MICRO-CREDENTIALS IN HIGHER EDUCATION: A SYSTEMATIC REVIEW FOR QUALITY ASPECTS

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ABSTRACT

Quality assurance and accreditation is regarded as a significant facilitator and a barrier at the same time in the integration of micro-credentials in higher education. Micro-credentials can be used to complement and enhance education, training, lifelong learning and employability ecosystems without changing the nature of higher education and vocational training systems. Therefore, it is important to establish quality assurance and accreditation criteria to build trust in micro-credentials, facilitate their understanding and recognition, ensure their validity and reliability, and support the sustainability of micro-credentials. This study aimed to systematically analyze the literature, related reports and documents published between 2020 and 2024 to explore how the quality assurance of micro-credentials can be established. A total of 26 articles and 40 reports were thematically analyzed, generating free codes grouped into 22 categories and four themes: (1) integration into the higher education ecosystem and recognition, (2) institutional responsibility and capacity for change, (3) external quality assurance, and (4) challenges related to quality assurance and accreditation. The study examines key quality assurance aspects for integrating micro-credentials into higher education and highlights considerations for providers.

Keywords: Accreditation, higher education, lifelong learning, micro-credentials, quality assurance, quality assurance agencies.

INTRODUCTION

Micro-credentials can enhance education, training, lifelong learning, and employability systems without undermining existing qualifications and degrees, ensuring they remain complementary rather than disruptive and competitive (Council of the European Union, 2022; Greere, 2023). In this respect, quality assurance of micro-credentials is crucial. Quality assurance and accreditation are identified as one of the key issues for the recognition and integration of micro-credentials into higher education (Council of the European Union, 2022), but also as one of the obstacles to the acceptance of micro-credentials (Raj et al., 2024; Tamoliune et al., 2023). Cirlan (2023) states that quality assurance is essential to build trust in micro-credentials and to facilitate their understanding and recognition. Olcott (2022) sees quality of micro credentials as a “gamechanger”, a “market differentiator” among competing institutions.

For higher education institutions (HEIs) that have previously focused on macro degrees, activities related to micro degrees are quite challenging and complex, and the development of an innovative, robust and consistent quality framework to ensure the validity, reliability and recognition of micro-credentials becomes important in this context (O'Leary et al., 2022). MODUS (2023) report states that for micro-credentials to be sustainable in higher education, there is a need for mandatory quality assurance standards in all HEIs. The report addresses the quality assurance of micro-credentials from two perspectives: defining the quality assurance processes that HEIs should follow as providers and defining the recognition practices for micro-credentials awarded by alternative providers and including them in quality assurance processes. As highlighted in the German Rectors' Conference, higher education institutions play an essential role not only as providers but also as threshold gatekeepers for quality assurance of micro-credentials awarded by alternative providers (Cirlan, 2023).

Greere (2023) asserts that micro-credentials are a larger phenomenon than higher education and there is no evidence that micro-credentials offered by HEIs are of higher quality than those offered by alternative providers. It is important to note that the quality threshold all education providers in European Higher Education Area (EHEA) delivering or collaborating on micro-credentials must meet is its compliance with the European Standards and Guidelines for Quality Assurance in Higher Education (ESG) (Greere, 2023). On the other hand, micro-credentials require a more agile design, approval, delivery and monitoring mechanisms as they focus on more specific qualifications, respond to the changing labour market and provide up-to-date content (Greere, 2023). Another issue to consider is that micro-credentials are mostly delivered online. Brown and Duart (2024) note in their study that a considerable percentage of micro-credentials delivered by HEIs, and alternative providers are partly or fully online, and in countries that formulated distinct regulations for digital higher education, even if not explicitly stated, quality assurance systems relate to micro-credentials. Thus, these frameworks can be applied to the quality assurance of micro-credentials. It should therefore be noted that quality assurance mechanisms used for traditional higher education degrees may not be very effective for micro-credentials.

The importance of quality assurance and accreditation and the need to update quality frameworks according to the nature of micro-credentials have been highlighted in various studies carried out so far. Given this situation, the identification of quality criteria for micro-credentials is significant for the recognition and dissemination of them. Within this scope, this study aims to systematically analyse the literature, related reports and documents to explore how the quality assurance of micro-credentials can be established. This study was guided by the following questions: "What are the prominent themes in the field of quality assurance and accreditation of micro-credentials and what are the quality aspects that explain these themes?

RESEARCH BACKGROUND

Definition of Micro-credentials

European Commission (2021) defined micro-credentials as a *"record of the learning outcomes that a learner has acquired following a small volume of learning"* (p.1) and the Commission has identified 10 key principles that micro-credentials should have. These characteristics are listed as quality, transparency, being different and for a specific purpose, providing a valid assessment and evaluation process, being flexible and cumulative learning experiences, being officially recognised, stored and shared in digital wallets such as Europass, learner-centred, being able to check the legal identity of the learner and the provider, providing the date and the place of the micro-credential, having information systems that guide learners in their career choices. The report published by the Council of the European Union (2022) emphasises the importance of quality assurance and declares that *"They are underpinned by quality assurance standards recognised in the relevant sector or area of activity"* (p.21).

UNESCO (Oliver, 2022, p. 6) proposed another definition for micro-credentials: *"A micro-credential is a record of focused learning achievement, verifying what the learner knows, understands, or can do; includes assessment based on clearly defined standards and awarded by a trusted provider; has stand-alone value and may also contribute to or complement other micro- credentials or macro-credentials, including through recognition of prior learning; meets the standards required by relevant quality assurance"*. van der Hijden and Martin (2023) highlight that the definition, put forward by 50 experts, can be described as comprehensive and globally diverse. The report states that the lack of consensus on the definition of micro-credentials poses a problem in terms of quality assurance. The report also mentions that micro-credentials should refer to the level of the national qualification's framework that will help to measure learner success and ensure quality assurance of the course (van der Hijden & Martin, 2023).

Frameworks and Studies on Micro-credentials

According to MICROBOL (2022), Bologna Tools support quality assurance in micro-credentials and the Council of the European Union (2022) emphasizes that these tools enhance clarity in this process. The International Council of Open and Distance Education (ICDE) report on global quality perspectives in open, flexible and distance education states that ESG (2015) will remain as the foundation for European higher education, but highlights the need for additional reference frameworks (Chand et al., 2023). It also asserts that the E-xcellence benchmarking tool by the European Association of Distance Education Universities (EADTU) and studies by the European Association for Quality Assurance in Higher Education (ENQA) will create a road map for quality assurance frameworks and agencies (Chand et al., 2023). In addition, EADTU and the European MOOC Consortium (EMC) developed the Common Microcredentials Framework (CMF) to support the identification, design, and recognition of Short Learning Programmes (no larger than 30 ECTS) and micro-credentials (Antonaci et al., 2021)2021. CMF aligns with Bologna tools such as the European Qualifications Framework, ECTS, and the Diploma Supplement fostering accountability, recognition, and a common language among institutions (Antonaci et al., 2021).

As another reference framework for micro-credentials, Ward et al. (2023) refer to the European Skills, Competences, Qualifications and Occupations (ESCO) framework and state that ESCO aims to harmonise non-formal and informal learning with formal learning through open badges and digital certification, establishing a connection between micro-credentials frameworks, qualifications, skills, and employment. (In January 2025, the ESCO website stated these figures as 3,039 occupations and 13,939 skills.) Another player is the European Consortium of Innovative Universities (ECIU), which aligns its micro-credential quality assurance with the European Commission and the Microbol project (Brown et al., 2021; Greere, 2023; Mac Lochlainn et al., 2022). Additionally, International Council on Badges and Credentials (ICoBC) has published a taxonomy and quality criteria scale (Ossiannilsson & Darshan Singh, 2021).

Previous Systematic Reviews

When the previous systematic reviews on micro-credentials are analysed, it can be seen that there are no studies on quality assurance and accreditation of micro-credentials. The studies that have been carried out focus on identifying the potential of micro-credentials (Tamoliune et al., 2023), integrating micro-credentials into higher education (Ahsan et al., 2023; Johan et al., 2025; Selvaratnam & Sankey, 2021; Thi Ngoc Ha et al., 2023), revealing opportunities and threats for different stakeholders (Varadarajan et al., 2023) and examining blockchain-based micro-credentials systems (Alsobhi et al., 2023). All these systematic reviews highlighted the importance of significant issues such as quality assurance, accreditation, recognition, building trust and reputation. In this respect, this study addresses the importance of quality assurance, which is also emphasised in all these systematic reviews, and seeks to answer the question of how to establish the quality of micro-credentials and aims to fill this gap in the literature.

METHOD

Research Design

In this systematic review, the 21-item ENTREQ (Enhancing transparency in reporting the synthesis of qualitative research) framework (Tong et al., 2012) and the PRISMA (Preferred reporting items for systematic reviews and meta-analyses) 2020 Flowchart (Page et al., 2021) were used to increase transparency in the reporting and synthesis stages. The 21 items in the ENTREQ framework, which helps researchers identify the key steps during the research, increase transparency and provide a tool to help explain the various concepts and terms used. The items are divided into five areas: a) introduction, b) methodology, c) literature search and selection, d) evaluation, and e) synthesis of findings. The framework provides descriptors and examples for each item. PRISMA 2020 Flowchart systematically illustrates the progression of information through the various stages of a systematic review. It provides a visual representation of the number of records identified, included, and excluded, along with the specific reasons for exclusion. The structure of the chart varies depending on whether the review is original or an update, as well as the sources utilized for study identification.

Inclusion Criteria, Data Sources, Study Screening and Selection Results

Within the scope of the study, Web of Science and Scopus databases were searched several times, the first in June 2024 and the last in December 2024, using the search query ['micro-cred*' OR 'microcred*' OR 'alternative digital cred*' OR 'badge*' AND 'quality' OR 'quality assurance' OR 'accreditation']. The process of coding the data in MAXQDA took 7 months (June-December 2024), and new studies found as a result of intermittent searches were added to the dataset.

As a result of the first search in Scopus, 1031 studies were found, and the number of studies decreased to 418 after the application of the year criterion (between 2020-2024). Among the studies, only 'article' and 'conference paper' in 'English' were selected, book chapters and other studies were excluded. Book chapters were not included in the study since most of them generally are not open to access and may not be peer-reviewed. After the filtering, abstracts of the remaining 339 studies were manually screened and only 16 studies describing quality assurance and criteria in micro-credentials were included in the systematic review. With the final screening in December, 3 more studies were added to the 16 studies.

The results of the first search in Web of Science yielded 1310 articles, and the same process as in Scopus was followed in WOS. 475 studies between the years '2020-2024' were found and the abstracts of the remaining 435 studies were analysed using the filters 'article', 'conference paper' and 'English'. When the same publications between the two datasets were removed, the total number of publications included in the analysis was 26. While the number of studies on micro-credentials is quite high, focusing the keyword search on 'quality assurance and accreditation' resulted in a limited number of relevant studies. These 26 studies focus on quality and provide information on how to ensure quality in micro-credentials.

Similar criteria were applied to the web search. Documents such as reports, slides, infographics, brochures, etc. found in the web search with the phrase 'quality assurance and accreditation in micro-credentials' were filed and those between the years '2020-2024' were included in the analysis. The search was carried out in English. The study includes the analysis of a total of 40 documents, including 27 documents identified in January 2024 as a result of the first scan and 13 documents added in December 2024 with the latest scan. The documents include reports published by international organisations, national quality agencies, universities and the results of project work on micro-credentials and quality. Figure 1 shows the screening process flowchart of articles and documents and the reasons for their inclusion and exclusion.

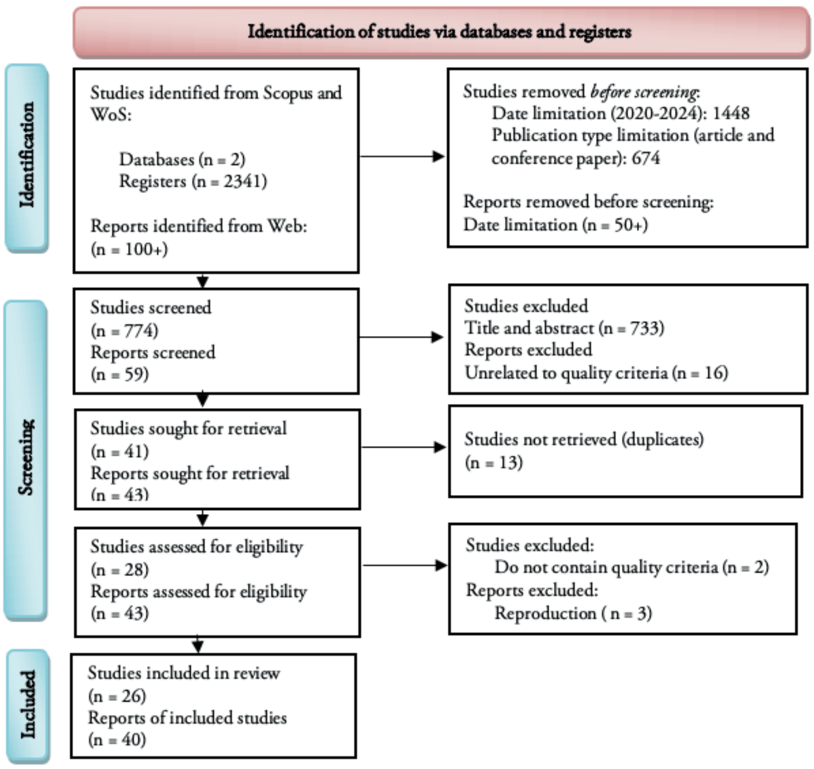

Figure 1. Systematic review flow chart (adapted from Page et al., 2021)

Study Characteristics and Rationale

Tables 1 and 2 provide identifying details about the 26 articles and 40 documents selected for analysis in this study, including dates, research methods, participants, institutions, the quality dimension they addressed and why they were selected. The studies were selected by the agreement between the two authors.

Table 1. Annotation of included studies: research designs, key quality aspects, and relevance.

	Study	Research Design	Quality Aspect	Key Words	Appraisal Criteria
1	Alasmari & Alzahrani (2024)	Survey study	Policies and practices	Micro-credentialing, Middle East, North Africa, Universities, Policies, Practice	Offers recommendations for quality, accountability, and financing
2	Bair et al. (2023)	Position paper	Transitioning to micro-credentials	Higher education, post-secondary, distance learning, certificates, digital badges, micro-credentials, cultural awareness	Various actions put in place while transitioning to micro-credentials
3	Canales (2020)	Scoping review	Recognition & evaluation of competences and skills	Digital badges, Badges design principles, Microcredentials; Continuing professional education	Redesigning accreditation and assessment procedures for academic and corporate settings
4	Casadesus et al. (2023)	Case study	Accreditation	Short learning programs, micro-credentials, evaluation, quality, European Qualifications Framework. European Standards and Guidelines	First experiences of accreditation
5	Clausen (2022)	Case study, field report	System aligned with the ISTE standards	Micro-credentials, Badges, Technology infusion, Technology integration, Teacher education	Feedback from stakeholders highlighted both opportunities and possible challenges in implementing the system
6	Donnelly & Maguire (2020)	Case study	Collaborative course design	Digital badges, teachers-as-designers, partnerships, professional development, scalable, triple-loop transformation	Offers an example of nationally recognized collaborative course design
7	Fan et al. (2024)	Mixed-methods design	Quality, benefits, and challenges of micro-credentialing	Micro-credentialing, Professional learning, Pursuers, Developers/ assessors, Mixed methods	Provides insights for designing and executing professional learning programs and shaping policies
8	Farias-Gaytan et al. (2023)	Case study	Strategy, design, assessment	Digital transformation, Alternative credentials, Higher Education, Educational Innovation, Organizational model, Case study	Offers recommendations for defining and managing alternative credentials
9	Goulding et al. (2024)	Survey and focus group	Assessment	Micro-credentials, assessment, motivation, digital badges	Offers an innovative assessment idea: Replacement of marks with digital badges
10	Griffiths et al. (2024)	Interviews and focus group	Business model	OER, assessment, micro-credentials, badges, competence, specifications, infrastructure, business model	Offers ideas about pedagogical, technical and business issues

11	Hamutoglu et al. (2022)	Case study	Scope of QA in HEI	Content analysis, England, higher education, quality assurance, Turkiye	Suggestions concerning both diploma and micro-credit systems
12	Kontzinos et al. (2024)	Case study	Blockchain technology	Higher education, blockchain, micro-accreditations, smart badges, skill verification, pilot execution, evaluation, lessons learned, policy recommendations	Offers policy recommendations
13	Mikroyannidis et al. (2024)	Interviews	Lifelong learning and decentralised micro-accreditation	Blockchain, decentralization, lifelong learning, microaccreditation, microcredentials, Smart Badges, LinkChains MerQL	Offers valuable insights into the different aspects of lifelong learning use of decentralization technologies
14	Noelle et al. (2024)	Case Study	Innovative new tool	Micro-credentials	Offers QA criteria
15	Norman et al. (2024)	Pilot study	Stackability	Distance learning, microcredentials, online learning, training, workforce development	Offers ideas about flexible micro-credentials
16	Noyes et al. (2020)	Systematic review	Design and implementation of digital badges	Digital badges	Design and implementation of credentialing system in health care education
17	O'Leary et al. (2022)	Position paper	QA principles	Micro-credentials, HE quality framework.	Offers QA principles for development, verification, and implementation of HE micro-credentials
18	Raj et al. (2024)	Survey research	Policy development	Micro-credentials, Online certifications, Implementation, Barriers	Offers theoretical, practical and methodological implications
19	Rami et al. (2024)	Focus group discussions	Readiness	Educational technology, Higher education Leadership, Micro-credentials, Public university, University leaders	Recommendations for the implementation of micro-credentials within the higher education institutions landscape
20	Reed (2023)	Case study	Assessment and credentialing practices	Assessment, Credentialing, Digital credentials, Evidence-based assessment, Micro-credentials	Explores challenges and offers several recommendations for practice
21	Sargent et al. (2023)	Descriptive case study	Micro credentials from the learners' perspectives	Microcredentials, postgraduate, online learning, FutureLearn, open	Offers pedagogical and practical considerations along with learners' perspective
22	Selvaratnam et al. (2024)	Survey Research	Maturity model	Micro-credential, Australasia, maturity model, policy, higher education, short form learning	Offers a maturity model for micro-credentialing
23	Tee et al. (2024)	Survey research	Programme design, experience and responses	Micro-credentials, Online learning, Experience, Engagement, Willingness to pay more, Emerging economy	Offers theoretical, practical and methodological implications

24	Trepule et al. (2021)	Case study	A list of quality criteria for DB description	Digital badges, metadata, criteria, assessment, recognition, higher education.	Offers distinct assessment and recognition criteria
25	Ward et al. (2021)	Exploratory study	21st Century skills taxonomy	Personalised Learning, Skills Taxonomy, Microcredential, Framework, Accreditation	Offers a skill taxonomy for accreditation process
26	Zouri & Ferworn (2021)	Literature Review	Curriculum mapping	Ontology reasoning, curriculum mapping, curriculum ontology, knowledge sharing, knowledge discovery	Curriculum mapping

Table 2. Annotation of included documents: institution/project, research design, participants and relevance

	Citation	Institution / Project	Research design	Participants	Appraisal Criteria
1	Altuna et al. (2023)	Microcredx	Whitepaper	Microcredx	Implementation framework
2	BAC (2022)	BAC	Whitepaper	BAC	An accreditation pilot scheme
3	Biaggi et al. (2024)	QA-FIT Project	Survey Research		QA and internationalization
4	Bigelow et al. (2022)	eCampusOntario	Blueprint	Ontario Online Learning Consortium	Recommendations about recognition
5	Brown et al. (2021)	ECIU	Whitepaper (Paper 1)	ECIU	Represents the vision of ECIU and Europe
6	Caforio et al. (2023)	MCE Project, EADTU	Case study	Partner universities	Comprehensive information about innovating HEI
7	Cirlan (2023)	ENQA / I'MINQA Project	Desk research Survey and Interviews	31 EHEA Countries, 12 QA Agencies, 14 HEIs and 6 alternative providers	Comprehensive information about QA of MC
8	Cirlan et al. (2024)	ENQA	Presentation	Agencies	Perspective of agencies about the future of external QA
9	Council of the European Union (2024a)	European Commission	Council Recommendation		European QA and Recognition System in HEI
10	Council of the European Union (2024b)	European Commission	Council Recommendation		Offers recommendation for attractive and sustainable careers in HEI
11	Council of the European Union, (2022)	European Union	Council Recommendation	European Union	The European strategy for micro-credentials in lifelong learning and employment.
12	den Hertog et al. (2023)	European Digital Education Hub	Whitepaper		A European Maturity Model for Micro-credentials in HEI
13	E4 Group, (2020)	ENQA, eua, EURASHE, esu	Whitepaper	ENQA, eua, EURASHE, esu	Recommendations for changing the landscape of HEI and ESG
14	ENQA (2024)	ENQA	Whitepaper		ENQA message to EHEA Ministers

15	EQAR (2023)	QA-FIT Project / EQAR	Survey Research	36 governmental members of EHEA/ 33 EQAR members	Presents mapping of evidence on the scope and implementation of internal and external QA
16	European Commission (2024)	European Commission	Blueprint		European Degree
17	European MOOC Consortium (2020)	EMC	Whitepaper	EMC	Common micro-credential framework
18	European Training Foundation (2022)	ETF Knowledge Innovation Centre	Survey responses and expert panels.	ETF partner countries, 140 experts and stakeholders	Comprehensive information about QA and recognition of MC
19	Galindo, Ed.D et al. (2024)	Digital Promise	Whitepaper		Explains the role of MC in lifelong learning and development
20	Gover et al. (2024)	QA-FIT Project	Survey Research		The future of ESG
21	Greere (2023)	ENQA Working Group	Survey Research / Case Study	18 representative agencies from 13 countries	Comprehensive information about QA of MC
22	IMINQA (2023)	I'MINQA Working Group	Project results		Reflective questions for internal and external QA
23	Mac Lochlainn et al. (2022)	ECIU	Whitepaper (Paper 3)	ECIU	Represents the vision of ECIU and Europe
24	MICRO QUEST (2021)	MICRO QUEST	Project Results	Austria, Germany, Ireland, Slovenia, Spain	Offers information about Micro-Credentials in VET, QA and QA frameworks
25	MICROBOL (2021)	MICROBOL project, EHEA	Output document		Observations and recommendations
26	MICROBOL (2022)	MICROBOL project, EHEA	Whitepaper	EHEA countries representatives	Recommendations for quality assurance, recognition, and qualification frameworks & ECTS.
27	Micro-Credential Approval and Accreditation Rules (2022)	NZQA	Regulation	NZQA	Micro-credential Approval and Accreditation Rules
28	MODUS (2023)	HRK	Whitepaper	Experts from different stakeholders	Offers relevant standards for QA, recognition, RPL, stackability etc.
29	OECD (2021)	OECD Education policy perspective Part B	Interview	Leaders of 8 largest HEI across Europe	Presents evidence on policy and practice environment
30	OECD (2023a)	OECD	Desk research, stakeholder interviews and workshops	Finland, the Slovak Republic, Slovenia and Spain.	Offering a strategic framework for the integration and effective utilization of micro-credentials
31	OECD (2023b)	OECD	Whitepaper	Experts	Public policies for effective micro-credential learning
32	OECD (2024)	OECD	Whitepaper		Recommendations for promoting green and digital innovation
33	Oliver (2022)	UNESCO	Whitepaper	Forty-seven experts from diverse region	Offers a common definition of micro-credentials
34	Orr et al. (2020)	European Commission	Case study		Explaining the European Approach

35	Ossiannilsson & Darshan Singh (2021)	ICoBC	Desktop research	COL, EC, ICDE, OECD, UNESCO, NZQA, Campus Ontario, etc.	Offers a taxonomy, quality criteria, and quality grid for MC
36	QAA (2022)	QAA	Whitepaper	QAA	Characteristics Statement for MC
37	QA-FIT (2023)	EUA, EURASHE QA-FIT Project	Survey Research	HEI, QA Agencies, students, national authorities	Maps the state of play of QA and ESG use
38	TPG-LRC CoRE Working Group, (2024)	EHEA Project/ CIMEA	Project output	Partners	Offers approaches to micro-credentials for HEI
39	van der Hijden & Martin (2023)	UNESCO	Policy Paper	Experiences from different countries	Comprehensive information about QA and recognition of MC
40	Zhivkovikj & Munjishvili (2024)	EQAR	Desk research, focus group		Results of feasibility results, scenarios in practice

Synthesis Methodology

The study used reflective thematic analysis and thematic document analysis. Bowen (2009) states that document analysis involves scanning, extensive reading and interpretation and that this iterative process combines elements of content analysis and thematic analysis. The analysis was carried out in the stages of 1) data recognition, 2) systematic coding, 3) initial theme formation, 4) theme development and revision, 5) theme clarification, definition and naming, 6) reporting the results of the analysis (Braun & Clarke, 2006). In addition, the thematic synthesis method, which is described in ENTREQ framework, was used to synthesise the findings. According to the thematic synthesis method, the free codes organised within the descriptive themes were interpreted to reveal analytical themes, and the analytical codes that emerged were intended to reveal an interpretation beyond the initial studies included in the systematic review (Tong et al., 2012).

RESULTS AND ANALYSIS

Descriptive Analysis

The study provides information on the methods used in studies on quality assurance of micro-credentials and alternative uses of the term "micro-credential". Most of the studies included in the analysis used "survey" and "case study" methods. 'Interview' and 'focus group' are other methods used. In most of the studies reviewed, the word micro-credential is written with a hyphen as "micro-credential". Terms such as "digital badges", "alternative digital credentials" and "badges" are the words used interchangeably or together with the term of "micro-credential". In some studies and reports, the word "micro-credential" is written as "microcredentials". While the term 'digital badge' was only used in two studies (Donnelly & Maguire, 2020; Noyes et al., 2020) other studies used the term 'digital badge' or 'digital credential' together with the term 'micro-credential'.

In their reports, ICDE and OECD use the term "alternative digital credentials" for micro-credentials, and ICDE states that this distinction is made because not every micro-credential is digital (Olcott, 2022). The term "alternative digital credentials", which is included in the keywords in the systematic review, was used for this reason. However, interestingly, in the published reports on quality (including OECD and ICDE), the term micro-credential was preferred. This reflects that quality assurance, whether digital or not, is addressed under the umbrella term micro-credentials and that these credentials need to be credited digitally in order to ensure transferability and stackability due to their nature.

Another point about terminology is the use of the word "accreditation". The word 'accreditation' is used in the sense of 'certification' in some articles. The studies by Kontzinos et al. (2024) and Mikroyannidis et al. (2024) use the term "micro-accreditation" among the keywords. Even when the word 'accreditation' is used in the sense of 'certification', these studies were not excluded from the analysis as they deal with the issue of quality assurance.

Thematic analysis

The first stage of data analysis, data identification and coding, took about ten months. Using an inductive method, 2217 free codes were identified, and initial themes were formed based on these codes. These themes, initially about 80 categories and 10 themes, were refined into 5 descriptive themes and 24 categories in the development and revision phase. In the process of clarifying and defining the themes, it was decided that the last theme could be interpreted under the first theme and reporting was done under 4 analytical themes and 22 categories. These themes are 1) integration into the higher education ecosystem and recognition, 2) institutional responsibility and capacity for change, 3) external quality assurance and 4) challenges related to quality assurance and accreditation. The first theme deals with determining the scope of micro-credentials for recognition, the second with strengthening institutions' internal quality assurance systems, and the third with adapting external quality assurance processes to micro-credentials. These themes explain the difference between the concepts of recognition, quality assurance and accreditation, and the quality aspects that emerge in the context of the themes provide insight into how micro-credentials should be addressed from all three perspectives.

Table 3. Themes, categories and codes about quality assurance and accreditation of micro-credentials

Themes	Categories	Analytical Codes
1. Integration into Higher Education Ecosystem and Recognition	Defining micro-credentials and determining their scopes	• Clear definition and transparent terms, consistency between stakeholders • Purpose, relevance and use
	Compliance with regulations or frameworks *Extension of ESG	• Establishment of common frameworks • Integration into the national qualifications framework (TQF), development of national policies • Compatibility with international standards (European Learning Model - ELM, European Qualifications Framework - EQF, etc.) • Compliance with professional frameworks (SFIA, ESCO, etc.) • Compliance with quality frameworks (ESG, EQAVET, ISO 9001, ISO/IEC 17024, etc.) • Compliance with digital systems (EDCI, European Blockchain, W3C-VC, etc.) • Compliance with Bologna tools (ECTS, Diploma Supplement, EQF) • Data protection compliance (GDPR, eIDAS,) • Use of clear frameworks for outputs (such as Bloom's Taxonomy)

2. Institutional Responsibility and Capacity for Change	Strategic planning	• Compatibility with the mission and objectives of the institution, adaptation of micro-credentials business models in line with the mission • Integrating lifelong learning strategies into institutional policies • Integrating micro-credentials into internal quality assurance processes
	Academic responsibility	• Learner-centred designs • Identifying outcomes • Pedagogical strategies • Improving the skills of teaching staff • Collaboration in design • Quality of learning materials
	Assessment and evaluation	• Assessment and evaluation design • Diversified assessment methods • Competence-based approach • Performance-based assessment • Authentic assessment • Evidence-based assessment • Technology focused assessment • Feedback
	Technical infrastructure	• Technology infrastructure • Compatible and interoperable systems • Combining formal and informal qualifications in a single registry • Authentication and data security • Training and support for stakeholders in technical know-how and certification of competences
	Transparency and continuous improvement	• Transparency of information • Stakeholder involvement • Continuous improvement practices
	Funding	• Sustainability of resources • Organisational support and engagement • Aligning national and institutional education policies and funding strategies

3. External Quality Assurance	Accreditation or recognition	• From the institutional level to the national • From the concept of 'accreditation' to the 'recognition'
	Standards and frameworks	• Universal standards and fit for purpose frameworks
	Flexible and tailored approaches	• Reducing bureaucracy/thematic reviews/automated recognition/collaboration between QA and HEIs • Linking QA and recognition
	Institutional or programme evaluation	• A combination of institutional and programme evaluation
	Cross-border and transnational quality assurance	• Accreditation of joint online education programmes
	Quality indicators and data-based approaches	• Using metrics such as learner participation, satisfaction, labour market data, employer feedback, educator satisfaction etc.
	Stakeholder engagement	• Involvement of stakeholders in quality processes/ friend-of-a-friend model
	Transparency and trust	• Transparency of standards, guidelines and procedures applied to micro-credentials for authentication
	Developing a culture of quality	• Strengthening internal quality assurance systems to complement external quality assurance
4. Challenges Related to Quality Assurance and Accreditation	Lack of standardization and clarity	• Unclear definitions/ lack of standardised quality assurance procedures and transparency/ risk of misuse • Diversity in learning context and rapid changes in education and the market
	Recognition and trust issues	• Tendency towards traditional methods • Online learning and feedback gaps
	Inexperience about adult learning	• Adult learner needs
	Differences between education and industry	• Balancing quality and flexibility
	Accreditation barriers	• The burdensome nature of additional external quality procedures

Theme 1: Integration into the Higher Education Ecosystem and Recognition

This theme addressed the integration of micro-credentials into higher education and identified two important issues for the integration of micro-credentials into higher education: a) Defining micro-credentials and determining their scope and b) Compliance with regulations or frameworks.

a) Defining micro-credentials and determining their scope

- *Clear definitions, transparent terminology and consistency between stakeholders*

Council of the European Union (2022) and van der Hijden and Martin (2023) provide a general definition of micro-credentials and set out the necessary criteria for micro-credentials. The definition that this theme attempted to express actually refers to the use of common terms that are understandable for all stakeholders (MICRO QUEST, 2021) and defining the scope of micro-credentials, which take quite different forms. Micro-credentials are not an issue confined to the higher education agenda. Defining micro-credentials correctly and identifying their scope (Zouri & Ferworn, 2021), which are also considered in the context of vocational education and training, lifelong learning, continuing education and adult learning (den Hertog et al., 2023), will enable learners to achieve their career goals in any of these systems and micro-credentials to be understood and recognised by employers (Raj et al., 2024)learners and employers. Two ranking methods, namely Preference Ranking for Organization Method for Enrichment Evaluation (PROMETHEE. In this context, it is suggested that adopting only a higher education-based perspective may be insufficient to meet the demands (OECD, 2024).

- *Purpose, relevance and use*

Learners acquire micro-credentials to gain new qualifications, upgrade existing ones, complement formal qualifications, or create alternative career paths (O'Leary et al., 2022). These credentials can guide learners and serve as a substitute for traditional grading systems in assessment (Goulding et al., 2024). They may be standalone or part of a larger program, often derived from existing degrees (TPG-LRC CoRE Working Group, 2024). In this context, to avoid information loss and confusion that arises when large courses are broken into smaller modules (Raj et al., 2024)learners and employers. Two ranking methods, namely Preference Ranking for Organization Method for Enrichment Evaluation (PROMETHEE, it is essential to maintain a clear focus on the relevance of the course to the provider institution, the programme, the labour market and the individual's career goals (European Training Foundation, 2022).

Micro-credentials are short, flexible and modular learning experiences, focus on a specific qualification and consist of small chunks (Norman et al., 2024; O'Leary et al., 2022; Selvaratnam et al., 2024). They prioritize the qualification itself rather than previous education, certificates or experience of participants (Galindo, et al., 2024). This agile assessment and evaluation structure reinforces the open-to-all nature of micro-credentials, allowing individuals to develop qualifications at their own pace. Defined as competence-based and outcome-oriented, micro-credentials aim to provide transparent, measurable and comparable qualifications in terms of outcomes, workload and assessment methods (Council of the European Union, 2022; den Hertog et al., 2023). This structure aligns with the European Degree, respecting the diversity of academic traditions and systems and being open to all universities, sectors, disciplines and levels.

Micro-credentials, in the form of digital badges, certificates or e-certificates, should be cumulative and transferable across different systems, sectors, and digital platforms, including formal, non-formal, and informal education, vocational training, and the labor market. Innovations such as the Europass Digital Credits Infrastructure (EDCI) aim create a single European digital framework that supports the seamless recognition of micro-credentials across Member States (Orr et al., 2020). Designing micro-credentials to be interoperable and to meet the diverse needs of learners (responding to societal, personal, cultural and labour market needs) enhances their integration into professional settings and their global accessibility (Ossiannilsson & Darshan Singh, 2021). Interoperability is a key feature (TPG-LRC CoRE Working Group, 2024) and Council of the European Union (2022) recommends that the Database of External Quality Assurance Results (DEQAR) should include higher education providers and other relevant alternative providers. As recognition is also a social process, increasing trust in micro-credentials across education, training, labour market and society is a key to change. The concept of 'open recognition', promoting the acknowledgment of qualifications throughout life, implies a change in the culture of recognition of qualifications (Orr et al., 2020).

b) Compliance with regulations or frameworks

Quality assurance practices are important because they integrate and support higher education, lifelong learning, recognition of prior learning and professional development through micro-credentials (Cirlan, 2023). They ensure that micro-credentials remain reliable and up-to-date, valuable for students and respected by employers. Since micro-credentials can be awarded for a wide variety of reasons (such as upskill, reskill, complementarity, lifelong learning, labour market adaptation and recognition of prior learning), can be obtained by unbundling existing degrees or independently and can be stackable both within and outside the higher education ecosystem, thus establishing a common understanding, functioning system, and quality assurance processes become challenging. This situation highlights the need for clear definitions (Zhivkovikj & Munjishvili, 2024) and adaptable quality assurance standards that are compatible with the frameworks already in use (Greere, 2023).

Issues such as "developing common frameworks and national policies (Rami et al., 2024) that consider the target audiences and do not heavily rely on educational jargons (den Hertog et al., 2023), integrating micro-credentials into the existing national and international qualifications frameworks (EQF, UNESCO's ISCED) (Casadesus et al., 2023; Council of the European Union, 2022), updating qualifications frameworks to include formal, informal and non-formal learning (OECD, 2024), recognizing prior learning and aligning it with international standards" are seen as important to ensure quality assurance. Ensuring quality across Vocational Education and Training (VET) systems, providers, and various learning environments such as school or work-based learning, apprenticeships, digital, face-to-face or hybrid are also critical for quality assurance (den Hertog et al., 2023). For instance, The European Learning Model, a data model for the interoperability of learning opportunities, qualifications, certificates and credits, aims to create a common language for learning in Europe. Micro-credentials are intended to add value and to complement rather than replace traditional degree programs (Council of the European Union, 2022). Effective recognition and quality assurance require a framework that fosters synergies between education systems, including VET, research, innovation and community service; increases the competitiveness of HEIs (Council of the European Union, 2024a); and ensures quality, transparency, cross-border comparability and agreement on certification and interoperability (Alasmari & Alzahrani, 2024).

Although the compatibility of micro-credentials with occupational frameworks (ISTE, SFIA, ESCO, etc.) is discussed (Clausen, 2022; Ward et al., 2021)Austria","event-title":"2021 IEEE Global Engineering Education Conference (EDUCON, it is noted that these frameworks are too detailed to provide a common agreement between higher education and employers (Ward et al., 2021). Quality assurance is assessed through frameworks like ESG, EQAVET, ISO 9001, ISO/IEC 17024 and TQM. MICRO QUEST (2021) states that the most compatible quality framework for micro-credentials is ISO/IEC 17024. Digital system integration (EDCI, eIDAS, European Blockchain, W3C-VC. etc.) (den Hertog et al., 2023; Griffiths et al., 2024)combining badges or micro-credentials with competence frameworks and digital seals. This study identified the current situation of open credentials in post-secondary education in Europe, the main themes of the discourse, and the points of agreement and divergence surrounding them. The data comprised a corpus of transcriptions from 12 expert interviews and a focus group. Qualitative text analysis identified the principal themes. Findings included the following: (a, Bologna tools (ECTS, Diploma Supplement, EQF) (Council of the European Union, 2022), General Data Protection Regulations (GDPR) compliance (den Hertog et al., 2023; Kontzinos et al., 2024) and clear frameworks for outcomes (Bloom's Taxonomy, etc.) and specification of qualification levels are also key to ensure quality (den Hertog et al., 2023; MICRO QUEST, 2021). MODUS (2023) emphasizes the need for established rules and guidelines to enhance the recognition and transferability while European Commission (2024) advocates reducing bureaucratic barriers for greater adaptability to higher education.

Quality assurance frameworks are essential for reliable micro-credentials. These frameworks ensure the academic integrity and quality of education, while requiring adaptations to the unique characteristics of micro-credentials. The theme suggests the need of a dynamic quality assurance approach that accommodates flexibility while maintaining standards (BAC, 2022), allowing providers autonomy in designing with tailored quality management frameworks. Maintaining this balance is challenging, as micro-credentials offer diverse learning pathways. The agility is crucial in a rapidly evolving educational environment, enabling institutions to adapt without compromising programme integrity. A balanced approach that allows for creative programme designs while maintaining rigorous quality standards is essential for the long-term success of micro-credentials (MODUS, 2023).

- *Extension of the ESG*

The ESG sets out the quality assurance framework for the European Higher Education Area (EHEA) and was adopted by higher education through Bologna Process (E4 Group, 2020). Developed by stakeholder organisations known as the E4 Group - representing quality assurance agencies (ENQA), universities (EUA), professional higher education institutions (EURASHE) and students (ESU)- it is argued to be flexible enough to respond to recent developments in higher education, like e-learning and micro-credentials and to support innovation and diversity in higher education and quality assurance (E4 Group, 2020). Greere (2023) emphasizes that the use of ESG in micro-credentials requires proper interpretation and highlights the quality assurance features specific to micro-credentials. Cirlan (2023) states that ESG provides a general framework but may need adaptation for micro-credentials.

Micro-credentials are a wider phenomenon than higher education. Therefore, it is stated that all providers and stakeholders must comply with the ESG, as a minimum threshold for micro-credentials (Greere, 2023). To map accredited programmes and institutions under the ESG, the European Quality Assurance Register for Higher Education (EQAR) developed DEQAR (External Quality Assurance Results Database). which now includes micro-credentials from alternative providers accredited by an EQAR-registered institution (den Hertog et al., 2023). This shows that the ESG will remain to be a quality assurance framework for micro-credentials, with further adaptations and interpretations.

It is stated that the most relevant part of the ESG framework for micro-credentials is ESG 1.1 (den Hertog et al., 2023) and that minor changes are needed in areas such as micro-credentials, lifelong learning, digitalization, internationalization, social dimension and inclusiveness in line with the changing nature of higher education in relation to ESG (Biaggi et al., 2024; Cirlan et al., 2024; Gover et al., 2024; QA-FIT, 2023)" These reports also address the complementarity of ESG with other frameworks and tools (Cirlan et al., 2024) and state that it is necessary to question the impact of the changes for countries/institutions in the process of adapting to the current form of ESG (Gover et al., 2024).

As the current form of ESG is based on the quality assurance of a single institution, issues such as the quality assurance of established university associations, internationalisation, recognition of transnational education and cross-border quality assurance (Biaggi et al., 2024) are also issues that will be addressed as part of the ESG extension. These issues are also related to micro-credentials, as university associations are providers of micro-credentials, and their international recognition is important for the dissemination of micro-credentials. Similarly, issues such as lifelong learning and digitalisation, which are addressed in the context of the extension, serve to establish quality assurance processes that are appropriate to the nature of micro-credentials.

Theme 2: Institutional Responsibility and Capacity for Change

This theme highlights the responsibility that institutions, whether higher education or alternative providers, must bear, along with the capacity for change they need in order to provide micro-credentials. Reflecting a kind of internal quality assurance of institutions, the theme addresses a) strategic planning and institutional motivation, b) academic responsibility, design and qualifications of the teaching staff, c) assessment and evaluation, d) technical infrastructure, e) transparency and continuous improvement and f) funding activities in the context of micro-credentials.

a) Strategic planning

Each institution may want to provide micro-credentials for different purposes. On the other hand, questions such as whether the institution really needs to provide micro-credentials, whether being a provider of micro-credentials is compatible with the strategic plans of the institution or to what extent the institution is ready to adapt to issues such as flexibility, openness, inclusiveness that micro-credentials will bring are important questions to ensure that the micro-credentials are fit for purpose and ensure quality assurance.

- *Compatibility with the mission and objectives of the institution, adaptation of micro-credentials business models in line with the mission*

Institutions want to deliver micro-credentials to compete globally and build reputation (European Commission, 2024), reduce costs (Farias-Gaytan et al., 2023), meet diverse learners' needs through flexible pathways (Raj et al., 2024; Rami et al., 2024). They also aim to enhance accessibility, equity, inclusiveness (Council of the European Union, 2024a; Galindo, et al., 2024), respond to labour market needs and trends (Kontzinos et al., 2024; Mikroyannidis et al., 2024) and compete with private providers (MICRO QUEST, 2021). They may also use micro-credentials instead of traditional grading mechanisms (Trepule et al., 2021). Micro-credentials serve as both required qualifications (Noyes et al., 2020), and a way for learners to differentiate themselves (Reed, 2023), accelerate careers and enhance personal development and well-being (Clausen, 2022). They help graduates acquire competences such as independent learning, passion, persistance and teamwork (Ward et al., 2021). At this point, institutions also have a responsibility to balance graduate employability with a more holistic approach to higher education (EQAR, 2023) and align micro-credentials with their mission, priorities, and values (den Hertog et al., 2023). The institution should choose the appropriate business model for itself (whether through faculties, continuing education or distance learning centre, or separate units) by taking into account its existing system (entry requirements, methods of course delivery and assessment) and mission (e.g. education, research, technology or regional development) (den Hertog et al., 2023; Griffiths et al., 2024; Hamutoglu et al., 2022; O'Leary et al., 2022).

Issues such as making micro-credentials academic and learner-centred (O'Leary et al., 2022), integrating them into the institution's existing programmes (Alasmari & Alzahrani, 2024; Donnelly & Maguire, 2020; IMINQA, 2023), creating depth and breadth of experience across programmes and aligning them with existing assessment and evaluation processes (Clausen, 2022), and ensuring consistency across programmes (Goulding et al., 2024) are also points for institutions to consider when embedding micro-credentials within their mission. Graduation can be the sum of a learner's major, minor and micro-credentials (O'Leary et al., 2022), and more detailed diplomas that include micro-credentials can be offered instead of generic diplomas and certificates (Canales, 2020) that do not give details of how, when and where knowledge was acquired.

- *Integrating lifelong learning strategies into institutional policies*

Micro-credentials primarily support lifelong learning and its recognition. MICRO QUEST (2021) emphasises the importance of giving lifelong learning a chance. Key quality assurance themes for micro-credentials include fostering a lifelong learning culture, enhancing accessibility through policies, labor market cooperation, flexible admissions, and recognizing prior learning, and it is emphasised that higher education institutions should take transformation into account (OECD, 2024). HEIs should set clear lifelong learning objectives (den Hertog et al., 2023). It is also seen as the responsibility of institutions to reduce centralisation in lifelong learning processes and to guide learners on how they can benefit from lifelong learning pathways to achieve their goals, and to guide them towards courses that will provide them with additional qualifications. Lifelong learning should be integral to education strategies (Council of the European Union, 2022) and embedded in the DNA of the academic systems, requiring a shift toward learner-centred approaches (den Hertog et al., 2023).

- *Integrating micro-credentials into internal quality assurance processes*

Institutions must strategically position micro-credentials and set criteria for integrating them into internal quality assurance systems as both providers and recognizers of credentials from alternative providers (MODUS, 2023). Higher education institutions are defined as threshold gatekeepers providing quality assurance for alternative providers (Cirlan, 2023). They are also responsible for adapting their internal quality assurance mechanisms to the characteristics of micro-credentials (den Hertog et al., 2023; IMINQA, 2023), developing the technological competencies of teaching staff (BAC, 2022; Greere, 2023), establishing support teams for both educators and learners outside the formal system (Noelle et al., 2024).

Strategic partnerships should be meaningful, flexible, and context-appropriate, leveraging stakeholder expertise and resources (Donnelly & Maguire, 2020), while maintaining academic integrity in collaborations. Institutions must foster openness to innovation in delivering, evaluating, and improving micro-credentials and take the advantage of interdisciplinary and transdisciplinary dimensions (European Commission, 2024). They should address technology, artificial intelligence (AI), green transformation, and avoid qualification duplication (Council of the European Union, 2024a), use AI-supported data for candidate selection, create repositories to manage the micro-credentials well and ensure that these repositories are connected to larger repositories (Griffiths et al., 2024). Making quality assurance processes more agile (European Commission, 2024) is among the responsibilities of institutions, as micro-credentials need to be monitored more frequently and require a different approach than traditional degrees (den Hertog et al., 2023).

Institutions' reputations and quality assurance (Orr et al., 2020), more effective use of resources and policy formulation will increase their readiness and enable them to provide micro-credentials of high standards (Rami et al., 2024). Integrating micro-credentials into institutions' internal quality assurance processes requires faculty to interact with national quality agencies and professional bodies (Casadesus et al., 2023; Griffiths et al., 2024). Quality assurance processes support higher education institutions in these transformation processes, and it is recommended that self-reaccreditation procedures should be considered as part of internal quality assurance (Council of the European Union, 2024a). The ability of institutions to assess their current capacities, to carry out evaluation and comparative analyses at sector and provider level, and to use these to guide their future progress, implies that they have reached a level of maturity in the context of micro-credentials (Selvaratnam et al., 2024).

b) Academic responsibility

The academic responsibility that institutions should take is one of the categories under the theme of institutional responsibility and capacity for change. In other words, the provider ensures that academic staff are trained to deliver micro-credentials and that the most appropriate design and delivery method for micro-credentials is chosen.

- *Learner-centred designs*

TThe purpose of micro-credentials is to provide adaptable, flexible and personalised learning pathways appropriate to learners' goals and progress, to complement formal learning with online non-formal and informal learning, and to provide the perfect bridge between knowing and doing (Fan et al., 2024; Noelle et al., 2024; Norman et al., 2024; OECD, 2024). For micro-credentials to serve this purpose, they should be designed to be modular, flexible, cumulative, self-paced, multilingual, scalable, and provide opportunities for asynchronous experiences (Bair et al., 2023; Galindo, et al., 2024; Noelle et al., 2024; Norman et al., 2024; Raj et al., 2024; Sargent et al., 2023), and bring together synchronous and asynchronous experiences in a meaningful way to ensure active learning and participation in the course. It is noted that well-designed asynchronous trainings that provide short and needed training at the right time are more effective for busy adults, and asynchronous designs are seen as more scalable than synchronous ones (Norman et al., 2024). The importance of timing in the delivery of micro-credentials is also emphasised (O'Leary et al., 2022), and it is noted that delivery at different times of the year provides more opportunities for learners (Sargent et al., 2023).

When creating micro-credentials, especially when doing so by unbundling macro-credentials, it is important to balance detail with consistency to avoid loss and fragmentation of information (Raj et al., 2024). When designing courses, it is important to consider the characteristics of learners (i.e., age, motivation, prior knowledge, needs, culture) (Bair et al., 2023; Noyes et al., 2020), to understand the target audience well (TPG-LRC CoRE Working Group, 2024), and to ensure that the design is inclusive and accessible. Aligning content with in-demand competencies, life experiences (Noelle et al., 2024), labour market needs (OECD, 2024), conducting a needs analysis (den Hertog et al., 2023), expert review (Donnelly & Maguire, 2020) and ensuring alignment with outcomes are other important elements in the design. Micro-credentials are seen as a tool for transforming the latest research findings into learning opportunities (Council of the European Union, 2022), therefore micro-credentials should be regularly evaluated whether they are still relevant in design, whether they reflect the latest research and best practices (Galindo, et al., 2024).

- *Identifying outcomes*

In designing micro-credentials, it is necessary to determine the outcomes and the ECTS credit of the workload (Alasmari & Alzahrani, 2024; MICRO QUEST, 2021; Noyes et al., 2020; TPG-LRC CoRE Working Group, 2024) and to consider whether the outcomes are relevant and fit for purpose. In this context, the mapping of outcomes is addressed in three stages: institutional, programme and course levels. Three domains including cognitive, affective and psychomotor skills in educational objectives and Bloom taxonomy are expressed as a reference in mapping (Clausen, 2022; Zouri & Ferworn, 2021) USA","event-title":"2021 IEEE 11th Annual Computing and Communication Workshop and Conference (CCWC. Alasmari and Alzahrani (2024) states that higher education providers focus on more general qualifications and try to ensure permeability between the academy and the labour market, while alternative providers focus on more specific qualifications. Although studies indicate that there is no recommendation on the number of learning outcomes required for a micro-credentials, they mention the importance of ensuring coherence between knowledge, skills and competences (Alasmari & Alzahrani, 2024; Altuna et al., 2023) and the need to consider outcomes from the first stage of design to the assessment process, especially for formative evaluation (TPG-LRC CoRE Working Group, 2024).

- *Pedagogical strategies*

The reviewed studies highlight various pedagogical strategies including microlearning, competency-based learning, self-directed learning, collaborative approach, experiential learning, storytelling, universal learning design, social constructivist approach, critical sensitive pedagogy, achievement goal theory and gamification (Bair et al., 2023; Clausen, 2022; Fan et al., 2024; Noelle et al., 2024). Considering the different pedagogical needs of adults and the difficulties of juggling full-time work and learning, the use of peer interaction, learning communities and multimedia design principles is recommended for reasons such as reducing cognitive load and increasing participation and enjoyment (Norman et al., 2024; OECD, 2024; Sargent et al., 2023). Learning activities include project work, teamwork, discussion groups, seminars, conferences and workshops, internships and work experience (Trepule et al., 2021), case studies and simulations (Bair et al., 2023). Courses and modules should follow a structured sequence at three difficulty levels - basic, intermediate and advanced (Canales, 2020), and maintain a consistent format for coherence (Norman et al., 2024).

- *Improving the skills of teaching staff*

The safe and transparent use of micro-credentials and artificial intelligence, the integration of green transformation and sustainable development into courses, inclusive learning approaches for different student groups, transnational cooperation in education, and the provision of digital and innovative teaching approaches for teachers to share knowledge through online courses based on Open Education principles are significant codes for ensuring quality assurance through improving the skills of teaching staff (Bair et al., 2023; Council of the European Union, 2024b).

- *Collaboration in design*

The design of micro-credentials requires multidisciplinary design teams and collaboration between experts from different fields, such as educators, programmers, instructional designers, field experts, librarians, human resource managers and technicians, educational architects, web, multimedia and graphic designers, video producers and editors (Bair et al., 2023; Canales, 2020; Farias-Gaytan et al., 2023). There is also a need to provide constructive and supportive feedback to teams in terms of content and level (Donnelly & Maguire, 2020), to provide training in micro-credentials design (Clausen, 2022; Trepule et al., 2021), to provide the necessary instructional design knowledge for adult education, and to provide mandatory training and technical support for asynchronous and online teaching (OECD, 2024). In addition, consultation with employers and experienced professionals during the design phase to ensure the relevance of micro-credentials to the sector (Canales, 2020; den Hertog et al., 2023) and feedback from learners reflect the need for stakeholder involvement and collaboration in design.

- *Quality of learning materials*

Materials should be appropriate to the competencies being targeted (Griffiths et al., 2024). The identification of studies, resources and support elements that can be used to present or demonstrate a skill, such as blog posts, videos and templates, and the creation of a materials sheet that shows the totality of knowledge and skills (Galindo, et al., 2024) are necessary for quality. It is also important for quality that materials are broken down into small, flexible and achievable chunks for learners (Raj et al., 2024; Sargent et al., 2023). The use of formats such as images, audio recordings, infographics and videos to allow learners to demonstrate their competencies in a much more diverse way than traditional methods (Clausen, 2022) and transferring the content to digital format (Donnelly & Maguire, 2020) will ensure that micro-credentials include materials that are suitable for the diversity of learners, accessible and inclusive. Since the use of technology depends on the competencies of the instructor and does not show a stable application in course design (Clausen, 2022), materials and multimedia objects (Canales, 2020) need to be developed in a way that will increase the readiness of micro-credentials (Rami et al., 2024)

C) Assessment and evaluation

Assessment and evaluation are one of the important elements that ensure the quality of micro-credentials and increase confidence in the micro-credentials. Designing assessment and evaluation processes according to the nature of the micro-credentials, determining the right method to measure specific qualifications outside traditional assessment and evaluation activities, properly integrating technology and carrying out identity verification processes in a reliable way, especially in online assessment and evaluation, are issues that are the responsibility of institutions offering micro-credentials. Assessment and evaluation can be carried out by the provider institution or a recognised assessment provider (Council of the European Union, 2022) and must be a valid assessment (MICRO QUEST, 2021).

- *Assessment and evaluation design:*

Assessment activities should be designed in accordance with the level of the competence framework and the learning outcomes which is identified within it (Altuna et al., 2023). How lifelong learning activities can be included in the assessment processes in accordance with the nature of micro-credentials should be decided at the design stage. Each institution needs a committee specialised in lifelong learning to provide support in this regard, and an expert faculty committee responsible for the provision and assessment of micro-credentials (den Hertog et al., 2023). Whether the assessment and evaluation will be by examination or assignment (Farias-Gaytan et al., 2023), how much evidence is needed to measure the competence, who is the competent person to carry out the assessment and evaluation process (Donnelly & Maguire, 2020), and what assessment and evaluation activities will be used are issues that need to be planned at the design stage.

The use of a wide range and different types of activities during the course and during the assessment phase allows instructors to evaluate the success of the learners in a more detailed and accurate way (Canales, 2020).

Participation of learners in the design of the assessment process, whether micro-credentials will be used instead of grades or together with grades, explaining the process in detail to learners and reducing anxiety (Goulding et al., 2024) sharing submission criteria, rubrics and assessment criteria with learners in a transparent way (Council of the European Union, 2022; Galindo, et al., 2024; Trepule et al., 2021) are also points to be considered in the design. The issue of openness in the provision of micro-credentials is frequently mentioned, but it is stated that this situation is technically impossible in terms of assessment and evaluation and that it is not possible to be completely open (Griffiths et al., 2024). Griffiths et al. (2024), who address the issue in the context of open educational resources, state that there are no other open educational resources other than massive open online courses where assessment is integrated into the course. They note that in addition to the time spent on preparing open educational resources, the design of the assessment and evaluation process also brings a lot of work and does not yield much return. From this point of view, measurement and evaluation design is an issue that should be considered separately from course design.

- *Diversified assessment methods*

To assess the learners' knowledge, skills and competences more accurately and successfully, it is expected that the measurement methods used in micro-credentials should be more diversified, different from traditional examination practices (OECD, 2024), and based on demonstrable skills, research-based justification, transparent and rigorous evaluation (Galindo, et al., 2024). The assessment and evaluation methods recommended in the studies are competency-based approach, authentic assessment and evaluation, performance-based approach, evidence-based, technology-focused assessment and feedback.

- *Competency-Based/Performance-Based Approach and Authentic Assessment and Evaluation:* In the assessment and evaluation process of micro-credentials, real-life scenarios that require competencies such as creativity, critical thinking and problem solving (Galindo, et al., 2024), modern recruitment practices (Reed, 2023) or workplace performance (Noyes et al., 2020) can be used as criteria. The creation of mandatory discussion groups and learning communities has also been considered as part of assessment and evaluation to ensure the communication between individuals that is considered valuable in traditional courses (Bair et al., 2023). For micro-credentials, assessment and evaluation is seen as a combination of self-assessment, peer assessment and feedback from a third party (lecturer, employer, etc.) (Clausen, 2022; Donnelly & Maguire, 2020; Fan et al., 2024; Trepule et al., 2021).

  Trepule et al. (2021), who consider authentic assessment as a combination of formative and summative assessment, also consider issues such as collaboration, communication, consultation, networking, teamwork, leadership, discussion groups, workshops, class attendance, timely submission of assignments, e-portfolios, learning journals, emotional awareness, determination, self-regulation, divergent thinking and creativity as part of assessment and evaluation. The combined use of formative and summative assessment, communication, collaboration, interaction and assessment and evaluation methods such as digital portfolios, case studies, simulations have also been addressed by other studies (Canales, 2020; Clausen, 2022; Farias-Gaytan et al., 2023; Goulding et al., 2024; OECD, 2024). Digital portfolios or e-portfolios have been defined as online platforms where participants can store the materials, documents and evidence they produce throughout the course and present all their achievements to the community (Canales, 2020). Digital portfolios are usually accessible to everyone, but participants should be able to decide on the level of access to the content and for how long the content is accessible (Canales, 2020; Mikroyannidis et al., 2024).

  Galindo, et al. (2024) explain the methods of awarding micro-credentials in three ways: The first is the recognition of participation, which does not require measurement and assessment. The others are recognition and assessment of learning and knowledge, and recognition and assessment of the application of skills, which require an assessment and evaluation process. While recognition of participation is provided by a certificate of participation or completion, recognition of learning and knowledge is provided by institutional credits, standardised tests, diplomas and degrees. Internships, skills laboratories, apprenticeships, performance assessments and competency-based programme certificates are listed for the recognition of skills application. The study defines the options available to institutions in both the provider and the learner/earner dimensions for all recognition processes and institutions could offer micro-credentials within these options.

- *Evidence-based assessment:* Evidence of learning should be clearly presented in assessment (Griffiths et al., 2024) and measurement and assessment should be an inclusive activity (Reed, 2023). Evidence can be a product such as a project or test answers presented by the learner, a skill such as an oral presentation, a URL linking to documents or an embedded file (Reed, 2023). Reed (2023), who notes that evidence cannot be confined to a single context or person, expresses the need for evidence for micro-credentials to be innovative and groups examples of evidence into direct, indirect and contributing evidence. Direct evidence includes measured, modelled data, graphs, coding developed by the learner, videos demonstrating the ability to use a scientific equipment. Evidence that reflects the learner's perspective, perception and self-assessment of the learning experience and does not indicate the learner's actual ability is considered indirect evidence. Evidence such as peer review, feedback from a field or industry expert or mentor are examples of contributing evidence.
- *Technology-based assessment:* The use of technology in the assessment and evaluation of micro-credentials includes the verification of learners' identities and automated or artificial intelligence-based assessment. It is stated that it is necessary to use biometrics such as facial recognition, voice recognition, keystroke dynamics and security techniques such as timestamps and digital signatures in online systems to verify learners' identities (Trepule et al., 2021). In addition to the self-assessment, peer assessment and expert assessment mentioned above, computer-assisted automated assessment (Canales, 2020; Farias-Gaytan et al., 2023) and assessments supported by AI are also mentioned. However, Galindo, et al. (2024) also state that the capacity of AI is limited to pattern recognition and statistics, and it has a limited capacity for competency-based measurement. Therefore, this should be taken into account in the assessments using AI. Furthermore, Galindo, et al. (2024) note that the measured competencies can be made visible through digital badges, by sharing them on online platforms or by adding them to standard CVs.
- *Feedback:* Performance evaluation is considered important not only for scoring but also for providing feedback and individualised guidance (Galindo, et al., 2024). While summative evaluation is only about scoring, process evaluation also provides feedback (Reed, 2023). Individualised, constructive and motivating comments that support the acquisition and development of competences (Canales, 2020; Galindo, et al., 2024) are considered very valuable and contributing evidence in the measurement and evaluation process.

d) Technical Infrastructure

Technical infrastructure for delivering quality micro-credentials includes the establishment of the technological infrastructure, management of the process, ensuring data security, training of stakeholders and the establishment of a scalable and sustainable academic and technical ecosystem (Selvaratnam et al., 2024).

- *Technology infrastructure*

Institutions offering micro-credentials should have a systematic approach, define a standard template, reduce confusion as much as possible, and use a common open badge/micro-credential platform (e.g. Badgr Backpack) (Clausen, 2022) with crediting engines (Alasmari & Alzahrani, 2024) where micro-credentials are collected and viewed externally. These platforms must integrate with university learning management systems and student information systems, and ensure seamless data flows, and supported by open standards for data storage and accuracy verification (Council of the European Union, 2022; den Hertog et al., 2023). The reliability and stability of the system, the quality of the software, the compatibility of the code, the speed, the ability to access and share materials, the ability to provide interaction between the learner and the teacher, an effective user interface that is easy to use (Tee et al., 2024), the ease of manoeuvring, tracking and loading (Fan et al., 2024) are listed as issues that should be taken into account for the quality of the systems.

- *Combining formal and informal qualifications in a single registry*

Blockchain technology is recommended to create systems where learners can individualise their own educational processes, determine lifelong learning processes and combine them with formal learning and permanently document them (Mikroyannidis et al., 2024; Raj et al., 2024). Blockchain technology also provides transparency, data security and integrity in administration, testing and evaluation, reduces the risk of fraud and manages credit transactions and tuition payments (Kontzinos et al., 2024), and provides unique, open and unchangeable certificates (MICRO QUEST, 2021). Examples of studies conducted in this context include automating administrative processes as much as possible (den Hertog et al., 2023), combining digital and open educational services of higher education institutions on a single platform, and using learner data, which is important for increasing the quality and relevance of the qualification development process, by analysing it with AI-based technologies to provide guidance to learners as in Digivisio 2030 project (OECD, 2023a, 2024).

- *Authentication and data security*

While verifying the identity of the micro-credential holder, the legal identity of the provider, the place and time of the qualification is essential for quality assurance, verifying the identity of the person who has received the qualification is one of the most challenging issues (Council of the European Union, 2022; den Hertog et al., 2023). The adoption of a formal CV standard, such as Europass, The European Digital Identity (EUDI) Wallet, Open Badges, and European Digital Credits Infrastructure (EDCI), which makes micro-credentials usable and transferable for the public and private sectors both online and offline throughout the EU (Council of the European Union, 2024a; den Hertog et al., 2023; Kontzinos et al., 2024), is also considered important for the quality assurance of micro-credentials. In addition, ensuring the confidentiality of data and its protection under the GDPR and the eIDAS Regulation (Council of the European Union, 2022; TPG-LRC CoRE Working Group, 2024), the use of digital identity verification systems such as eSignature, eTimestamp, Qualified Web Authentication Certificate, eSeal and Electronic Registered Delivery Service and EU Login authentication service are also examples given in this context (den Hertog et al., 2023).

- *Training and support for stakeholders in technical know-how and certification of competences*

The capacity of institutions to use technology (Griffiths et al., 2024), specific technical expertise (Council of the European Union, 2024a), the balance between support for content development and technological dimensions (Donnelly & Maguire, 2020) all raise critical issues. Institutions must also ensure they train all stakeholders to maintain the quality of micro-credentials they offer.

e) Transparency and continuous improvement

The transparency and continuous improvement cycle, which is one of the most important points for quality assurance processes, reflects the transparency of information for micro-credentials, the participation of stakeholders and the practices that can be undertaken for continuous improvement.

- *Transparency of information*

Informing society and increasing transparency, the close relationship between transparency and quality, and the link between quality and the dissemination and development of micro-credentials have been highlighted in many studies (Alasmari & Alzahrani, 2024; Council of the European Union, 2022; den Hertog et al., 2023; ENQA, 2024; Griffiths et al., 2024). The design of a higher education institution's portfolio of micro-credentials in line with the interests of all internal and external stakeholders, including the strategic, civic, regional and internationalisation goals of the labour market, and the submission of annual reports to the Academic Council on issues such as course delivery, attendance/absence rates, pass/fail rates (O'Leary et al., 2022), the production of videos and brochures (Raj et al., 2024), and the publication of innovative practices (Bair et al., 2023) are important in terms of sharing information about micro-credentials in a transparent way. The establishment of comprehensive assessments and standardised verification processes with clear transparency will ensure universal acceptance of micro-credentials (Ossiannilsson & Darshan Singh, 2021).

- *Stakeholder participation*

Stakeholder participation is crucial for the reliability and effectiveness of micro-credentials quality assurance. This theme addresses the dynamics between different stakeholders, such as education providers, students, employers and quality assurance institutions, and how their interactions affect the quality assurance process. It also reveals that active stakeholder participation not only improves quality assurance processes but also increases trust and recognition of micro-credentials in the labour market and education sectors (Greere, 2023). International cooperation is highlighted for the global recognition and equivalence of micro-credentials (Cirlan, 2023). For quality assurance, institutions need to foster an environment that values and uses feedback, and institutional review mechanisms need to be developed that use stakeholder feedback to guide change.

- *Continuous improvement practices*

To support continuous improvement in institutions, reflective evaluation of professional practices, comparison of programme results, inferences about learning outcomes at programme level, data on recruitment, acceptance rates and opinions and expectations shared in discussion forums about the course are essential. Observing the entire programme life cycle, reviewing intervals, and utilizing data-driven predictions contribute to ensuring quality assurance. Continuous updates help maintain competitiveness and sustainability. (Alasmari & Alzahrani, 2024; Council of the European Union, 2022; den Hertog et al., 2023; Noelle et al., 2024; Reed, 2023). Widespread support and validation through feedback, environmental and needs analysis are also crucial for the success and sustainability of micro-credentials (Council of the European Union, 2022; den Hertog et al., 2023; Donnelly & Maguire, 2020; Goulding et al., 2024; MODUS, 2023; TPG-LRC CoRE Working Group, 2024).

f) Funding

Although providing the necessary resources for micro-credentials is a very important issue to ensure quality micro-credentials and sustainability, it is rarely addressed in studies. Low participation and support (Clausen, 2022) and limited financial support are identified as the main barriers to sustainability (Rami et al., 2024).

- *Sustainability of resources*

In order to ensure the sustainability of resources, the importance of establishing a well-planned funding structure and identifying funds and models for financial support is highlighted (Alasmari & Alzahrani, 2024; OECD, 2024). The integration of open education and certification models and the support of public funding for lifelong learning, which is consistently highlighted in the field of micro-credentials, are also identified as essential (Council of the European Union, 2022; Griffiths et al., 2024).

- *Organisational support and engagement and learner access*

While financial support such as grants, loans, tuition vouchers and individual learning accounts are mentioned to facilitate learners' access to micro-credentials, tax incentives for institutions to receive support, encouraging government and private sector participation in funding, and aligning funding with institutional objectives are also issues that are addressed in terms of funding and the provider institution (OECD, 2024). In this context, it is important to align national and institutional education policies with funding strategies.

Theme 3: External Quality Assurance

In the successful implementation of quality assurance for micro-credentials, quality assurance organisations have an important role to play in providing external quality assurance and impartial assessment, as well as the internal quality assurance responsibilities of institutions (Greere, 2023; MODUS, 2023). External quality assurance processes are also seen as very important for the recognition of micro-credentials, and it is stated that micro-credentials should be subject to a pre- and post-assessment process (MICRO QUEST, 2021). Micro-credentials should be assessed according to valid quality assurance mechanisms and universal standards, should truly measure knowledge and skills, and should be issued by accredited and reputable institutions (Raj et al., 2024). The principle of separation of powers is considered important in quality assurance and it is stated that the organisation providing the training and the organisation assessing it should not be the same (MICRO QUEST, 2021). External quality assurance should focus on how organisations integrate micro-credentials into their existing processes, should be a combination of self-assessment, external observation and development processes, and the processes should maintain the leadership required for micro-credentials without compromising quality (Hertog et all, 2024). It is recommended that quality assurance for micro-credentials should be integrated into existing processes rather than creating new systems (ENQA, 2024; TPG-LRC CoRE Working Group, 2024), and that external quality assurance should not be course-based but should assess whether providers or higher education institutions have functioning internal quality assurance systems or not (Council of the European Union, 2022; den Hertog et al., 2023). Options for external quality assurance include accreditation or licensing procedures where external quality assurance is part of the legal framework, external quality assurance certification schemes using frameworks such as ISO, platform certification schemes where courses are reviewed before being made available on MOOC platforms or professional and employer certification schemes (den Hertog et al., 2023).

- *The difference between accreditation and recognition*

The main responsibility for quality assurance of micro-credentials lies with HEIs as providers and gatekeepers (Council of the European Union, 2024a). For external quality assurance, it is recommended to promote a culture of quality, to encourage quality assurance organisations and to have an external quality assurance process that is more agile, process-oriented, formative, evaluates the appropriateness of micro-credentials in the context of the institution's goals and strategies, takes account of diversity and is evaluated by independent accreditation organisations (Council of the European Union, 2024a; den Hertog et al., 2023; ENQA, 2024; Noelle et al., 2024; TPG-LRC CoRE Working Group, 2024). Integrating the recognition of prior learning into quality assurance processes, extending the mutual recognition of micro-credentials across borders through institutions registered in EQAR, providing external quality assurance of micro-credentials offered by alternative providers and registering them in DEQAR, creating fit-for-purpose quality assurance and automatic recognition systems (Council of the European Union, 2024a; den Hertog et al., 2023; OECD, 2024) also show that the perspective is shifting from the institutional level to the national and even international level, from the concept of 'accreditation' to the newly discussed concept of 'recognition' (Donnelly & Maguire, 2020). It is noted that traditional education systems have difficulties in recognising and understanding qualifications/certificates from other regions and sectors (MICRO QUEST, 2021). At this point, HEIs require clear guidance on how to differentiate between the automatic recognition of a qualification for access purposes and their authority to decide on admission to a specific program (Council of the European Union, 2024a).

- *Standards and frameworks*

External assessment and the comprehensive mechanisms established in this context ensure that micro-credentials continue to meet high quality standards and help to maintain accountability, continuous improvement and recognition of micro-credentials (Ossiannilsson & Darshan Singh, 2021). The development of a common understanding of the international recognition of micro-credentials depends on the universal standards and frameworks used. The European Qualifications Framework used for traditional qualifications and the national qualifications frameworks developed in this context should also be used for micro-credentials; programme descriptions should be written at the level of knowledge (type, depth, breadth and diversity), skills (cognitive, creative, technical, practical, etc.) and competences (such as learning and professional environment), ECTS value should be determined and they should be compatible with ESG or fit-for-purpose frameworks mentioned in the section on legislative and framework compatibility (Casadesus et al., 2023; Council of the European Union, 2024b; den Hertog et al., 2023). Organisations delivering micro-credentials should be formalised and standardised at national level or have a clear articulation of the common, reliable and measurable quality approach behind the accreditation (MICRO QUEST, 2021).

- *Flexible and tailored approaches*

The Council of the European Union (2024a) speaks of a new and integrated approach to quality that also allows for the recognition of micro-credentials, reduces bureaucracy and costs associated with different administrative approaches to the same regulations, fully respects institutional autonomy, includes thematic reviews focused on improvement, aims to automate recognition, and links quality assurance and recognition. The new quality approach addresses issues such as focusing on qualifications according to levels of competence rather than specific curriculum content; adopting an approach focused on flexibility, simplification and improvement; reducing the workload, bureaucracy and cost implications of external quality assurance processes for higher education institutions; encouraging and supporting staff capacity building and networking through training and digital tools in ENIC-NARIC centres (an ongoing cooperation between the national information centers for the recognition of academic qualifications of a total of 55 countries operating on the principles of the Lisbon Recognition Convention, 1997) and higher education institutions; reducing bureaucratic barriers to the establishment of joint degree programmes; and allowing quality assurance agencies to be registered with EQAR (Council of the European Union, 2024b; ENQA, 2024). Quality assurance agencies are increasingly recognising that micro-credentials are a growing part of institutional provision (den Hertog et al., 2023), and collaboration between quality assurance agencies and institutions is becoming more important in this process (IMINQA, 2023). It is recommended that higher education institutions and national recognition agencies work together to monitor decisions taken in recognition processes and to improve data collection and evidence-based approaches (Council of the European Union, 2024b).

- *Institutional evaluation / programme evaluation*

The dilemma between quality assurance at programme level and at institutional level that has emerged in this theme also highlights the need for quality assurance frameworks that can be adapted to different types of micro-credentials (Cirlan, 2023). Considering the scope of external evaluation at programme level, it is felt that applying the same procedures to micro-credentials may not be appropriate and may create too much workload (Casadesus et al., 2023). However, Estonian Education Quality Agency's (HAKA) research in the field of continuing education has shown that a small informal educational institution cannot provide high quality education in every field, so field-specific evaluation is also necessary (den Hertog et al., 2023; OECD, 2023b). Quality assurance in micro-credentials is seen as a combination of institutional and programme evaluation (TPG-LRC CoRE Working Group, 2024). The need for new quality assurance systems is also highlighted by recommendations to extend the Database of External Quality Assurance Results (DEQAR) to include alternative providers and programme-level accreditation (Zhivkovikj & Munjishvili, 2024), to involve multiple stakeholders in quality processes (Council of the European Union, 2024b), to explore different models for future collaboration between stakeholders, and to reconsider the mandate and role of quality assurance agencies (Greere, 2023).

- *Cross-border and transnational quality assurance*

The openness of systems to cross-border quality assurance and quality assurance of transnational education are seen as additional issues to be addressed in the ESG (Biaggi et al., 2024). It is recommended to use a single quality assurance process, the European Approach, to support transnational education through adaptable quality assurance and accreditation practices, to build mutual trust through external quality assurance and accreditation of joint online education programmes, and to achieve automatic mutual recognition of higher education programmes (Council of the European Union, 2024a). In joint degree programmes, there is a need for individual assessment of members as well as assessment in the context of the alliance, and issues such as inconsistencies in qualifications, different accreditation timelines, language issues, national legislative decisions and multiple administrative procedures make it difficult to use the European approach (Biaggi et al., 2024). It was noted that very few of the cross-border assessments recorded in DEQAR were institutional and joint programme assessments, with the majority being at programme assessment level. In order to develop a culture of joint degree programmes, it is recommended that EQAR-registered quality assurance bodies should be involved in the process, that reports should be published in a widely used language, that diversity of systems, institutional autonomy and national requirements should be respected, that institutions should be guided in developing their internal quality assurance processes, and that institutions should themselves accredit joint degree programmes (Council of the European Union, 2024a, 2024b; ENQA, 2024; OECD, 2024).

- *Quality indicators and data-based approaches*

In quality assurance of micro-credentials, the use of metrics such as learner participation, interest and satisfaction, integration of labour market data and employer feedback (O'Leary et al., 2022), educator satisfaction with the programme and likelihood to recommend it (Fan et al., 2024), benchmarking of data against international quality standards, use of comparable, reliable and clear performance indicators, avoidance of duplication and risk (Council of the European Union, 2024a; ENQA, 2024; Selvaratnam et al., 2024), audit and inspection criteria (Noelle et al., 2024), more collaboration with higher education institutions, flexible and simplified tailor-made procedures, risk-based approaches that use a variety of data and focus on improvement and development (Cirlan et al., 2024) are examples of what data-driven approaches and quality indicators can be in this context. There is a shift from input-based to output-based factors (TPG-LRC CoRE Working Group, 2024).

- *Stakeholder involvement*

The involvement of all stakeholders such as learners, trainers, employers, etc. in quality assurance processes, the operation of feedback mechanisms, the compatibility of micro-credentials with social and labour market needs, the enhancement of the capacity and cooperation of assessors, trainers and managers through training (Casadesus et al., 2023; Council of the European Union, 2022, 2024a, 2024b; den Hertog et al., 2023; Hamutoglu et al., 2022) are prominent issues in the external quality assurance of micro-credentials. Griffiths et al. (2024) mention a friend-of-a-friend model as a solution to the problems of ensuring quality assurance between the content and assessment activities of online courses based on open educational resources, where assessment and evaluation take place in different countries. If a university (A) trusts the quality of courses, content and assessment of another university (B), it will accept its courses, and another university (C) will trust A because it trusts B. In this equation, the involvement of stakeholders in quality processes, which helps to create an environment of trust from different perspectives, is also important for the development of joint degree programmes and the recognition of micro-credentials.

- *Transparency and trust*

Transparency of standards, guidelines and procedures applied to micro-credentials, clear specification of assessment and accreditation criteria, publication of quality assurance assessments in commonly used languages, use of secure, verifiable digital systems for authentication of micro-credentials, provision of useful information portals and guidance services (den Hertog et al., 2023; MICRO QUEST, 2021; OECD, 2024) are recommended considerations in quality assurance and accreditation processes to ensure trust in micro-credentials.

- *Developing a culture of quality*

Promoting cooperation between institutions and quality assurance organisations, developing a culture of accountability and quality, supporting peer learning and capacity building between institutions, and strengthening internal quality assurance systems to complement external quality assurance are some of the key issues in developing the quality culture that institutions need to have in order to deliver micro-credentials (Council of the European Union, 2024a, 2024b; ENQA, 2024; OECD, 2024).

Theme 4: Challenges Related to Quality Assurance and Accreditation

Although the topic of challenges related to micro-credentials is quite broad under different headings (pedagogical challenges, financial challenges, etc.), this study only addresses challenges related to quality assurance and accreditation. Unclear definitions of micro-credentials, lack of standardised quality assurance procedures, lack of information, doubts about the validity of micro-credentials and a tendency towards traditional methods (den Hertog et al., 2023; Raj et al., 2024) are among the main problems affecting quality assurance. Difficulties for non-formal education organisations to adapt to traditional quality frameworks (den Hertog et al., 2023), the fact that micro-credentials are often delivered on online platforms and the lack of constructive feedback (Fan et al., 2024), the differences between the priorities, operations and cultures of higher education institutions and private enterprises (OECD, 2024) are some of the challenges for quality assurance of micro-credentials.

Adult learning is another challenge in the field of micro-credentials (OECD, 2024; Sargent et al., 2023). The limited time available to adults due to full-time work, learning and family responsibilities, etc. create complexities in the design and delivery of micro-credentials, and inexperience in making flexible arrangements that can respond to the needs of adults creates problems in terms of quality assurance.

Other problems in ensuring the quality assurance of micro-credentials include the lack of cooperation between universities and the labour market in terms of co-design (Alasmari & Alzahrani, 2024), the frequent misuse of micro-credentials (Trepule et al., 2021), the inadequacy of existing accreditation procedures to accredit such courses, which limits their recognition and transfer (Ward et al., 2021). The burdensome nature of additional external quality procedures such as programme accreditation and the unwillingness of accredited external quality assurance bodies to undertake such accreditation (Casadesus et al., 2023) and the confusion caused by different national quality assurance practices (Council of the European Union, 2024a) are other challenges in quality assurance.

The implementation of a business model that provides agility for the continuous renewal of micro-credentials in line with the demands and needs of the market, ensuring interoperability with technology-enabled systems (den Hertog et al., 2023), the risk of positioning education as a commodity and students as consumers (Sargent et al., 2023), the financial burden on institutions and the alleviation of this burden through regulation such as tax policy (OECD, 2024) are also among the difficulties mentioned.

CONCLUSION

The inadequacy of current systems to meet the needs for reskilling and upskilling, and the pace of change, suggest that the use of micro-credentials to complement and support current systems can be an innovative solution. Therefore, quality assurance and accreditation is essential for the improvement of existing systems through micro-credentials. Moreover, quality assurance and accreditation is expected to facilitate the recognition and dissemination of micro-credentials. Although micro-credentials is a phenomenon larger than the higher education system, HEIs have an important role to play in the recognition of micro-credentials. It is therefore important to develop quality frameworks for quality assurance and accreditation of micro-credentials that are contextual, compatible with existing systems and at the same time appropriate to the nature of micro-credentials. Institutions need to decide how to integrate micro-credentials, whether they are unbundled from existing qualifications, stand alone or offered by alternative providers, into their internal quality assurance processes and how to position them strategically within the institution, depending on the nature of the micro-credentials. In external quality assurance processes, a quality approach is needed that resolves the dilemma of institutional and programme accreditation in terms of workload balance and proportionality, defining the role of quality assurance agencies (monitoring, supporting or guiding) and the position of alternative providers. In this context, there is a need for a new and agile approach to quality in micro-credentials that is open to flexibility and change, open to systems, open to cooperation between stakeholders and that prioritises transparency, stackability and transferability.

This study explores the key issues that need to be considered to ensure quality assurance of micro-credentials. It also examines the factors that HEIs should consider in relation to these issues. The themes that were identified in this study show that the four important issues for quality assurance of micro-credentials are "integration of micro-credentials into higher education and their recognition", "institutional responsibility and capacity for change", "external quality assurance" and "challenges in quality assurance and accreditation of micro-credentials". The first theme reflects the quality aspects that higher education institutions need when recognizing micro-credentials and addresses the need for clear definition and appropriate scoping of micro-credentials for recognition. Additionally, it highlights the importance of quality frameworks that institutions can adopt to ensure consistency, comparability, and credibility in the recognition process. The second theme, 'Institutional responsibility and capacity for change', explores the internal quality assurance dimensions associated with the implementation of micro-credentials. The issues raised in this theme can guide institutions in organizing their internal quality assurance processes and help them to examine their own capacity for change in this context. External quality assurance, addressed in the context of the third theme, highlights the issues necessary to ensure accreditation appropriate to the nature of micro-credentials. These aspects give an idea of the legal arrangements to be made in this context, and particularly the role of quality assurance agencies in these processes, while they also reflect the difference between the concepts of accreditation and recognition and a quality understanding that is shifting towards the concept of recognition. The final theme of the study is the challenges that arise in the context of quality assurance and accreditation of micro-credentials. These challenges can provide direction for future studies in this context. Future research should contextualize the emerging themes and assess their relevance within a national framework, taking into account the perspectives of higher education institutions, accreditation agencies and alternative providers. Future research could focus on emerging issues such as recognition, internal quality assurance and accreditation, exploring them in greater depth and modelling them in ways appropriate to institutions or countries. These models could be strengthened by the views of relevant stakeholders in the quality assurance process.

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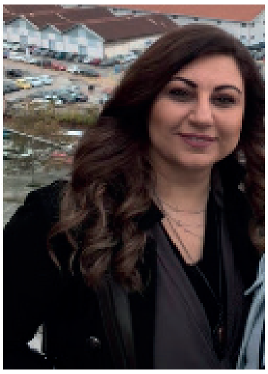

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