

Date Received : March 2026
Date Revised : May 2026
Date Accepted : May 2026
Date Published : May 2026

MICRO-CREDENTIALS IN HIGHER EDUCATION: MAPPING AND NETWORKING DATA USING BIBLIOMETRIC ANALYSIS

Nanah Sujanah¹

Universitas Sultan Ageng Tirtayasa, Indonesia. (nanahsujanah@untirta.ac.id)

Sholeh Hidayat

Universitas Sultan Ageng Tirtayasa, Indonesia. (sholeh.hidayat@untirta.ac.id)

Fadlullah

Universitas Sultan Ageng Tirtayasa, Indonesia. (fadlullah@untirta.ac.id)

Kata Kunci:

Kata kunci: mikro-kredensial; pendidikan tinggi; pembelajaran sepanjang hayat; employability; analisis bibliometrik

ABSTRAK

Mikro-kredensial telah menjadi inovasi penting dalam pendidikan tinggi seiring meningkatnya kebutuhan terhadap sistem pembelajaran yang fleksibel, berbasis kompetensi, dan berorientasi industri. Transformasi digital, disrupsi dunia kerja, dan kebutuhan pembelajaran sepanjang hayat telah meningkatkan perhatian akademik terhadap mikro-kredensial sebagai jalur alternatif untuk pengembangan keterampilan dan peningkatan employability. Penelitian ini bertujuan memetakan tren publikasi, struktur intelektual, tema dominan, dan arah penelitian masa depan terkait mikro-kredensial dalam pendidikan tinggi. Penelitian menggunakan pendekatan bibliometrik dengan data publikasi terindeks Scopus yang dianalisis melalui science mapping, co-occurrence analysis, Hukum Bradford, dan teknik visualisasi jaringan. Analisis dilakukan terhadap 341 publikasi yang diperoleh dari basis data terindeks Scopus, sehingga memberikan gambaran yang komprehensif mengenai struktur intelektual dan perkembangan penelitian mikro-kredensial. Hasil penelitian menunjukkan bahwa riset mengenai mikro-kredensial mengalami tingkat pertumbuhan publikasi tahunan sebesar 16,1%, terutama pada tema digital credentials, employability, lifelong learning, workforce development, online learning, dan educational technology. Amerika Serikat menjadi negara paling produktif, sementara jurnal dan universitas berbasis teknologi mendominasi lanskap publikasi. Analisis juga mengidentifikasi tema-tema baru seperti integrasi blockchain, personalized learning, quality assurance, dan artificial intelligence sebagai arah penelitian potensial di masa depan. Secara keseluruhan, temuan ini menunjukkan bahwa mikro-kredensial telah berkembang menjadi bidang kajian interdisipliner yang tumbuh pesat dan memiliki peran strategis dalam transformasi pendidikan tinggi, ekosistem pembelajaran digital, dan adaptabilitas tenaga kerja.

¹ Correspondence author

Keywords:	ABSTRACTS
Keywords: micro-credentials; higher education; lifelong learning; employability; bibliometric analysis	<i>Micro-credentials have become an important innovation in higher education due to growing demands for flexible, competency-based, and industry-oriented learning systems. Digital transformation, workforce disruption, and lifelong learning needs have increased scholarly attention toward micro-credentials as alternative pathways for skills development and employability enhancement. This study aims to map publication trends, intellectual structures, dominant themes, and emerging research directions related to micro-credentials in higher education. A bibliometric approach was employed using Scopus-indexed publications analyzed through science mapping, co-occurrence analysis, Bradford's Law, and network visualization techniques. The analysis was based on 341 Scopus-indexed publications retrieved from the database, providing a comprehensive overview of the intellectual structure and development of micro-credentials research. The findings show that research on micro-credentials has grown at an annual rate of 16.1%, particularly in themes related to digital credentials, employability, lifelong learning, workforce development, online learning, and educational technology. The United States emerged as the most productive country, while technology-oriented journals and universities dominated the publication landscape. The analysis also identified emerging topics such as blockchain integration, personalized learning, quality assurance, and artificial intelligence as promising directions for future research. Overall, the study demonstrates that micro-credentials have evolved into a rapidly growing interdisciplinary field that plays an increasingly strategic role in higher education transformation, digital learning ecosystems, and workforce adaptability.</i>

A. INTRODUCTION

The rapid transformation of higher education in the digital era has intensified global attention toward flexible, competency-based, and industry-oriented learning systems. Traditional degree structures are increasingly criticized for limited responsiveness to changing labor market demands, technological disruption, and the growing need for continuous reskilling and upskilling. In this context, micro-credentials have emerged as alternative educational mechanisms designed to provide short, modular, and competency-validated learning experiences supporting lifelong learning and workforce adaptability [1]. The increasing relevance of micro-credentials is closely associated with digital transformation, online learning ecosystems, and demand for flexible educational pathways capable of reducing the gap between higher education and employment sectors. Brown et al. argued that micro-credentials represent a new credential ecology emphasizing modularity, stackability, and learner-centered flexibility within lifelong learning systems (Brown et al. 2021). Carţiş et al. (2023) also explained that micro-credentials have become increasingly important because they support personalized competency development and rapid adaptation to labor market transformation.

The growing adoption of micro-credentials reflects broader structural changes in higher education institutions worldwide. Universities increasingly integrate digital credentials, short courses, professional certifications, and competency-based modules into formal educational systems to improve graduate employability and strengthen collaboration with industry stakeholders. Recent findings indicate that micro-credentials are widely perceived as mechanisms capable of supporting workforce

readiness, professional development, and lifelong learning (Rullyana, Siregar, and Kustandi 2025). This trend intensified after the COVID-19 pandemic, which accelerated online learning expansion and highlighted the importance of flexible and accessible educational models. Pirkkalainen et al. (2023) emphasized that micro-credentials empower learners through targeted skill acquisition aligned with evolving occupational demands while supporting institutional innovation within higher education. Yılık also argued that micro-credentials provide strategic value by connecting higher education systems with dynamic labor market expectations and rapidly changing skill ecosystems (Wheelahan and Moodie 2022).

Another important dimension underlying the rise of micro-credentials concerns technological innovation and digital credential ecosystems. The integration of blockchain, artificial intelligence, learning management systems, and digital badges increasingly shapes discussions on micro-credential implementation (Rullyana, Siregar, and Kustandi 2025). Digital badges and blockchain-based verification systems are frequently promoted as mechanisms capable of improving transparency, interoperability, portability, and trust in digital credentials. Rustemi et al. highlighted that the combination of blockchain and artificial intelligence may strengthen credential security and automated verification processes in higher education ecosystems (Rustemi et al. 2024). Cuya and Palaoag (2024) also argued that blockchain technology offers substantial potential for advancing academic credential verification by reducing fraud risks and enabling decentralized credential management systems. These technological developments indicate that micro-credentials are no longer viewed solely as pedagogical innovations but also as digital infrastructures supporting new forms of credential governance and educational transformation.

The literature also demonstrates that employability and workforce development constitute central rationales behind micro-credential implementation. Numerous studies emphasize that micro-credentials support the development of specific technical and soft skills aligned with industry expectations, thereby improving graduate competitiveness in increasingly volatile labor markets (Rullyana, Siregar, and Kustandi 2025). Thi Ngoc Ha et al. (2024) found that employers increasingly value micro-credentials because they provide targeted evidence of competencies and practical skills compared with traditional academic transcripts. Li and Ironsi (2024) also demonstrated that micro-credential learning environments contribute significantly to the development of twenty-first-century skills, including communication, critical thinking, teamwork, and problem-solving abilities. The increasing focus on employability, skills gaps, and lifelong learning suggests that micro-credentials are becoming strategic tools for enhancing workforce adaptability and supporting continuous professional development in digital economies.

Despite growing scholarly attention toward micro-credentials, the literature still reveals substantial conceptual, methodological, and policy-related fragmentation. Existing studies frequently emphasize definitions, implementation models, technological integration, or employability outcomes independently, while comprehensive understanding of the intellectual structure and thematic evolution of the field remains limited. Several publications highlighted that micro-credential frameworks vary considerably across countries and institutions, resulting in inconsistent definitions, fragmented quality assurance systems, and uneven employer recognition (Rullyana, Siregar, and Kustandi 2025). Fisher and Leder (2022) explained

that New Zealand has developed relatively advanced operational frameworks for micro-credentials through formal recognition mechanisms and integration into vocational education systems. Other countries still face significant challenges concerning standardization, transferability, and governance. Keoy et al. (2024) emphasized that unclear implementation standards, institutional readiness, and insufficient policy frameworks remain major barriers to effective micro-credential adoption in higher education institutions.

Another important issue concerns uneven development of research themes within the field. Existing studies predominantly focus on employability, digital badges, online learning, and workforce development, while emerging topics such as blockchain interoperability, quality assurance systems, personalized learning, institutional governance, artificial intelligence integration, and learner-centered assessment remain relatively underexplored (Rullyana, Siregar, and Kustandi 2025). Reed (2023) argued that evidence-based assessment and learner-centered credentialing models are still insufficiently integrated into current micro-credential systems despite their importance for transparency and inclusivity. Varadarajan, Koh, and Daniel (2023) also emphasized the need for stronger stakeholder collaboration involving learners, higher education institutions, employers, and governments to support sustainable micro-credential ecosystems. These findings indicate that the field continues to evolve without a fully consolidated theoretical and conceptual structure.

Methodologically, previous studies largely relied on systematic literature reviews, conceptual discussions, policy analyses, and case studies focusing on specific institutional or regional contexts. While these studies provide important insights into micro-credential implementation and policy development, relatively few studies comprehensively map the intellectual structure, thematic evolution, collaboration networks, and emerging research trends using bibliometric approaches. Existing bibliometric studies also remain limited in scope and often focus on narrow datasets or specific educational contexts (Rullyana, Siregar, and Kustandi 2025). Rullyana, Siregar, and Kustandi (2025) conducted a bibliometric analysis using Scopus and Web of Science databases, identifying publication growth and major thematic trends related to micro-credentials. However, the rapid expansion of publications after 2023 indicates the need for updated and more comprehensive bibliometric mapping capable of capturing recent developments, intellectual structures, and emerging thematic directions within the field. Limited studies also integrate bibliometric mapping with deeper thematic interpretation explaining how micro-credentials evolve conceptually across higher education, workforce development, and digital transformation discourses.

This study addresses these research gaps by conducting a comprehensive bibliometric analysis of micro-credentials research in higher education using Scopus-indexed publications. Unlike previous studies focusing primarily on conceptual reviews or limited bibliometric scopes, this study systematically maps publication trends, productive authors, influential sources, institutional contributions, country collaboration patterns, thematic evolution, and keyword networks within the field. The study also identifies emerging research opportunities and underexplored themes related to blockchain integration, digital credential ecosystems, personalized learning, quality assurance, employability, and lifelong learning. Through science mapping and network visualization approaches, this research provides a more comprehensive understanding

of the intellectual structure and future directions of micro-credentials research in higher education.

The significance of this study lies in its contribution to theoretical and practical development of micro-credential ecosystems. Theoretically, this study enriches understanding of how micro-credentials evolve as interdisciplinary educational phenomena intersecting higher education transformation, educational technology, digital governance, workforce development, and lifelong learning. Practically, the findings provide insights for higher education institutions, policymakers, employers, and technology developers regarding dominant research trends, emerging innovations, and critical challenges affecting micro-credential implementation. The study also contributes to the growing global discourse on flexible learning systems and digital credential transformation by highlighting the importance of governance frameworks, technological infrastructure, employability alignment, and learner-centered educational strategies in shaping sustainable micro-credential ecosystems for future higher education systems. Furthermore, the findings contribute to knowledge on learning design and Islamic education by demonstrating how micro-credentials can support flexible, competency-based, and lifelong learning models that may be adapted within Islamic higher education institutions to enhance graduate employability, digital learning innovation, and continuous professional development.

A. METHOD

This study employed a bibliometric analysis approach to systematically map and visualize the development of research on micro-credentials in higher education. Bibliometric analysis is widely recognized as an effective quantitative method for identifying publication trends, research productivity, citation structures, collaboration patterns, and thematic evolution within a specific scientific field (Rullyana, Siregar, and Kustandi 2025). The approach is also useful for revealing intellectual structures, dominant themes, and emerging research directions through the analysis of keywords, authors, institutions, citations, and countries (Donthu et al. 2021). The use of bibliometric analysis in this study was motivated by the rapid growth of micro-credential research and the need to comprehensively understand its conceptual development, institutional contributions, and future research opportunities within higher education ecosystems.

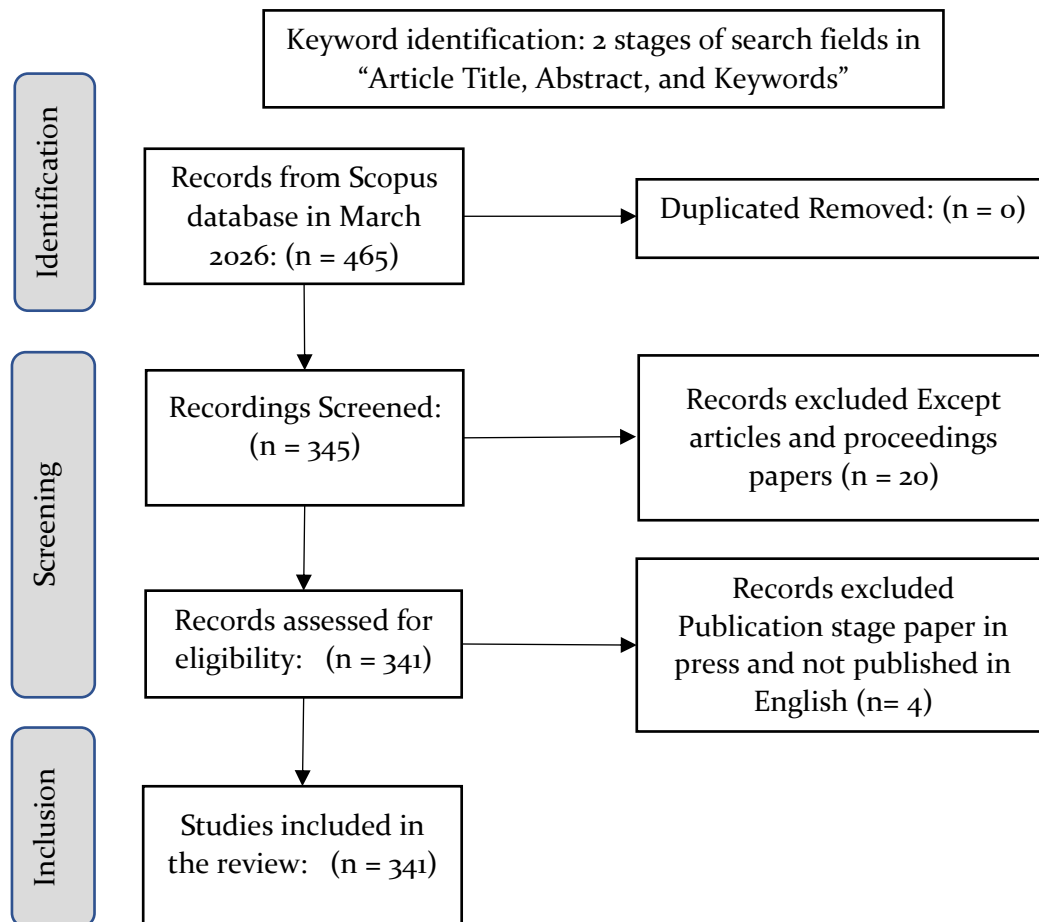


Figure 1. The PRISMA Flow Chart adapted from Rullyana, Siregar, and Kustandi (2025)

The bibliographic data were retrieved from the Scopus database in March 2026 using the following Boolean search string: (“micro-credentials” OR microcredentials OR “digital credentials” OR “alternative credentials”) AND (“higher education” OR “tertiary education” OR “postsecondary education” OR universities). The search was conducted through article titles, abstracts, and keywords to ensure the relevance of the retrieved publications to the research topic. Scopus was selected because it is one of the largest and most comprehensive international indexing databases, covering high-quality peer-reviewed journals, conference proceedings, and multidisciplinary scholarly publications. Previous bibliometric studies frequently utilized Scopus because of its broad coverage, standardized metadata structure, reliable citation tracking system, and compatibility with bibliometric software such as VOSviewer and Biblioshiny. These features make Scopus particularly suitable for science mapping and bibliometric network visualization studies.

The data collection and selection procedures followed the PRISMA framework proposed by (Page et al. 2021) to ensure transparency and methodological rigor during the identification, screening, and inclusion processes. As presented in Figure 1, the initial search identified 465 publications from the Scopus database. No duplicate records were found during the identification stage. During the screening process, 20

records were excluded because they were not categorized as journal articles or conference proceedings. Four additional documents were excluded because they were still in press or not published in English. As a result, 341 publications were included in the final bibliometric analysis. The inclusion of journal articles and conference proceedings was intended to maintain academic rigor while capturing recent innovations and emerging discussions related to micro-credentials in higher education.

The selected bibliographic data were exported in CSV format and analyzed using VOSviewer and Biblioshiny in RStudio. VOSviewer was employed to construct and visualize bibliometric networks involving authors, keywords, institutions, citations, and countries through VOS mapping techniques. The software was selected because of its capability to process large bibliometric datasets, generate visual network mapping, perform text mining, and identify relationships among scientific entities efficiently. Biblioshiny was utilized to support descriptive bibliometric analysis and publication performance evaluation. The analysis consisted of two main approaches: performance analysis and science mapping (Donthu et al. 2021). Performance analysis was conducted to identify publication productivity, influential journals, highly cited documents, leading authors, institutional contributions, and country productivity. Science mapping was applied through co-authorship, co-occurrence, citation, and thematic network analyses to examine conceptual structures, research collaborations, dominant themes, and emerging research directions in micro-credentials research within higher education.

C. RESULT AND DISCUSSION

Main Information

The main information in Figure 2 indicates that research on micro-credentials in higher education has experienced substantial development during the 2003–2026 period. A total of 341 documents were published across 225 different sources, reflecting the growing academic attention and interdisciplinary expansion of this topic. The annual growth rate of 16.1% demonstrates a consistently increasing publication trend, suggesting that micro-credentials have become an emerging and rapidly evolving issue within higher education research. The dataset involved 1,070 authors, indicating broad scholarly participation and expanding research collaboration networks. However, only 47 publications were produced by single authors, implying that this field is largely dominated by collaborative research practices. This is further supported by the average of 3.5 co-authors per document and an international co-authorship rate of 18.18%, showing that research collaboration across institutions and countries has become increasingly important in studying micro-credentials. In addition, the presence of 1,017 author keywords reflects a highly diverse conceptual landscape, suggesting that micro-credential research intersects with various themes such as digital learning, employability, lifelong learning, educational technology, competency-based education, and workforce development. The database also contains 10,740 references, indicating a strong theoretical and empirical foundation within the literature. Meanwhile, the average document age of 2.95 years confirms that the field is relatively new and rapidly developing, while the average citation per document of 10.54 suggests that publications in this area have gained considerable academic visibility and scholarly impact.



Figure 2. Main Information on Micro-Credentials in Higher Education
Source: Biblioshiny (2026)

Document by Years

Figure 3 presents the annual scientific production related to micro-credentials in higher education during the 2003–2026 period. The publication trend shows that research on micro-credentials remained relatively limited and stagnant between 2003 and 2014, indicating that the topic had not yet become a major focus within higher education research. A gradual increase began to emerge after 2015 and became more significant after 2020, reflecting the growing importance of flexible learning pathways, digital transformation, lifelong learning, employability, and competency-based education in higher education institutions. The most substantial growth occurred between 2023 and 2025, where publication output increased sharply and reached its peak in 2025, demonstrating that micro-credentials have evolved into a rapidly expanding and globally relevant research area. This growth also reflects increasing academic and institutional interest in digital badges, alternative credentials, industry collaboration, and workforce reskilling. Meanwhile, the decline observed in 2026 should be interpreted cautiously because the data collection process was conducted in March 2026, meaning that publications for the year had not yet been fully indexed in the Scopus database.

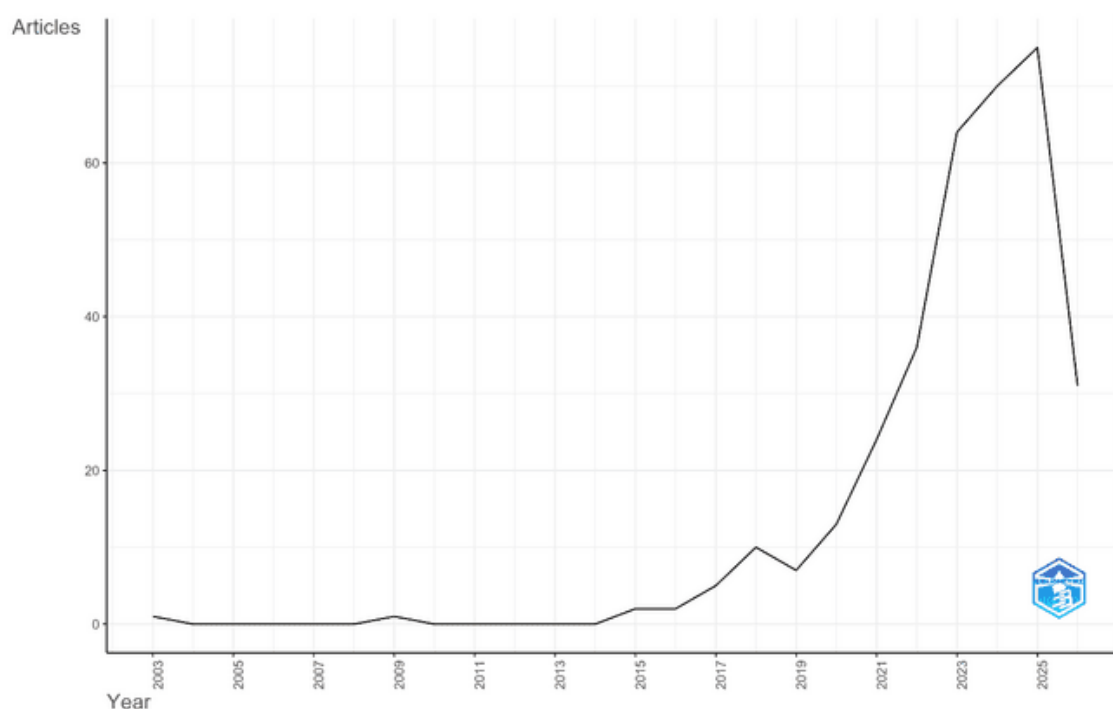


Figure 3. The Annual Scientific Production in the field of Micro-Credentials in Higher Education
Source: Biblioshiny (2026)

Most Relevant Sources in Micro-Credentials Research

Table 1 presents the most relevant publication sources in research related to micro-credentials in higher education. The findings indicate that *Lecture Notes in Networks and Systems* emerged as the most productive source with 11 publications, followed by *CEUR Workshop Proceedings* with 7 publications and the *International Journal of Information and Learning Technology* with 6 publications. The dominance of conference proceedings and technology-oriented publication outlets demonstrates that micro-credential research is strongly associated with digital learning innovation, educational technology, online certification systems, and competency-based education. In addition, journals such as *Distance Education* and *Journal of Learning for Development* highlight the growing relevance of flexible learning pathways, lifelong learning, and open education in discussions surrounding micro-credentials. The presence of IEEE, ACM, and engineering education conference proceedings further indicates that the field is interdisciplinary and highly connected to technological advancement, digital platforms, and workforce-oriented educational transformation. Overall, the distribution of publication sources suggests that micro-credentials research is evolving through the intersection of higher education, digital technology, professional development, and alternative learning ecosystems.

Table 1. Most Relevant Sources in Micro-Credentials Research

No	Sources	Number of Articles
----	---------	--------------------

1	Lecture Notes in Networks and Systems	11
2	CEUR Workshop Proceedings	7
3	International Journal of Information and Learning Technology	6
4	Distance Education	5
5	IEEE Global Engineering Education Conference (EDUCON)	5
6	Journal of Learning for Development	5
7	Proceedings – Frontiers in Education Conference (FIE)	5
8	ACM International Conference Proceeding Series	4
9	ASEE Annual Conference and Exposition, Conference Proceedings	4
10	Communications in Computer and Information Science	4

Figure 4 presents the distribution of publication sources based on Bradford's Law in the field of micro-credentials in higher education. The findings indicate that the literature is concentrated within a relatively small group of highly productive core sources, followed by a larger number of moderately and less productive publication outlets. The core zone consists of 27 highly influential sources that contribute the largest share of publications, while Zone 2 and Zone 3 contain 85 and 113 sources, respectively, reflecting the wider dispersion of research across multidisciplinary journals and conference proceedings. The Bradford multiplier value ($k = 2.24$) demonstrates a substantial expansion pattern of publication sources across zones, while the high coefficient of determination ($R^2 = 0.9188$) confirms a strong fit between the observed distribution and Bradford's theoretical model. In addition, the significant KS p-value (0.000787) indicates that the dataset follows the Bradford distribution pattern effectively. These results suggest that research on micro-credentials remains concentrated within several dominant educational technology and digital learning outlets, although the field has increasingly expanded into broader areas such as lifelong learning, competency-based education, workforce development, and professional training within higher education.

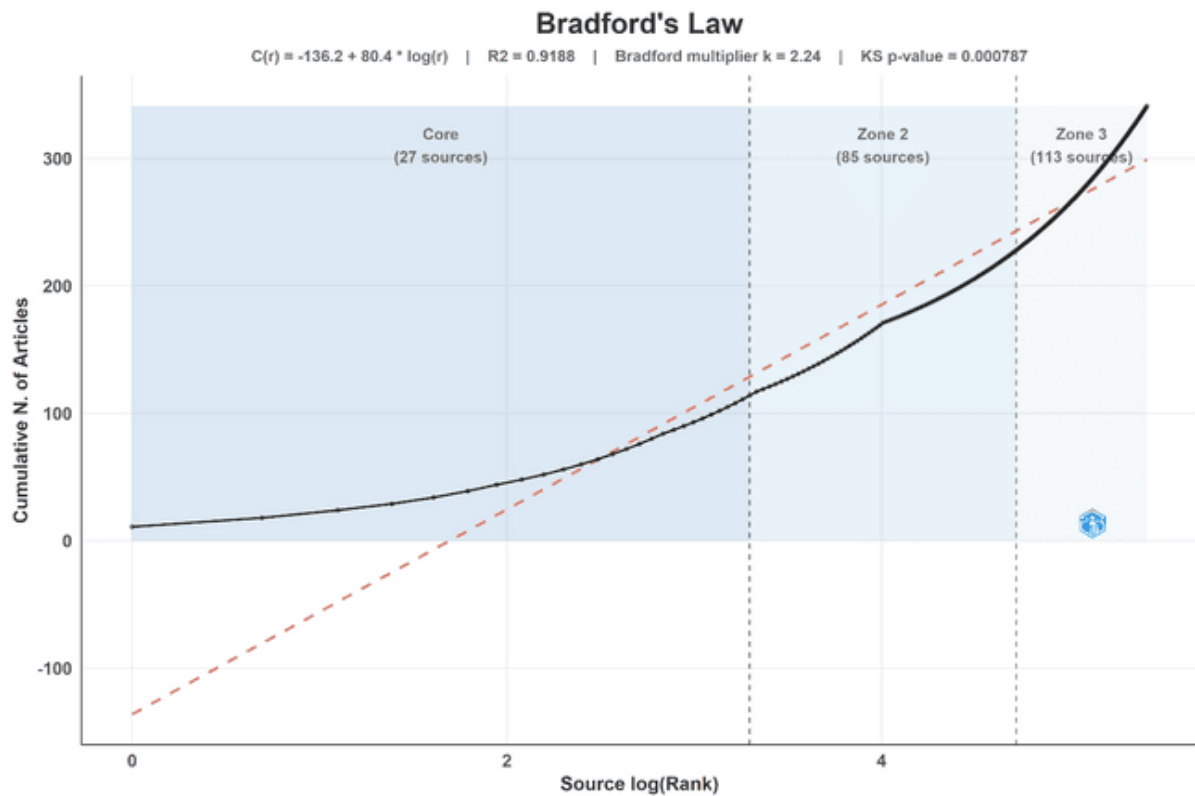


Figure 4. Bradford's Law in the field of micro-credentials in higher education
Source: Biblioshiny (2026)

The Most Productive Authors

Figure 5 illustrates the most productive authors in the field of micro-credentials in higher education based on the number of published documents. The findings show that *Pirkkalainen H* and *Reed A* emerged as the most productive authors, each contributing four publications to the field. Several other authors, including *Abramovich S*, *Brown M*, *Cheng Z*, *Isawasan P*, *Ismail IA*, *Keoy KH*, *Kiiskilä P*, and *Kloos CD*, each contributed three publications. The relatively balanced distribution of publications among authors indicates that research on micro-credentials is still developing and has not yet been dominated by a single leading scholar or research group. In addition, the diversity of productive authors reflects the interdisciplinary nature of micro-credential research, which involves scholars from educational technology, online learning, digital credential systems, lifelong learning, workforce development, and higher education policy. These findings also suggest that the field continues to expand globally through collaborative and cross-disciplinary research contributions.

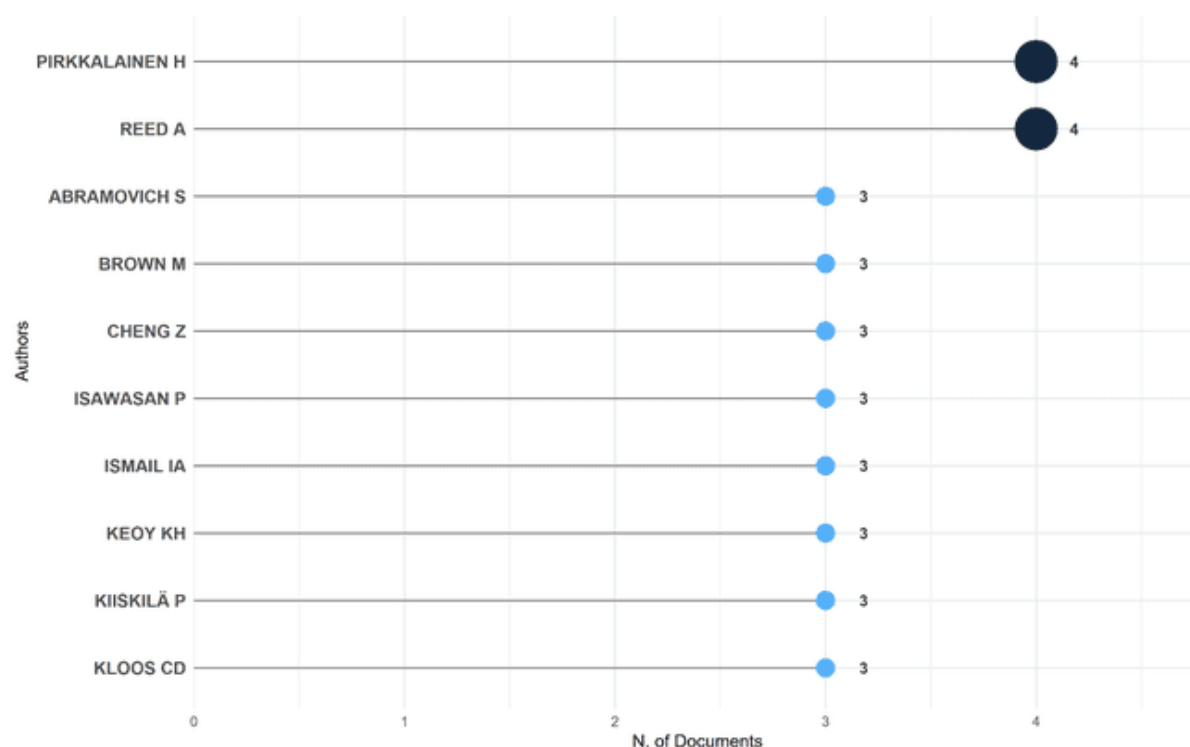


Figure 5. Most Productive Authors in the field of micro-credentials in higher education
Source: Biblioshiny (2026)

Authors with Most Citation

Figure 6 presents the most locally cited authors in the field of micro-credentials in higher education. The findings indicate that *McGreal R* is the most influential author with 84 local citations, followed by *Olcott D Jr* with 79 citations, while *Moodie G* and *Wheelahan L* each received 78 local citations. Other highly influential authors include *Brown M* with 73 citations and *Pirkkalainen H* with 57 citations. The high number of local citations demonstrates that these authors play a central role in shaping the intellectual foundation and conceptual development of micro-credential research. Their works are frequently referenced within the same research domain, indicating strong scholarly influence on discussions related to digital credentials, lifelong learning, competency-based education, employability, and higher education transformation. In addition, the presence of several frequently cited authors suggests that the field has begun to develop a more consolidated theoretical and conceptual structure, particularly regarding flexible learning ecosystems, alternative credential systems, and digital learning innovation in higher education

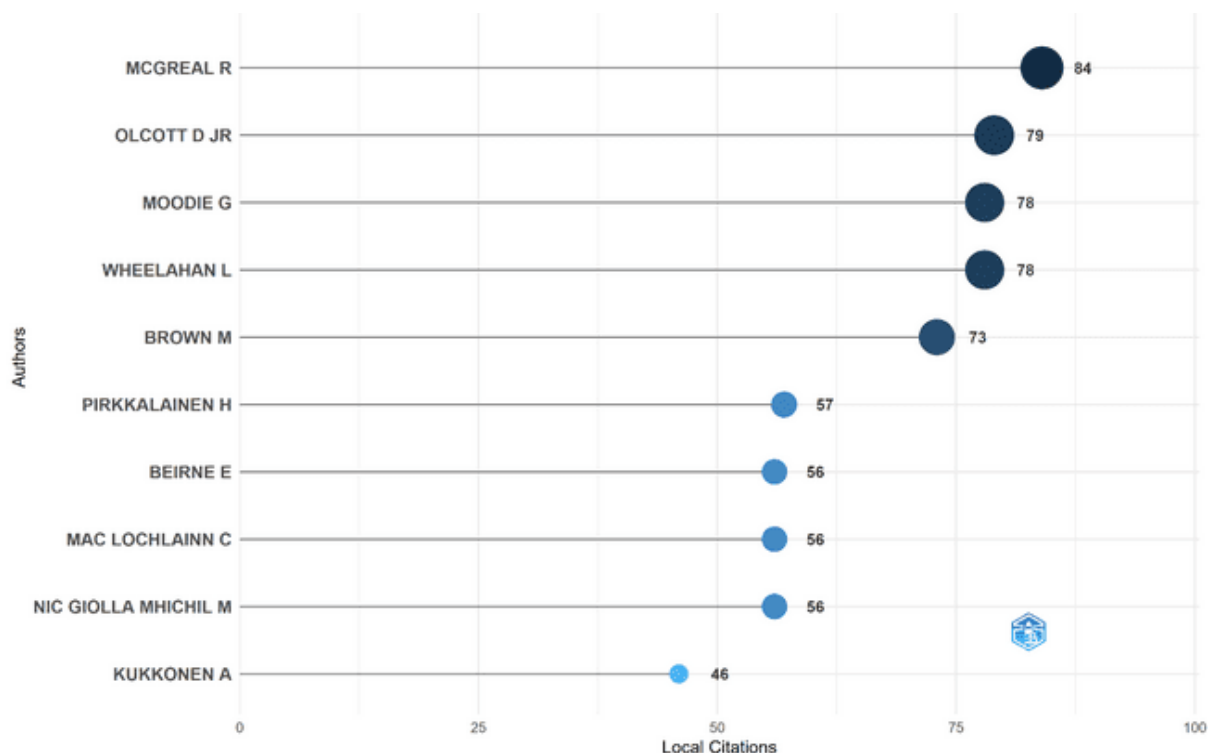


Figure 6. The Most Locally Cited Authors in the field of micro-credentials in higher education
Source: Biblioshiny (2026)

Most Productive Countries

Figure 7 presents the country production over time in research related to micro-credentials in higher education. The findings show that the United States emerged as the most productive country, demonstrating a substantial increase in publication output particularly after 2020 and reaching the highest number of publications by 2026. This dominance indicates that the United States plays a central role in shaping the development of micro-credential research, especially in areas related to digital learning innovation, workforce development, employability, and alternative credential ecosystems. Australia and Malaysia also demonstrated significant publication growth, particularly between 2021 and 2026, reflecting increasing institutional and governmental interest in flexible learning pathways and competency-based education within higher education systems. Meanwhile, Canada, Indonesia, and Spain showed moderate but steadily increasing research productivity, indicating the expanding global adoption of micro-credentials across different educational and policy contexts. Overall, the figure demonstrates that research on micro-credentials has evolved into an internationally growing field, with developed countries leading publication productivity while emerging economies increasingly contribute to the global research landscape.

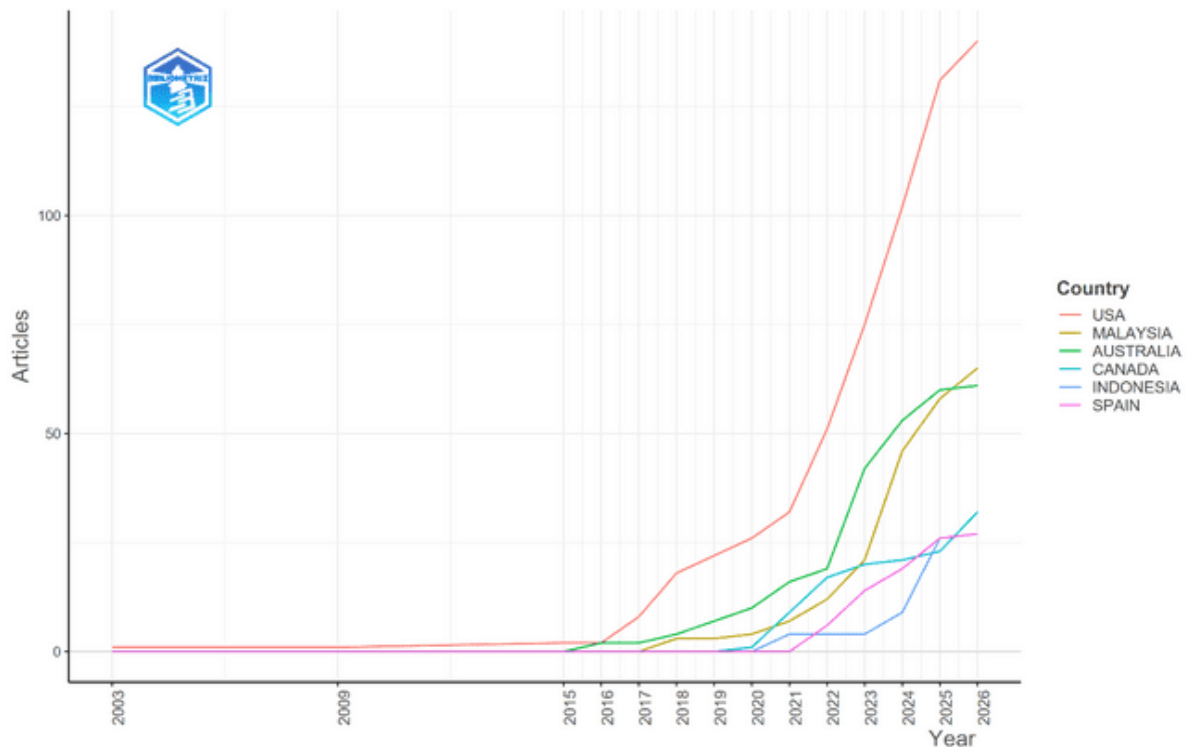


Figure 7. The Country Production Over Time In Research Related To Micro-Credentials In Higher Education
Source: Biblioshiny (2026)

Most Productive Universities

Table 2 presents the most relevant universities contributing to research on micro-credentials in higher education. The findings indicate that UCSI University emerged as the most productive institution with 8 publications, followed by Universiti Teknologi MARA with 7 publications and Purdue University with 6 publications. Several other institutions, including Ajman University, Edith Cowan University, Medical University of South Carolina, Norwegian University of Science and Technology, and the University of Calgary, each contributed 5 publications. The presence of universities from Malaysia, the United States, Australia, Canada, Norway, the United Arab Emirates, and Indonesia demonstrates that research on micro-credentials has developed into a globally collaborative and internationally distributed field. The dominance of technologically oriented and innovation-driven universities also reflects the strong connection between micro-credentials, digital learning ecosystems, workforce development, lifelong learning, and higher education transformation. In addition, the inclusion of Bina Nusantara University among the most productive institutions indicates that developing countries, particularly in Southeast Asia, are increasingly engaging in research and implementation of micro-credential systems within higher education contexts.

Table 2. Most Relevant Universities in Micro-Credentials Research

No	University	Number of Articles
1	UCSI University	8

2	Universiti Teknologi MARA	7
3	Purdue University	6
4	Ajman University	5
5	Edith Cowan University	5
6	Medical University of South Carolina	5
7	Norwegian University of Science and Technology	5
8	University of Calgary	5
9	Bina Nusantara University	4
10	McMaster University	4

Research Mapping and Network Analysis

Trend Topics in Micro-Credentials Research

Figure 8 illustrates the evolution of research topics in micro-credentials within higher education from 2017 to 2025. The findings indicate that early discussions were initially dominated by themes such as *open badges*, *digital badges*, *learning management systems*, and *assessment*, reflecting the technological foundations of digital credential ecosystems and online learning environments. Over time, the research focus shifted toward broader themes including *alternative credentials*, *digital credentials*, *microcredentials*, and *e-learning*, particularly between 2021 and 2023, suggesting increasing scholarly attention to flexible certification systems, competency-based education, and digital learning pathways. In the most recent period, *micro-credentials*, *micro-credential*, and *higher education* emerged as the most dominant and highly frequent topics, indicating that the field has entered a more mature and specialized stage of development. Additionally, emerging themes such as *personnel training*, *education computing*, and *curricula* demonstrate that micro-credentials are increasingly associated with workforce development, curriculum innovation, employability, and digital transformation in higher education institutions.

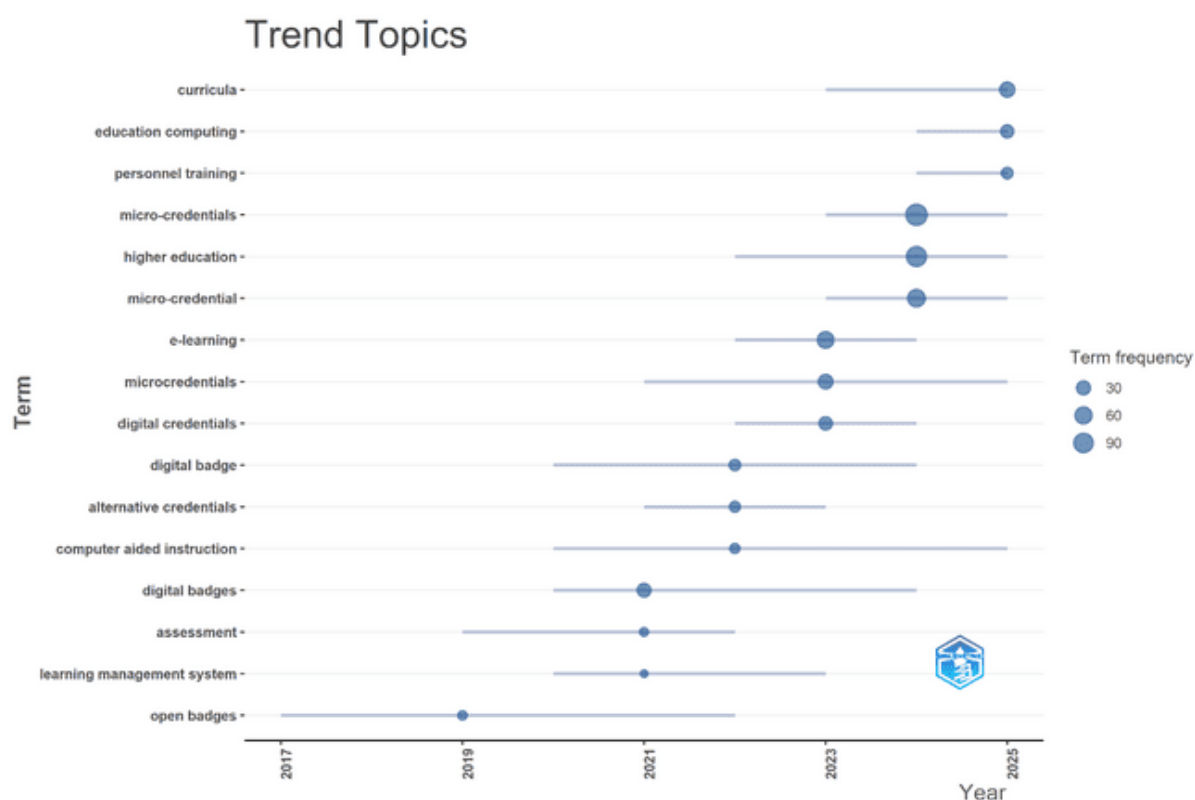


Figure 8. The Evolution Of Research Topics In Research Related To Micro-Credentials In Higher Education
Source: Biblioshiny (2026)

Research Focus in Micro-Credentials Studies

Figure 9 presents the network visualization of research focus in the field of micro-credentials in higher education based on keyword co-occurrence analysis using VOSviewer. The visualization shows that *micro-credentials*, *higher education*, and *micro-credential* occupy the central positions within the network, indicating that these concepts serve as the core foundation of the research landscape. The strong interconnections among keywords demonstrate that micro-credential research has developed into an interdisciplinary field integrating educational technology, digital learning, competency-based education, workforce development, and lifelong learning. Several major thematic clusters can be identified from the network structure. One cluster emphasizes educational transformation and curriculum innovation through keywords such as *curricula*, *engineering education*, *education computing*, *MOOCs*, *computer aided instruction*, and *digital transformation*, reflecting the integration of micro-credentials into modern digital learning systems and pedagogical practices. Another prominent cluster focuses on employability and professional development, represented by terms such as *lifelong learning*, *employment*, *workforce development*, *skills gaps*, *upskilling*, and *industry 4.0*, indicating that micro-credentials are increasingly positioned as strategic tools for workforce preparation and continuous professional learning.

relevance to digital transformation and labor market adaptation in higher education. In particular, the integration of blockchain technology and smart contracts into micro-credential ecosystems offers substantial novelty for future studies related to credential security, verification systems, and decentralized certification models. Similarly, themes associated with workforce readiness, employability, and industry-oriented learning pathways indicate the need for more empirical studies examining the effectiveness of micro-credentials in improving career outcomes and reducing skills mismatches. The visualization also demonstrates limited attention to issues such as quality assurance frameworks, policy governance, ethical implications, learner motivation, and institutional readiness, indicating significant research gaps that can contribute to the future advancement of micro-credential systems in higher education. Overall, the density analysis suggests that future research should move beyond descriptive discussions toward more integrative, technology-driven, policy-oriented, and impact-based investigations to strengthen the theoretical and practical development of micro-credentials within global higher education systems.



Figure 10: Density visualisation analysis using VOSviewer

Discussion

Research on micro-credentials in higher education is predominantly centered on the transformation of conventional higher education systems toward more flexible, competency-oriented, and digitally mediated learning ecosystems. Across the literature, micro-credentials are consistently positioned as alternative credentialing mechanisms capable of addressing limitations of traditional degree structures, particularly in responding to rapidly evolving labor market demands and technological disruption. Moodie and Wheelahan (2021) emphasized that micro-credentials reflect the fragmentation of knowledge into smaller competency units that can be accumulated and stacked over time, enabling learners to pursue more personalized and employment-oriented educational pathways. Similarly, Palmieri, Cukierman, and Vendrell Vidal (2024) argued that micro-credentials represent a significant shift in credential ecology

by emphasizing demonstrable skills and lifelong competency development rather than solely academic duration or institutional prestige. The recurrence of keywords such as *higher education*, *students*, *curricula*, *skills*, *professional development*, and *lifelong learning* further demonstrates that the literature strongly associates micro-credentials with educational adaptability, learner mobility, and continuous professional reskilling.

A substantial portion of the literature also concentrates on employability and workforce alignment as the principal rationale for micro-credential implementation. Several studies highlight that higher education institutions increasingly adopt micro-credentials to reduce the mismatch between graduate competencies and industrial expectations. Ngoc and Kunio (2025) and Ngoc Ha, Van Dyke, and Spittle (2025) found that employers value micro-credentials primarily because they provide evidence of specific competencies and practical skills directly relevant to workplace needs. Likewise, Bruguera et al. (2025) emphasized that micro-credentials are increasingly integrated into professional development frameworks to support workforce flexibility and employability in rapidly changing economic sectors. Other studies discuss how micro-credentials support labor market competitiveness through targeted certifications in communication skills, leadership, digital literacy, data analytics, and technical competencies. Pirkkalainen et al. (2023) further argued that modular learning pathways enabled by micro-credentials facilitate faster adaptation to industrial transformation and emerging occupational demands. These findings indicate that employability has become one of the strongest conceptual drivers shaping the global expansion of micro-credential systems.

Another dominant theme emerging from the literature concerns the integration of micro-credentials with digital learning technologies and online educational infrastructures. The studies demonstrate strong connections between micro-credentials and online learning environments such as MOOCs, learning management systems, e-learning platforms, and digital portfolio systems. Maina et al. (2022) explained that micro-credentials are closely linked to the expansion of open and flexible digital learning ecosystems, where learners increasingly seek short, stackable, and personalized educational experiences. Similarly, Chakraborty et al. (2021) emphasized the role of educational computing and metadata systems in enabling scalable digital credential infrastructures capable of supporting automated verification and competency tracking. The repeated appearance of keywords such as *digital badges*, *open badges*, *digital credentials*, *education computing*, and *online learning* confirms that technological innovation constitutes a foundational dimension of the micro-credential ecosystem. Moreover, several publications stress that integrating digital credential systems into higher education institutions requires significant institutional readiness, interoperability standards, and robust technological infrastructures to ensure long-term sustainability and recognition.

The literature further demonstrates increasing scholarly attention toward blockchain technology and decentralized credential verification systems. Multiple studies discuss blockchain as an emerging technological solution capable of enhancing transparency, portability, and trust in digital credential ecosystems. Alsobhi et al. (2023) argued that blockchain-based credentials can reduce fraud risks and strengthen verification efficiency by enabling immutable and decentralized record systems. Baratto et al. (2024) similarly highlighted the potential of blockchain technology to improve interoperability among educational institutions and employers through secure

credential-sharing mechanisms. However, despite growing theoretical enthusiasm surrounding blockchain integration, empirical implementation studies remain relatively limited. Many publications still focus on conceptual frameworks, technological proposals, or pilot initiatives rather than large-scale institutional applications. Karavidas et al. (2023) noted that issues related to governance, scalability, interoperability standards, and legal regulation continue to hinder broader adoption of blockchain-based credential ecosystems within higher education.

The literature also demonstrates strong interest in lifelong learning and learner-centered educational models. Numerous studies position micro-credentials as instruments for enabling continuous learning across different stages of professional and personal development. Wheelahan and Moodie (2021) emphasized that micro-credentials support lifelong learning by allowing individuals to continuously update competencies in response to changing technological and occupational conditions. This perspective is reinforced by recurring themes such as *upskilling*, *reskilling*, *workforce development*, *personalized learning*, and *professional development*. Several studies additionally highlight the inclusivity potential of micro-credentials, particularly for non-traditional learners, working adults, refugees, and individuals seeking alternative educational pathways outside formal degree systems. Fatmawati et al. (2024) found that flexible digital credential systems may improve educational accessibility for marginalized learner groups by reducing barriers related to cost, location, and rigid academic structures. These findings indicate that micro-credentials are increasingly associated with educational democratization and flexible access to higher education opportunities.

Pedagogical innovation also emerges as an important but comparatively less mature theme within the literature. Several studies examine the relationship between micro-credentials and learner engagement through gamification, digital badges, competency-based assessment, and blended learning strategies. (Moore 2022) reported that badge-based micro-credential systems positively influence learner motivation and participation by creating visible and incremental achievement structures. Gregg et al. (2022) similarly demonstrated that gamified learning environments integrated with digital credentials can enhance student engagement and extracurricular skill development. Nevertheless, research examining the long-term pedagogical effectiveness of micro-credentials remains limited. Most studies still emphasize conceptual discussions, implementation frameworks, or institutional strategies rather than robust longitudinal evaluations of learning outcomes, knowledge retention, or behavioral impact. This suggests that pedagogical dimensions of micro-credential systems require deeper empirical investigation in future research.

The geographical distribution of publications additionally reflects the global diffusion of micro-credential discourse across both developed and developing countries. While the United States, Australia, Canada, and the United Kingdom remain dominant contributors to the field, emerging research productivity from Malaysia, Indonesia, and other Asian countries indicates increasing regional interest in digital credential systems and higher education transformation. Cheng et al. (2025) noted that Malaysian universities have actively integrated micro-credentials into higher education curricula to improve industry alignment and curriculum flexibility. Similarly, studies from Indonesia emphasize the role of micro-credentials in supporting digital learning ecosystems and enhancing workforce competitiveness in developing educational

contexts. This expansion demonstrates that micro-credentials are increasingly recognized as global educational strategies rather than regionally isolated innovations.

Finally, several research gaps and emerging opportunities remain insufficiently explored within the current literature. Topics such as personalized adaptive learning systems, quality assurance frameworks, institutional governance, employer recognition, ethical implications, information literacy, and policy harmonization appear frequently within recommendation sections but remain weakly supported by empirical evidence. Artificial intelligence and learning analytics also receive limited attention despite their strong potential for supporting adaptive credential pathways and personalized competency mapping. In addition, very few studies examine the long-term socioeconomic impact of micro-credentials on career mobility, wage growth, or labor market resilience. These findings indicate that future research should prioritize interdisciplinary and evidence-based investigations capable of connecting technological innovation, educational policy, institutional governance, and learner outcomes in order to strengthen the theoretical and practical development of micro-credential ecosystems within global higher education systems.

Synthesis of Thematic Clusters and Future Research Directions

The bibliometric findings reveal that micro-credentials research in higher education has evolved into a rapidly growing and interdisciplinary field characterized by strong connections among higher education transformation, employability, lifelong learning, educational technology, and digital credential ecosystems. To provide a clearer synthesis of the findings, Table 3 summarizes the major thematic clusters identified through keyword co-occurrence, network visualization, and thematic mapping analyses. The table highlights dominant themes, representative keywords, principal research focuses, and supporting studies that collectively shape the intellectual structure of micro-credentials research.

Table 3. Synthesis of Thematic Clusters in Micro-Credentials Research in Higher Education

Thematic Cluster	Representative Keywords	Main Research Focus	Representative Studies
Digital Credential Ecosystems	Micro-credentials, digital credentials, digital badges, open badges	Alternative credential systems, credential verification, digital and certification, recognition mechanisms	Brown et al. (2021); Palmieri et al. (2024); Reed (2023)
Employability and Workforce Development	Employability, workforce development, upskilling, reskilling, skills gaps	Workforce readiness, professional development, and alignment between higher education and labor market needs	Ngoc Ha et al. (2025); Bruguera et al. (2025); Pirkkalainen et al. (2023)
Lifelong Learning and	Lifelong learning, higher education, professional	Flexible learning pathways, learner mobility, and	Wheelahan and Moodie (2021); Maina et al. (2022)

Thematic Cluster	Representative Keywords	Main Research Focus	Representative Studies
Flexible Education	development, students	competency-based education	
Educational Technology and Online Learning	MOOCs, online learning, learning management systems, e-learning, education computing	Integration of micro-credentials within digital learning environments and educational innovation	Chakraborty et al. (2021); Maina et al. (2022)
Blockchain and Emerging Technologies	Blockchain, smart contracts, artificial intelligence, digital verification	Credential security, interoperability, decentralized verification, and future digital credential infrastructures	Alsobhi et al. (2023); Rustemi et al. (2024); Karavidas et al. (2023)
Governance and Quality Assurance	Quality assurance, policy governance, institutional readiness, credential recognition	Standardization, regulatory frameworks, institutional implementation, and ecosystem sustainability	Keoy et al. (2024); Fisher and Leder (2022)

The synthesis demonstrates that employability, lifelong learning, and digital credential ecosystems remain the dominant pillars of micro-credentials research. At the same time, emerging themes such as blockchain integration, artificial intelligence, quality assurance, and institutional governance indicate promising opportunities for future investigations. These themes remain relatively underexplored compared with more established topics such as digital badges, online learning, and workforce development. Therefore, future studies should move beyond descriptive analyses and focus on empirical assessments of learning outcomes, credential effectiveness, employer recognition, policy implementation, and technology-enabled credential ecosystems. Such efforts will contribute to the development of more sustainable, scalable, and inclusive micro-credential models capable of supporting higher education transformation and lifelong learning in the digital era.

CONCLUSION

This study demonstrates that research on micro-credentials in higher education has grown substantially, particularly after 2020, reflecting the increasing importance of flexible, competency-based, and digitally mediated learning systems. The bibliometric findings show that micro-credentials have evolved into an interdisciplinary field positioned at the intersection of higher education transformation, employability, workforce development, lifelong learning, and educational technology. Dominant themes include digital credentials, online learning, professional development, digital badges, competency recognition, and skills-based education, while emerging topics such as blockchain integration, artificial intelligence, personalized learning,

information literacy, and quality assurance offer promising directions for future research. Although research productivity remains concentrated in technologically advanced countries, contributions from emerging economies continue to expand the global discourse on micro-credentials. The findings also highlight important implications for higher education institutions, including Islamic higher education institutions, by demonstrating the potential of micro-credentials to support flexible learning pathways, enhance graduate employability, strengthen lifelong learning opportunities, and facilitate digital transformation within contemporary educational ecosystems. However, this study is limited to Scopus-indexed publications and bibliometric analysis; therefore, future studies should integrate multiple databases and employ systematic reviews or empirical approaches to examine the effectiveness, governance, employer recognition, and long-term impact of micro-credential ecosystems in higher education.

Acknowledgments: The authors would like to express their gratitude to all institutions, scholars, and academic databases that supported the completion of this study. Appreciation is also extended to colleagues and reviewers for their valuable insights, constructive feedback, and technical assistance throughout the research and manuscript preparation process.

Conflicts of Interest: The authors declare no conflict of interest. The authors confirm that there are no personal, professional, or financial relationships that could be perceived as influencing the representation or interpretation of the research findings reported in this study.

Author Contributions: All authors contributed substantially to the conception and design of the study, data collection, bibliometric analysis, interpretation of findings, manuscript drafting, and final revision of the article. All authors have read and approved the published version of the manuscript and meet the criteria for authorship according to the journal's authorship policy.

Funding: This research received no external funding.

Data Availability: The data used in this study were obtained from the Scopus database and are available from the corresponding author upon reasonable request. The bibliometric dataset analyzed during the study was collected using the specified search keywords and inclusion criteria described in the methodology section.

Disclaimer: The views and interpretations expressed in this article are solely those of the authors and do not necessarily represent the official position of any affiliated institution, organization, or funding body.

REFERENCES

- Alsobhi, H A, R A Alakhtar, A Ubaid, O K Hussain, and F K Hussain. 2023. "Blockchain-Based Micro-Credentialing System in Higher Education Institutions: Systematic Literature Review." *Knowledge-Based Systems* 265. <https://doi.org/10.1016/j.knosys.2022.110238>.
- Baratto, G, M Caramagna, C Giraudo, A Lasala, F Natale, K Presutti, and F Vindigni. 2024. "Toward an Ecosystem for Digital Credentials: Projects and Challenges of the University of Turin for Lifelong and Lifewide Learning Certifications." In *Lecture Notes in Networks and Systems*, 839:135–45. IT Systems, Website Management, E-Learning Division, University of Turin, Turin, Italy: Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-981-99-8324-7_13.
- Brown, M, M Nic Giolla Mhichil, E Beirne, and C Mac Lochlainn. 2021. "The Global Micro-Credential Landscape: Charting a New Credential Ecology for Lifelong Learning." *Journal of Learning for Development* 8 (2): 228–54. <https://www.scopus.com/pages/publications/85111444796?origin=resultslist>.
- Bruguera, C, C Pagés, M Peters, and À Fitó. 2025. "Micro-Credentials and Soft Skills in Online Education: The Employers' Perspective." *Distance Education* 46 (1): 56–76. <https://doi.org/10.1080/01587919.2024.2435645>.
- Cartîş, A, J Leoste, R Iucu, K Kikkas, K Tammemäe, and K Männik. 2023. "Conceptualising Micro-Credentials in the Higher Education Research Landscape. A Literature Review." In *Smart Innovation, Systems and Technologies*, 908:191–203. University of Bucharest, Panduri St. 90, 050663, Bucharest, Romania. https://doi.org/10.1007/978-981-19-5240-1_13.
- Chakraborty, Pinaki, Prabhat Mittal, Manu Sheel Gupta, Savita Yadav, and Anshika Arora. 2021. "Opinion of Students on Online Education during the COVID-19 Pandemic." *Human Behavior and Emerging Technologies* 3 (3): 357–65. <https://doi.org/10.1002/hbe2.240>.
- Cheng, J K, I.S.-C. Yong, C K Ch'ng, and H T Lim. 2025. "Micro-Credentials in Malaysian Higher Education: A Comprehensive Case Study Approach." *Education and Information Technologies* 30 (8): 10751–75. <https://doi.org/10.1007/s10639-024-13278-7>.
- Cuya, K C, and T D Palaoag. 2024. "Blockchain in Higher Education: Advancing Security, Verification, and Trust in Academic Credentials." *Nanotechnology Perceptions* 20 (S3): 373–86. <https://doi.org/10.62441/nano-ntp.v20iS3.28>.
- Donthu, Naveen, Satish Kumar, Debmalya Mukherjee, Nitesh Pandey, and Weng Marc Lim. 2021. "How to Conduct a Bibliometric Analysis: An Overview and Guidelines." *Journal of Business Research* 133 (April): 285–96. <https://doi.org/10.1016/j.jbusres.2021.04.070>.
- Fatmawati, E, B Suharto, S R Amrozi, W K Suhma, A Yudiawan, M Ilyasin, and F M Suhma. 2024. "Change Management towards Good University Governance in Indonesia: Study at Islamic Religious Universities Based on BLU Mandate." *Cogent Social Sciences* 10 (1). <https://doi.org/10.1080/23311886.2024.2333081>.
- Fisher, R M, and H Leder. 2022. "An Assessment of Micro-Credentials in New Zealand Vocational Education." *International Journal of Training Research* 20 (3): 232–47. <https://doi.org/10.1080/14480220.2021.2018018>.
- Gregg, A, J Park, C Fenton, D Lang, and M Handley. 2022. "Exploring the 'Why' of Micro-Credentials and Digital Badges: Engineering Students' Motivations for and Perceived Utility of Learning Outside of Class." In *Proceedings - Frontiers in Education Conference, FIE*. Vol. 2022-October. Pennsylvania State University, Department of Mechanical Engineering, University Park, PA, United States: Institute of Electrical and Electronics

- Engineers Inc. <https://doi.org/10.1109/FIE56618.2022.9962376>.
- Karavidas, L, T Tsiatsos, I Stamelos, K Zourou, and S Terzi. 2023. "Acceptance of Blockchain in Education." In *Lecture Notes in Networks and Systems*, 763 LNNS:927–38. Aristotle University of Thessaloniki, Thessaloniki, Greece: Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-42467-0_87.
- Keoy, K H, Y J Koh, J Iqbal, S S Anjum, S F Yeo, A K Cherukuri, W Y Teoh, and D A A Piut. 2024. "Streamlining Micro-Credentials Implementation in Higher Education Institutions: Considerations for Effective Implementation and Policy Development." *Journal of Information and Knowledge Management* 23 (1). <https://doi.org/10.1142/S0219649223500697>.
- Li, W, and C S Ironsi. 2024. "Efficacy of Micro Credential Learning Spaces in Developing Students' Twenty-First Century Skills: Towards Graduate Work Readiness." *Education and Information Technologies* 29 (1): 1201–16. <https://doi.org/10.1007/s10639-023-12294-3>.
- Maina, M F, L Guàrdia Ortiz, F Mancini, and M Martinez Melo. 2022. "A Micro-Credentialing Methodology for Improved Recognition of HE Employability Skills." *International Journal of Educational Technology in Higher Education* 19 (1). <https://doi.org/10.1186/s41239-021-00315-5>.
- Moodie, G, and L Wheelahan. 2021. "Credentialing Micro-Credentials." *Journal of Teaching and Learning for Graduate Employability* 12 (1): 58–71. <https://doi.org/10.21153/jtlge2021vol12no1art1564>.
- Moore, R L. 2022. "Introducing Mesocredentials: Connecting MOOC Achievement with Academic Credit." *Distance Education* 43 (2): 271–89. <https://doi.org/10.1080/01587919.2022.2064823>.
- Ngoc Ha, N T, N Van Dyke, and M Spittle. 2025. "Micro-Credentials in Higher Education: Perceived Benefits for Graduate Employability and Interest Levels in Micro-Credentials for Training Employability Skills." *Studies in Higher Education*. <https://doi.org/10.1080/03075079.2025.2516709>.
- Ngoc, M.T.T., and S. Kunio. 2025. *Agile Marketing as a Driver for Dynamic Capabilities Through Knowledge-Creation Perspective. Knowledge Creation and Sharing for Social and Economic Development*. <https://doi.org/10.4018/979-8-3373-2362-6.ch008>.
- Page, Matthew J., David Moher, Patrick M. Bossuyt, Isabelle Boutron, Tammy C. Hoffmann, Cynthia D. Mulrow, Larissa Shamseer, et al. 2021. "PRISMA 2020 Explanation and Elaboration: Updated Guidance and Exemplars for Reporting Systematic Reviews." *The BMJ* 372. <https://doi.org/10.1136/bmj.n160>.
- Palmieri, J M, U Cukierman, and E Vendrell Vidal. 2024. "Open Digital Badges and Micro-Accreditation in the International Engineering Educator Certification Program (IEECP)." In *Lecture Notes in Networks and Systems*, 901 LNNS:175–86. Universidad Tecnológica Nacional, Mozart 2300, Buenos Aires, C1407IVT, Argentina: Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/978-3-031-53022-7_18.
- Pirkkalainen, H, I Sood, C Padron Napoles, A Kukkonen, and A Camilleri. 2023. "How Might Micro-Credentials Influence Institutions and Empower Learners in Higher Education?" *Educational Research* 65 (1): 40–63. <https://doi.org/10.1080/00131881.2022.2157302>.
- Reed, A. 2023. "Micro-Credentials and the Role of Evidence: Increasing the Potential for Learner-Centeredness, Inclusivity and an Expansive Model of Assessment and

- Credentialing.” *International Journal of Information and Learning Technology* 40 (5): 401–12. <https://doi.org/10.1108/IJILT-12-2022-0228>.
- Rullyana, G, E Siregar, and C Kustandi. 2025. “Research Trends on Micro-Credentials in Higher Education: A Bibliometric Analysis Using Scopus and WoS Databases.” *Journal of Learning for Development* 12 (3): 484–500. <https://doi.org/10.56059/jl4d.v12i3.1950>.
- Rustemi, A, F Dalipi, V Atanasovski, and A Risteski. 2024. “Enhancing Academic Credentials: The Synergy of Blockchain and Artificial Intelligence.” In *2024 7th International Balkan Conference on Communications and Networking, BalkanCom 2024*, 206–11. Ss. Cyril and Methodius University, Faculty of Electrical Engineering and Information Technology, Skopje, North Macedonia. <https://doi.org/10.1109/BalkanCom61808.2024.10557185>.
- Thi Ngoc Ha, N, N Van Dyke, M Spittle, A Watt, and A Smallridge. 2024. “Micro-Credentials through the Eyes of Employers: Benefits, Challenges and Enablers of Effectiveness.” *Education and Training* 66 (7): 948–63. <https://doi.org/10.1108/ET-08-2023-0340>.
- Varadarajan, S, J H L Koh, and B K Daniel. 2023. “A Systematic Review of the Opportunities and Challenges of Micro-Credentials for Multiple Stakeholders: Learners, Employers, Higher Education Institutions and Government.” *International Journal of Educational Technology in Higher Education* 20 (1). <https://doi.org/10.1186/s41239-023-00381-x>.
- Wheelahan, L, and G Moodie. 2021. “Analysing Micro-Credentials in Higher Education: A Bernsteinian Analysis.” *Journal of Curriculum Studies* 53 (2): 212–28. <https://doi.org/10.1080/00220272.2021.1887358>.
- . 2022. “Gig Qualifications for the Gig Economy: Micro-Credentials and the ‘Hungry Mile.’” *Higher Education* 83 (6): 1279–95. <https://doi.org/10.1007/s10734-021-00742-3>.