checked for duplications and metadata inconsistencies. The cleanup process includes checking and standardizing bibliographic information such as title, author name, affiliation, abstract, keywords, year of publication, publication source, citations, and references. Standardization also addresses variations in how terms referring to the same concept are written to avoid fragmentation in keyword analysis. For example, variations of micro-credentials, micro-credentials, microcredentials, and microcredential are standardized to micro-credentials, while life-long learning is standardized to lifelong learning. This procedure aligns with the reference article by eliminating duplication and standardizing metadata before bibliometric analysis.

The cleaned data are analyzed using Biblioshiny, a web-based interface for the Bibliometrix package in R. Performance Analysis describes research progress based on annual scientific output, publication sources, state contributions, citation patterns, and influential documents. Meanwhile, Science Mapping identifies the conceptual structure and development of research themes through keyword co-occurrence, trend topics, thematic maps, and thematic evolution. Together, these approaches provide an overview of the quantitative development, as well as the knowledge structure and dynamics, of micro-credentials research themes for skill development and lifelong learning. The reference article also distinguishes analysis into Performance Analysis to examine productivity and Science Mapping to explore the intellectual structure of the research field.

To ensure transparency and repeatability, the authors explicitly report search strategies, databases, publication periods, inclusion and exclusion criteria, screening processes, data-cleaning procedures, and bibliometric analysis techniques. Figure 1 visualizes all stages of document collection and screening, including identification, screening, feasibility, and final dataset determination. Because this study uses secondary bibliographic data from Scopus and does not involve participants directly, it does not collect personal data from research subjects. The reference article also emphasizes transparent search strategies and inclusion criteria as part of efforts to improve the validity, reliability, and replicability of the analysis.



Figure 1. Data Collection and Filtering Pipeline

RESULTS AND DISCUSSION

RESULTS

Key Information and Publication Trends

The bibliometric analysis includes 135 articles published from 2015 to 2026 across 93 publication sources. The corpus involves 390 authors, with an average of 3.02 co-authors per document and an international collaboration rate of 19.26%. The average citations per document reached 15.99, while the annual publication growth rate was recorded at 38.86%. These characteristics provide a preliminary overview of the corpus's size, development, and authorship patterns before the analysis shifts to scientific production trends, citation impacts, conceptual structures, thematic developments, and scientific collaboration.

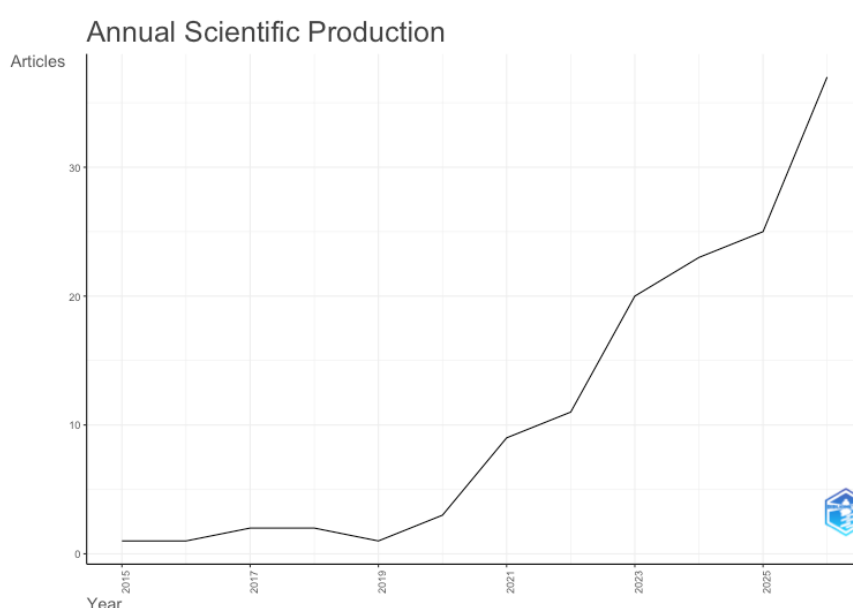


Figure 2. Annual Scientific Production of Micro-Credentials Research, 2015-2026

As shown in Figure 1, scientific production in the early period (2015-2020) remained relatively limited, fluctuating between one and three articles per year. The increase began in 2021, with nine articles, and continued to 11 articles in 2022. Growth accelerated after 2023, when publications reached 20 articles, then rose to 23 in 2024, 25 in 2025, and 37 in 2026. Overall, 105 of 135 articles (77.8%) were published during 2023-2026, indicating that research activity has concentrated in recent years.

This pattern shows that micro-credentials are evolving from relatively limited topics to areas of study that are gaining increasing scientific attention. The concentration of publications in recent periods also shows increased academic attention to more flexible and alternative forms of credentials. However, the number of publications in 2026 should be interpreted with the timing of data collection in mind if the search is conducted before the end of the year.

Scientific Production by Country, Affiliation, Author, and Source

1. Most Productive Countries

The geographical distribution shows that micro-credentials research has involved a wide range of countries, although contribution levels vary noticeably.

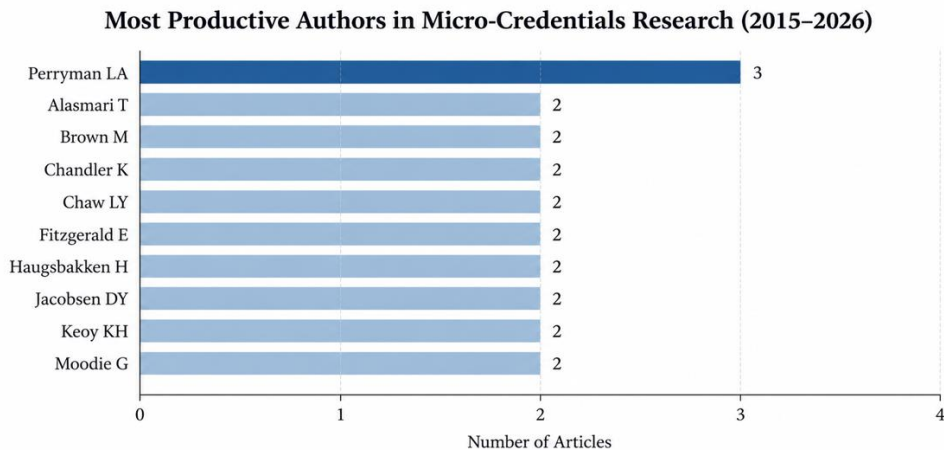


Figure 3. Most Productive Countries in Micro-Credentials Research

The United States recorded the highest frequency of scientific contributions, at 53, followed by Malaysia (33), Australia (32), the United Kingdom (25), and Canada and Turkey, which each had a frequency of 12. The distribution highlights the United States' outstanding contribution, as well as the strong research activity in Malaysia and Australia. Malaysia's position also shows that micro-credentials research development is not concentrated only in North American and European contexts. The findings show the widening geographical distribution of micro-credentials research. However, the Country Scientific Production indicator represents the frequency of country occurrences based on the author's affiliated metadata. It does not always match the number of unique articles produced by each country. Therefore, the frequency is not counted as a proportion of the overall 135 articles.

2. Most Productive Affiliates

An affiliation-level analysis identified the institutions that contributed most to micro-credentials research.

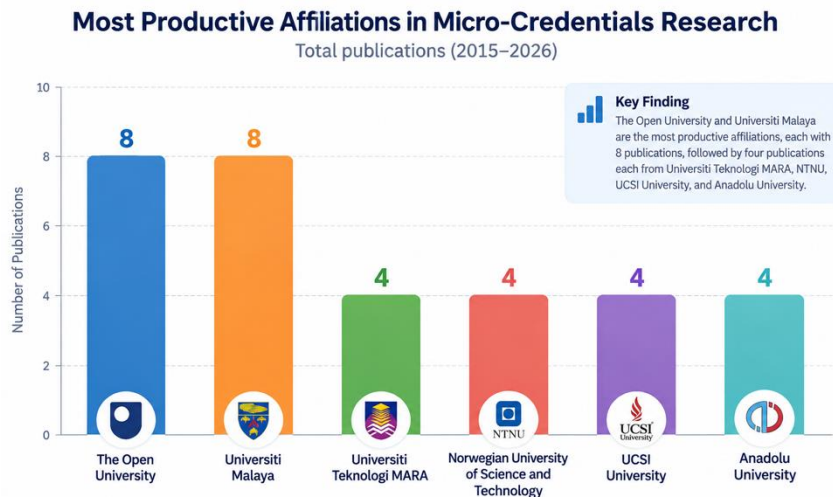


Figure 4. Most Productive Affiliates in Micro-Credentials Research

The Open University and Universiti Malaysia have the highest number of publications, with eight articles each. Despite having the same number of publications, they show different development patterns. The Open University has contributed since the dataset's early period, while Universiti Malaysia's increase was mainly seen in the more recent period. Furthermore, Universiti Teknologi MARA, Norwegian University of Science and Technology, UCSI University, and Anadolu University each produced four articles. The relatively small difference in publications between institutions shows that research production is not concentrated in one particular

research center. The involvement of institutions from Europe and Asia also aligns with the country-level geographical distribution and shows the widening institutional base of micro-credential research.

3. The Most Productive Writer

Author productivity was analyzed to determine whether the development of the micro-credentials literature was concentrated among a small number of researchers or spread across the wider academic community.

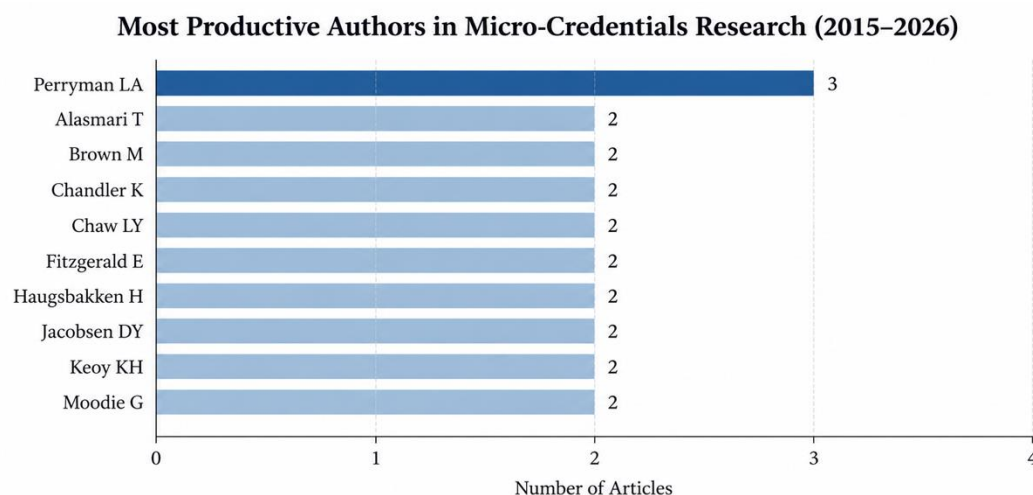


Figure 5. Most Productive Authors in Micro-Credentials Research

Perryman LA was the most prolific author with three articles. Furthermore, Alasmari T, Brown M, Chandler K, Chaw LY, Fitzgerald E, Haugsbakken H, Jacobsen DY, Keoy KH, and Moodie G each produced two articles in the dataset. The relatively low number of publications at the individual level indicates a fairly dispersed authorship structure. The micro-credentials literature has not been dominated by a small number of highly productive authors, but involves a wide range of researchers with relatively balanced contributions. The relatively low number of publications at the individual level suggests that author productivity in the corpus is dispersed rather than concentrated in one or a few authors with many more publications.

4. Most Relevant Publication Sources

The distribution of publications by source was analyzed to identify which journals publish the most research on micro-credentials and to assess publication concentration in certain outlets.

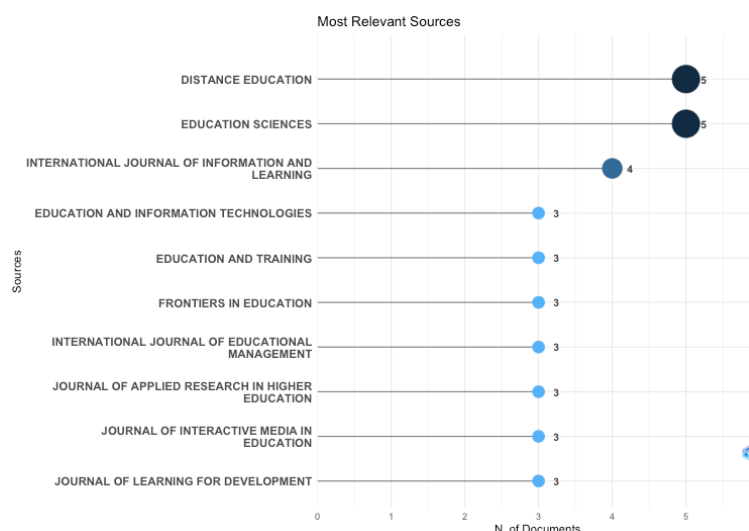


Figure 6. Most Relevant Publication Sources in Micro-Credentials Research

Distance Education and Education Sciences were the most prolific sources with five articles each, followed by the International Journal of Information and Learning Technology with four articles. Meanwhile, Education and Information Technologies, Education and Training, Frontiers in Education, International Journal of Educational Management, Journal of Applied Research in Higher Education, Journal of Interactive Media in Education, and Journal of Learning for Development each published three articles. Pasted markdown

The relatively small difference in publications among primary sources suggests that micro-credentials research has not concentrated in one particular publication outlet. In contrast, the literature is scattered across journals focused on distance education, educational technology, higher education, education management, and learning development. This distribution shows that micro-credentials are emerging as a topic that spans several areas of educational studies.

5. Most Cited Documents

In addition to scientific productivity, publication impact is assessed by the number of global citations each document receives. To identify publications with the highest scientific visibility, Table 1 presents documents with more than 100 global citations.

Table 2. Documents with Over 100 Global Citations

Ranking	Author	Year	Source	Total Citations	Citations per Year	Normalized TC
1	Jirgensons M.	2018	Journal of Teacher Education for Sustainability	208	23,1	1,88
2	Brown M.	2021	Journal of Learning for Development	148	24,7	2,78
3	Wheelahan L.	2021	Journal of Curriculum Studies	144	24,0	2,70
4	Zhang J.	2020	TechTrends	107	15,3	2,61

Jirgensons M. (2018) recorded the highest number of global citations with 208 citations, followed by Brown M. (2021) with 148 citations, Wheelahan L. (2021) with 144 citations, and Zhang J. (2020) with 107 citations. However, a slightly different pattern emerged when citations were normalized by year of publication. Brown M. (2021) had the highest Normalized TC value of 2.78, followed by Wheelahan L. (2021) of 2.70, Zhang J. (2020) of 2.61, and Jirgensons M. (2018) of 1.88.

The difference between absolute and normalized citations matters because older publications have more time to accumulate citations. In this dataset, the document with the highest absolute number of citations is not at the same time the document with the highest normalized citation impact. Thus, the scientific influence of documents in the field of micro-credentials is better understood by combining absolute citation counts with indicators that account for publication year.

6. Impact of Publication Sources

In addition to the document level, the scientific also analyze scientific impact at the publication-source level using the h-index, g-index, total citations (TC), and number of publications (NP). Using several indicators allows the contribution of a journal to be assessed not only by the number of articles published, but also by the impact of citations produced. Table 2 presents sources with an h-index of at least three.

Table 3. Publication Source with the Highest Local Impact

Ranking	Source	h-index	g-index	TC	NP
1	Distance Education	4	5	65	5
2	Education Sciences	3	5	42	5
3	International Journal of Information and Learning Technology	3	4	89	4
4	Journal of Learning for Development	3	3	160	3
5	International Journal of Educational Management	3	3	68	3
6	Journal of Interactive Media in Education	3	3	53	3
7	Education and Information Technologies	3	3	34	3

Distance Education has the highest h-index (4), with a g-index of 5, five publications, and 65 citations. The other six sources have an h-index of 3 but vary on other indicators. Education Sciences has a g-index of 5 with five publications, while the International Journal of Information and Learning Technology has a g-index of 4 with 89 citations from four publications. Meanwhile, the Journal of Learning for Development obtained the highest total citations among the sources shown, with 160 citations from three articles.

These differences suggest that productivity and source impact do not always follow the same pattern. Journals with a higher number of articles do not always have the highest total citations, whereas journals with fewer articles may have higher citation visibility. Therefore, combining h-index, g-index, number of citations, and number of publications provides a more comprehensive picture of sources' position in the research corpus of micro-credentials.

Conceptual and Thematic Structure

Productivity indicators indicate who produces research and where, but do not fully explain the structure of knowledge in the field. Therefore, further analysis focuses on the relationship between keywords and the thematic structure of the research. Keyword co-occurrence analysis identifies concepts that occupy a central position in the network, while thematic maps show the level of centrality and development of the theme.

1. Keyword Co-occurrence Network

Keyword co-occurrence analysis was performed to identify the conceptual structure of micro-credentials research based on the interconnectedness between keywords that appear simultaneously in the publications. In the network visualization, node size represents a keyword's relative weight, lines indicate co-occurrence relationships between keywords, and different colors indicate keyword groups that form thematic clusters.

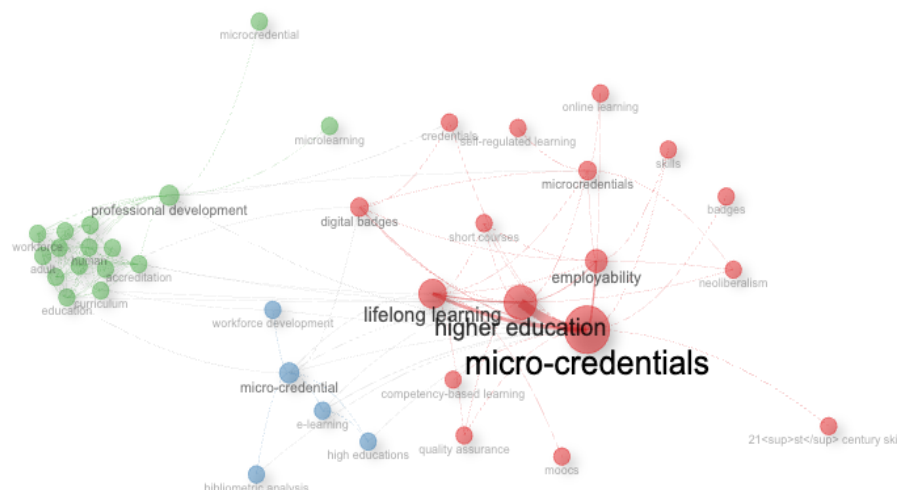


Figure 7. Keyword Co-occurrence Network Micro-Credentials Research

The analysis showed that the keyword network formed several interconnected clusters. Micro-credentials occupy the most central position in the network with a betweenness centrality value of 248.63 and a PageRank of 0.1274. Higher education ranks next, with an betweenness of 92.42 and a PageRank of 0.0821, followed by lifelong learning (57.61 and 0.0583, respectively) and employability (31.60 and 0.0515). These positions and connections show that micro-credentials, higher education, lifelong learning, and employability are important concepts in the structure of the analyzed research network.

Conceptually, the network structure shows that the study of micro-credentials is not only centered on the form of credentials, but also strongly linked to the context of higher education, lifelong learning, and employability. The relatively central position of lifelong learning and employability shows that the two concepts are structurally connected to various other themes in the corpus. The network also shows several clusters that indicate groupings of research focuses. Although each cluster has different internal connections, the relationships between clusters show that the conceptual structure of micro-credentials research is

interconnected and does not develop as completely separate themes. Thematic map analysis further clarifies these findings by identifying the position of each theme based on centrality and density.

2. Thematic Map

Thematic maps identify the position of research themes based on two dimensions: centrality and density. Centrality shows how connected a theme is to the overall research structure, while density represents a theme's level of internal development. Based on these two dimensions, themes are grouped into four quadrants, namely motor themes, niche themes, basic themes, and emerging or declining themes.

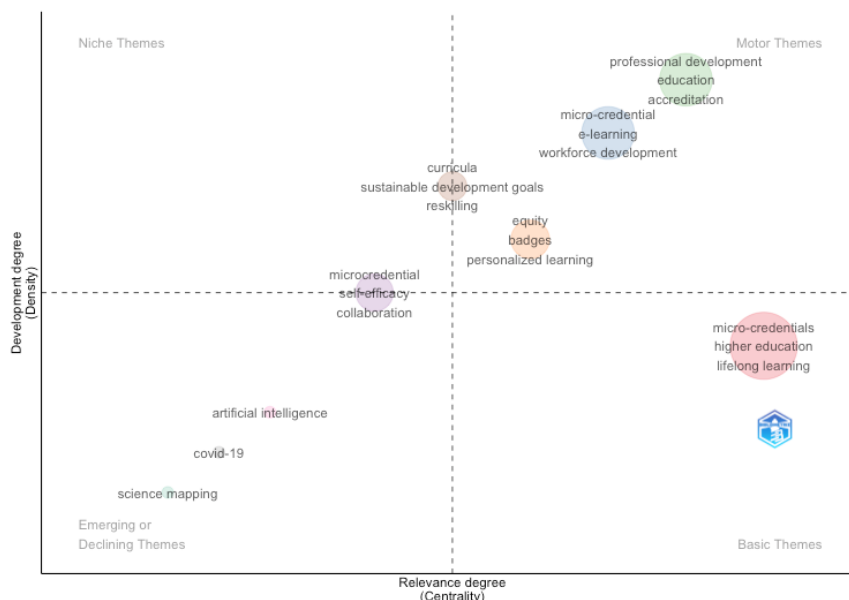


Figure 8. Thematic Map of Micro-Credentials Research

The mapping results show that micro-credentials, higher education, and lifelong learning fall in the basic themes quadrant. This position shows that the three themes have relatively high centrality but lower internal density. Thus, micro-credentials connect broadly to the overall research structure, while higher education and lifelong learning are the main contexts and orientations underlying the development of this field. Lifelong learning's position in the same group also reinforces findings from co-occurrence networks, which show its role as one of the central concepts in the corpus.

Meanwhile, some theme groups fall in the motor themes quadrant, showing a relatively high combination of centrality and internal development. The professional development–education–accreditation group occupies the top of this quadrant, while the micro-credential–e-learning–workforce development group also falls within the motor themes area. In addition, equity, badges, and personalized learning from other groups in the same quadrant. This position shows that professional development, accreditation, digital learning, workforce development, and equity and personalization issues are relatively developed themes while being connected to a broader research structure.

The themes of curricula, sustainable development goals, and reskilling sit near the boundary between niche and motor themes, while micro-credentials, self-efficacy, and collaboration sit near the center of the map. This position shows that these themes are neither strongly positioned as motor nor as basic themes in the corpus structure.

On the other hand, artificial intelligence, COVID-19, and science mapping fall into the quadrant of emerging or declining themes, characterized by relatively low centrality and density. However, this position cannot be interpreted as a developing theme because the thematic map does not distinguish whether a theme is truly emerging or declining. Determining its development direction requires a joint reading of topic trends and thematic evolution.

Overall, the thematic map shows that the research structure of micro-credentials is primarily grounded in higher education and lifelong learning, while more developed themes include professional development, accreditation, e-learning, workforce development, equity, and personalized learning. This pattern shows that

the literature not only discusses micro-credentials as a form of credential, but also links them to professional development, digital learning, workforce needs, and expanded access to learning.

Thematic Developments and Research Trends

In addition to identifying the overall conceptual structure, the temporal dimension is analyzed to see how the orientation of micro-credentials research themes evolves over time. Thematic evolution maps continuity, change, and theme incorporation across periods, while trend topics identify periods when certain topics gain attention in the literature.

1. Thematic Development

Thematic evolution analysis was carried out to identify changes and continuity in micro-credentials research themes between the 2015–2024 and 2025–2026 periods. The relationship between themes across the two periods is shown through streams that describe how themes from one period relate to themes in the next.

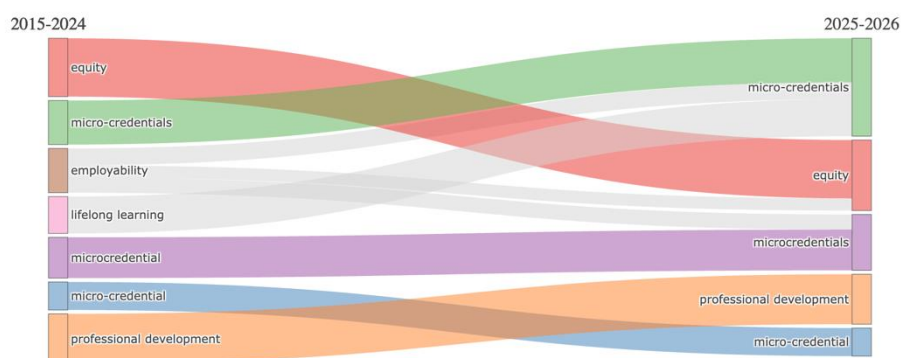


Figure 9. Thematic Development of Micro-Credentials Research

The results show continuity and consolidation across several research themes. Micro-credentials remain the main theme in the 2025–2026 period and link to several themes from the previous period. In particular, lifelong learning and employability, which emerged as separate themes in the 2015–2024 period, connect to the theme of micro-credentials in the 2025–2026 period. This pattern shows the increasingly close relationship between discussions of micro-credentials and lifelong learning and employment in the latest literature.

The equity theme shows relatively clear continuity from 2015–2024 to 2025–2026. Similarly, professional development remains emerging in both periods, indicating sustained attention to the use of micro-credentials in professional development. Overall, the evolutionary pattern shows that this field is marked not only by the emergence of new themes, but also by the strengthening and incorporation of themes that previously developed more separately.

2. Trend Topics

Trend topics analysis identifies the temporal development of prominent topics in micro-credentials research. This visualization shows the period of occurrence of a term and its relative frequency, providing an overview of changes in research attention over time.

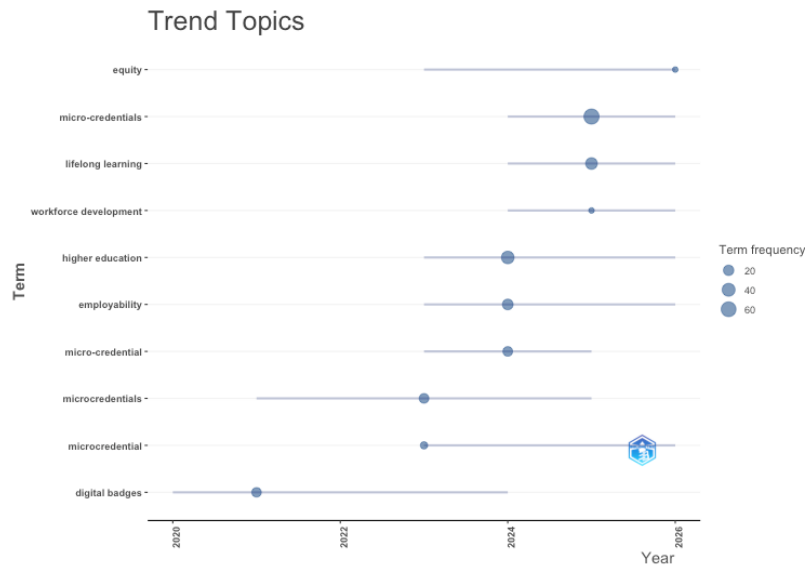


Figure 10. Trend Topics Penelitian Micro-Credentials

The analysis results show a shift in research focus during the observation period. Digital badges emerged early, with a key temporal position around 2021 and an emergence range through 2024. Furthermore, various terms referring to micro-credentials began to stand out in 2023-2024. Higher education and employability peaked around 2024, while micro-credentials, lifelong learning, and workforce development were more prominent around 2025. Meanwhile, equity showed an emerging trend that continued until 2026.

This pattern shows that research attention has expanded from the initial discussion of digital badges and alternative forms of credentials to broader issues related to higher education, employability, lifelong learning, workforce development, and equity. Thus, the literature's development shows the discussion of micro-credentials expanding from the form and recognition of credentials to their relationship with lifelong learning, labor needs, and equity issues.

Scientific Collaboration

Scientific analyzed scientific collaboration to identify patterns of international cooperation in micro-credentials research. This analysis uses the author's country of correspondence to distinguish Single Country Publications (SCP), in which all authors are from one country, and Multiple Country Publications (MCP), which involve authors from more than one country. Comparing the two indicators provides an overview of each country's level of involvement in international research collaboration.

Table 4. International Correspondence and Collaboration Author Countries

Country	Article	Article (%)	SCP	MCP	MCP (%)
Amerika Serikat	24	17,78	23	1	4,17
Australia	17	12,59	16	1	5,88
Malaysia	12	8,89	5	7	58,33
Inggris	11	8,15	9	2	18,18
Kanada	7	5,19	6	1	14,29
China	4	2,96	1	3	75,00
Irlandia	4	2,96	4	0	0,00
Spanyol	4	2,96	4	0	0,00
Italia	3	2,22	0	3	100,00
Turki	3	2,22	2	1	33,33

As shown in Table 3, the United States has the highest number of publications by country of correspondence, with 24 articles (17.78% of all articles). However, most of these publications are SCPs (23 articles), while only one article is classified as MCP, so the international collaboration ratio is 4.17%. A similar pattern is seen in Australia, with 16 SCPs and one MCP out of a total of 17 articles, or an MCP ratio of 5.88%. The United Kingdom and Canada also show a larger proportion of SCPs than MCPs, with MCP ratios of 18.18% and 14.29%, respectively.

Malaysia, China, and Italy showed a different pattern. Malaysia produced 12 articles, consisting of five SCPs and seven MCPs, so that 58.33% of its publications involved international collaborations. China had a higher proportion of MCPs, at 75.00%, although it was based on only four articles. Meanwhile, all articles with correspondence authors from Italy were MCPs, resulting in a 100% ratio. This value needs to be interpreted carefully because it is based on only three articles. In contrast, Ireland and Spain do not record MCPs in articles covered in the group of countries shown.

Overall, the results show that publication volume does not always match the proportion of international collaboration. Countries with a relatively high number of publications, such as the United States and Australia, show the dominance of publications within a single country, while Malaysia shows a larger proportion of cross-border collaboration. These findings show a variation in the pattern of internationalization of micro-credentials research between countries. The Countries' Collaboration World Map then visualizes these patterns and the geographic relationships among countries.

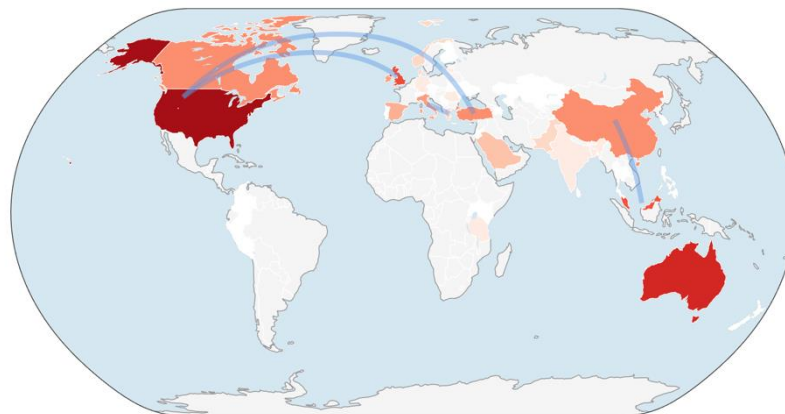


Figure 11. Map of Interstate Collaboration in Micro-Credentials Research

The Countries' Collaboration World Map complements the SCP and MCP indicators by providing a geographical representation of the cross-country research relationships in the corpus. Overall, the results show that micro-credentials research has developed in a variety of national contexts, but the intensity of international collaboration still varies among the contributing countries.

Overall, the conceptual and thematic analyses show that micro-credentials research develops around linkages between higher education contexts, lifelong learning, and employability orientation. Higher education occupies a central position as a key context in the conceptual networks, while lifelong learning and employability show strong interconnectedness with various themes in the corpus. At the same time, the emergence of professional development, workforce development, digital badges, and equity shows that the study of micro-credentials includes the dimensions of professional development, workforce needs, recognition of learning, and equity.

Taken together, the keyword co-occurrence results, thematic map, thematic evolution, and trend topics reveal an expanding context for micro-credential discussions. The literature addresses not only credential formats and the recognition of learning but also their connections to higher education, lifelong learning, professional development, employability, and workforce needs. These findings position micro-credentials as an increasingly prominent field of study that is closely connected to diverse learning pathways and lifelong competency development.

DISCUSSION

The results show that research on micro-credentials is growing rapidly, especially in recent years, with 77.8% of articles in the corpus published in the 2023-2026 period. This increase shows the growing academic attention to micro-credentials as part of the changing educational landscape and competency development. These developments are in line with the increasing need for more flexible forms of learning and recognition of competencies that can complement conventional qualifications (Ahsan et al., 2023; Ward et al., 2023). Previous research has also shown that the development of micro-credentials involves the interests of a wide range of stakeholders, including learners, higher education institutions, employers, and governments (Reynoldson, 2023; Varadarajan et al., 2023; Zhang & Alasmari, 2025). Thus, the growth in publications found in this study

reflects not only an increase in scientific activity, but also a growing attention to the position of micro-credentials in the relationship between education, competency development, and the needs of the workforce.

These developments are unfolding across a geographically dispersed research landscape. The United States shows the highest scientific activity, followed by strong contributions from Malaysia and Australia, along with involvement from other countries. This pattern suggests that the discourse of micro-credentials develops in diverse educational systems, rather than concentrated in a single national context. This matters because the design and implementation of micro-credentials interact with different qualification frameworks, recognition mechanisms, educational structures, and job market conditions across countries. Therefore, micro-credentials are better understood as a form of recognition of learning whose application and value can differ across institutional and national contexts, rather than as a completely uniform model.

In this landscape, higher education is a key context for micro-credentials research. The central position of higher education in the network of keyword co-occurrence, and its coexistence with micro-credentials and lifelong learning as basic themes, suggest that higher education is an important arena in discourse in this field. The findings align with previous research that identifies higher education as the primary environment for the design, implementation, assessment, and recognition of micro-credentials. However, the centrality of higher education does not mean that the scope of micro-credentials is limited to universities. Angwaomaodoko (2025); Dang & Tang (2026); and Gamage & Dehideniya (2025) for example, place micro-credentials in a broader context related to continuing education and lifelong learning. Thus, the dominance of higher education in the corpus reflects the field's current development and also highlights an opportunity to expand research on micro-credentials in lifelong learning beyond conventional formal education programs.

One important finding is the strong position of lifelong learning and employability in the conceptual structure of micro-credentials. Both relate to various themes in the research network, while lifelong learning also falls under basic themes. This position shows that micro-credential development is increasingly linked to the need for learning that does not stop at the acquisition of initial qualifications, but continues throughout life and can respond to changing competency needs. Coelho (2025) and Peters et al. (2025), micro-credentials link to lifelong learning and employability by offering more flexible learning pathways that respond to changing skills needs. In this perspective, micro-credentials can be understood as part of a lifelong learning ecosystem that recognizes more focused and actionable learning at different stages of life, rather than simply as an additional certificate.

The relatively central position of employability also shows the strong employment orientation in the micro-credentials literature. Previous research has linked micro-credentials to upskilling, reskilling, competency development, and increased skill relevance to changing job needs (Kemcha et al., 2025; Prosen & Ličen, 2025). However, bibliometric findings on the centrality of employability need careful interpretation. Conceptual linkages do not prove that possessing micro-credentials directly increases employment opportunities or career development opportunities. This analysis maps the structure of scientific discourse, rather than examining the causal relationship between micro-credentials and employment outcomes. Therefore, employability is better understood as one of the main substantive orientations in micro-credentials research, while empirical evidence of its value and impact on the job market still needs strengthening. This distinction matters so increased attention to employability is not mistaken for evidence of established effectiveness.

The link between competency development and the world of work is increasingly seen in thematic structures. The professional development–education–accreditation and micro-credential–e-learning–workforce development groups fall within the motor themes, suggesting that professional development, digital learning, recognition, and workforce needs have become a relatively structured part of this field. The findings are consistent with the literature that identifies upskilling, reskilling, and professional competency development as opportunities that are often associated with micro-credentials (Datta et al., 2025; Raghavan et al., 2025). However, such developments should not be interpreted as a shift from formal qualifications to micro-credentials. Instead, micro-credentials are more appropriately placed as complementary parts of the learning and qualification ecosystem that can provide more specific and flexible competency development pathways (Lee & Tan, 2023; Vlaović, 2025).

The presence of accreditation in the motor themes also confirms that the expansion of micro-credentials is followed by issues of quality, transparency, and recognition. The value of a micro-credential depends not only on its existence, but also on the extent to which educational institutions, students, and employers can understand and trust the competencies it represents. Previous literature has identified recognition, standardization, transparency, and trust as important challenges in the development of micro-credentials (Abdul Halim et al., 2024; Carşiş & Iucu, 2025; Rustambekov, 2025; Surono, 2024). Thus, the increase in the number and diversity of micro-credentials needs to be accompanied by clarity about learning outcomes,

assessment processes, the quality of organizers, and the recognition mechanism so that credentials have value that can be understood across educational and work contexts.

Another increasingly visible dimension is equity, which appears alongside badges and personalized learning in the area of motor themes and remains present in temporal development. These findings expand the discourse on micro-credentials from flexibility and relevance to questions about who gets access and benefits from these opportunities. Potentially, shorter, more flexible learning pathways can expand learning opportunities for individuals who cannot attend a long-term formal education program. However, flexibility does not automatically translate into equity. Cost, access to technology, digital literacy, information about program quality, and credential recognition can create new barriers. Therefore, equity as an important theme shifts research questions from whether micro-credentials provide flexible learning to who can access, complete, gain recognition for, and actually benefit from those credentials.

Temporal developments further clarify this expansion. Digital badges are more visible in the early phases of literary development, while higher education, employability, lifelong learning, workforce development, and equity gain attention in more recent periods. The thematic evolution analysis also shows the connection between lifelong learning and employability and the theme of micro-credentials in the 2025–2026 period, while professional development and equity show continuity across periods. This pattern should not be read as a paradigm shift or the loss of previous themes, but as expansion and thematic consolidation. Discourses on forms of credentials and technology remain, but increasingly intersect with educational functions, lifelong learning, professional development, employment, and access. This interpretation also needs to account for variations in writing such as micro-credentials, micro-credentials, and micro-credentials, which may emerge as technically separate themes in the analysis even though they conceptually refer to the same construct.

In the international dimension, research productivity does not always match the intensity of cross-country collaboration. The United States and Australia have a relatively large number of publications by country of correspondence. Still, most are Single-Country Publications, while Malaysia shows a higher proportion of Multiple-Country Publications. China and Italy also show high MCP ratios, albeit based on fewer articles. These findings suggest that the internationalization of micro-credentials research is evolving in a non-uniform pattern. Cross-border collaboration matters because national contexts strongly shape recognition, accreditation, qualification frameworks, and job market needs. Cross-border comparative and collaborative research can help identify aspects of micro-credentials that are more broadly relevant, as well as aspects that require adaptation to specific education systems, regulations, and job markets.

Overall, the findings show a micro-credential landscape increasingly connected to higher education, lifelong learning, employability, professional development, and workforce needs, along with growing concern for quality, recognition, and equity. Thus, the micro-credential literature has increasingly moved beyond discussions of the form of credentials themselves and placed them in a broader ecosystem that connects learning, competency development, and professional life. However, it is necessary to distinguish between the positional strength of a theme in the literature and evidence of its impact in practice. The literature still articulates the potential of micro-credentials, while longitudinal evidence on employability, career mobility, upskilling/reskilling, employer recognition, quality, and equitable benefits still needs strengthening. Therefore, the field's next development needs to move beyond mapping adoption and perception to empirically test who benefits, under what conditions micro-credentials are recognized, and the extent to which these credentials contribute to lifelong learning, educational outcomes, and employment.

CONCLUSION

This study maps the evolving landscape of micro-credentials research and demonstrates its rapid expansion and increasing thematic interconnectedness. The findings position micro-credentials, higher education, lifelong learning, and employability as central concepts in the field, while professional development, accreditation, e-learning, workforce development, and equity represent increasingly developed areas of inquiry. Temporal patterns further indicate a broadening and consolidation of the research landscape, with lifelong learning and employability becoming increasingly connected to micro-credentials alongside sustained attention to professional development and equity. However, the prominence of these themes in the literature should not be taken as evidence that micro-credentials improve educational or employment outcomes. Future research should therefore move beyond examining adoption, perceptions, and potential toward stronger empirical investigation of long-term outcomes, employer recognition, quality assurance, career development, and equitable access across different educational and labor-market contexts. Overall, micro-credentials are emerging as an increasingly important research area at the intersection of lifelong learning, employability, and

changing workforce needs. At the same time, their long-term value and impact remain important directions for further investigation.

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