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ΜΕΤΑΠΤΥΧΙΑΚΗ ΔΙΠΛΩΜΑΤΙΚΗ ΕΡΓΑΣΙΑ

της Αικατερίνης Λυγούρα (Α.Μ.: ΜΗΜ2117)

"Defining and comparing digital (micro-)credentials for learning.

A systematic literature review"

«Ορισμοί που έχουν δημιουργηθεί

για τα διάφορα ψηφιακά διαπιστευτήρια και μεταξύ τους σύγκριση.

Μια συστηματική βιβλιογραφική επισκόπηση»

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ΥΠΕΥΘΥΝΗ ΔΗΛΩΣΗ ΑΥΘΕΝΤΙΚΟΤΗΤΑΣ

ΒΕΒΑΙΩΣΗ ΕΚΠΟΝΗΣΗΣ ΔΙΠΛΩΜΑΤΙΚΗΣ ΕΡΓΑΣΙΑΣ

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Η εργασία αυτή έχοντας εκπονηθεί από εμένα, αντιπροσωπεύει τις προσωπικές μου απόψεις επί του θέματος. Οι πηγές στις οποίες ανέτρεξα για την εκπόνηση της συγκεκριμένης διπλωματικής αναφέρονται στο σύνολό τους, δίνοντας πλήρεις αναφορές στους συγγραφείς, συμπεριλαμβανομένων και των πηγών που ενδεχομένως χρησιμοποιήθηκαν από το Διαδίκτυο.

Παράβαση της ανωτέρω ακαδημαϊκής μου ευθύνης αποτελεί ουσιώδη λόγο για την ανάκληση του πτυχίου μου. Σε κάθε περίπτωση, αναληθούς ή ανακριβούς δηλώσεως, υπόκειμαι στις συνέπειες που προβλέπονται τις διατάξεις που προβλέπει η Ελληνική και Κοινοτική Νομοθεσία περί πνευματικής ιδιοκτησίας.

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ABSTRACT

In our digital era, the way we learn and work has changed radically. The global transition to a digital economy and society requires the development of all citizens' digital competences. In that context, micro-credentials and other forms of digital recognition of learning play a significant role in the urgent need for massive upskilling and reskilling of citizens and the workforce. The current master thesis examined and compared their definitions of micro-credentials, digital badges, digital credentials, and open badges. We conducted a systematic literature review of academic and grey literature following the PRISMA statement to locate, identify, contrast, classify, and analyse related definitions published in the last decade. We analysed 281 publications in-depth through a review matrix, locating and analysing 230 definitions, of which 139 were original and 91 adopted. The 139 original definitions were categorised and compared based on their key elements. The work presented in this thesis can contribute to a better understanding of digital (micro-) credentials and promote their further use in lifelong learning policy and practice.

Keywords: micro-credentials, digital credentials, open badges, digital badges, alternative credentials, definition, systematic literature review, PRISMA, lifelong learning.

ΠΕΡΙΛΗΨΗ

Ο κόσμος έχει εισέλθει στην ψηφιακή εποχή και ο τρόπος που μαθαίνουμε και εργαζόμαστε έχει αλλάξει δραστικά. Η παγκόσμια μετάβαση σε μια ψηφιακή οικονομία και κοινωνία απαιτεί την ανάπτυξη όλων των ψηφιακών ικανοτήτων των πολιτών. Σε αυτό το πλαίσιο, τα μικρό-διαπιστευτήρια (micro-credential) και άλλες μορφές ψηφιακής πιστοποίησης της μάθησης διαδραματίζουν σημαντικό ρόλο στην ανάγκη για μαζική επανεκπαίδευση των πολιτών και του εργατικού δυναμικού. Η παρούσα μεταπτυχιακή εργασία εξέτασε και συνέκρινε τους ορισμούς τους των μικρό-διαπιστευτηρίων (micro-credential), ψηφιακών διαπιστευτηρίων (digital credential), ανοικτών ετικετών ή σφραγίδων ποιότητας (open badges) και ψηφιακών ετικετών ή σφραγίδων ποιότητας (digital badges). Πραγματοποιήσαμε μια συστηματική βιβλιογραφική ανασκόπηση της ακαδημαϊκής και της γκρίζας βιβλιογραφίας ακολουθώντας τη μεθοδολογία PRISMA για να εντοπίσουμε, να αναγνωρίσουμε, να αντιπαραβάλουμε, να ταξινομήσουμε και να αναλύσουμε διαφορετικούς ορισμούς που δημοσιεύθηκαν την τελευταία δεκαετία. Αναλύσαμε 281 δημοσιεύσεις σε βάθος, εντοπίσαμε και αναλύσαμε 230 ορισμούς, εκ των οποίων οι 139 ήταν πρωτότυποι και οι 91 είχαν δανειστεί από άλλους συγγραφείς. Οι 139 πρωτότυποι ορισμοί κατηγοριοποιήθηκαν και συγκρίθηκαν σύμφωνα με τα δομικά στοιχεία τους. Η εργασία μπορεί να συμβάλει στην καλύτερη κατανόηση ψηφιακών (μικρό-) διαπιστευτηρίων και στην προώθηση της περαιτέρω χρήσης τους σε πολιτικές και πρακτικές δια βίου μάθησης.

Keywords: μικρό-διαπιστευτήρια, ψηφιακά διαπιστευτήρια, σφραγίδες ποιότητας, ψηφιακές ετικέτες, εναλλακτικά διαπιστευτήρια, ορισμός, συστηματική βιβλιογραφική επισκόπηση, μεθοδολογία PRISMA, δια βίου μάθηση και κατάρτιση.

1. INTRODUCTION AND DEFINITION OF THE PROBLEM

Digital (micro-)credentials for learning are the focus of research and policy interest because they can play a key role in the reskilling and upskilling required for the economy, the green and digital transition, as well as the digital transformation of education, training and lifelong learning. They have the potential to play an essential role in enabling more people to enter the labour market, reskill, and upskill, and in further recognising non-formal and informal lifelong learning.

This thesis examines the different terms used to describe the meaning of digital (micro-) credentials during the last decade. This study reports a systematic literature review of academic and grey literature on digital (micro-)credential research published between January 2013 and April 2023. It presents and analyses original and adopted definitions of micro-credentials, open badges, digital badges, and digital credentials provided by the scientific community and policymakers. It also examines their key dimensions, aspiring to contribute to the establishment of a comprehensive definition.

1.1   The context: The need to define micro-credentials

Several but equally important and interconnected drivers fuel the current digital (micro-) credentialing movement. They have received an accelerating interest from stakeholders - learners, educators, employees, employers, and policymakers- during the past years, especially since 2020.

They are considered a means of documenting upskilling and reskilling, personal development, and offer academic flexibility and diversity to support the students in customising their learning path, relying on their needs and demands (Uggeri & Barlassina, 2019). The necessity for micro-credentials was also accelerated because of the COVID-19 pandemic, the increasing cost of higher education and the need for students to have more learning options at lower cost, the growth of MOOCs, the changes caused in jobs due to the technological improvements, such as the introduction of AI. In addition, from the demand side, employers want entry-level employees with better skills and capacity to learn, also in a lifelong learning perspective. (International Council for Open and Distance Education (ICDE), 2019; Matkin, 2020; McGreal & Olcott, 2022).

Higher education and academic recognition are linked to academic mobility. This means that institutions face a rising demand in recognising academic qualifications that their students gain from mobility programmes in other countries. However, it is not only the qualifications a student gains during mobility. Qualifications on skills and competences that are not subject to a specific teaching procedure open new employment opportunities involving various stakeholders, such as higher education institutions, industry, and human resources departments, and link higher education students with the increasing demands of the labour market. However, the increased need for micro-credentials does not apply only to higher education and its institutions. A growing number of institutions in the VET sector are working towards developing and issuing micro-credentials (European Commission, 2021c).

In this context, the European Commission published several documents, papers, and policy reports to facilitate and endorse lifelong learning. An integrated European approach to micro-credentials that will facilitate lifelong learning and inclusion is presented in policy documents such as the Council Resolution on a Strategic Framework for European Cooperation in Education and Training Towards the European Education Area and Beyond (2021-2030); the European Skills Agenda; and the Digital Education Action Plan (2021-2027). The European Union strongly suggests creating job opportunities closer to the real economy and believes that support for employment and workers cannot be successful without support for companies and entrepreneurs. Furthermore, it is noted that special attention needs to be devoted to young people and the low-skilled, who are more vulnerable to the fluctuations in the labour market. The recognition of informal and non-formal education and the connection between the formal education systems and the labour market are essential for achieving these goals.

The European Approach to Micro-credentials was submitted in 2021. It aims to:

- Enable individuals to obtain the necessary information, skills, and competences to thrive in an increasingly competitive and globalised labour market.

- Support micro-credential providers to enhance the adaptability and reach of their educational offerings so that people can create customised career pathways.

- Encourage diversity and equitable opportunities, ultimately improving prosperity, social justice, and resilience (European Commission, 2021a).

Micro-credentials must be taken seriously as they raise questions about the future-fit status of traditional qualifications, employability issues, the changing nature of work and new lifelong learning models. They can increase the efficiency of education and training systems, spur innovations in lifelong learning, and benefit disadvantaged groups, such as migrants and refugees. As mentioned in all those documents, no universally agreed official definition of micro-credentials exists. Therefore, the European Commission devised a European pathway through some recommendations (Council of the EU, 2022; European Commission, 2021b, 2022):

- When creating micro-credentials, use a standard definition, key concepts, and a common approach.

- Create the micro-credential ecosystem.

- Expand micro-credentials' capacity to encourage lifetime learning.

The importance of micro-credentials is noted in several documents worldwide. According to the European approach, micro-credentials can play an essential role in the personalisation of learning to meet the rapid changes in the workplace and that both higher education and the vocational education and training sectors to actively participate in "promoting lifelong learning by providing more flexible and modular learning opportunities.". The Australian micro-credential framework recognises the shift in the educational landscape brought about by the increased demand for shorter courses that promote lifelong learning and help workers upskill faster (Australia. Department of Education, Skills and Employment, 2021).

However, the lack of a universally adopted definition of digital (micro-)credentials is among the factors that hinder their further adoption by policymakers, education stakeholders and the labour market. As Brown and colleagues mention (Brown, Mhichil, et al., 2021), "the current micro-credential landscape is messy and poorly defined, with many competing viewpoints and disconnected initiatives". As Rossiter and Tynan (Rossiter & Tynan, 2019) report, various constituencies worldwide may have slightly varied interpretations of what a "micro-credential" means. In fact, it can be challenging to understand and traverse due to the lack of a universal taxonomy and accepted description.

As the European Commission stresses, the biggest obstacle to the continued advancement and use of micro-credentials in the European Union, according to current perceptions, is the absence of a standard definition (European Commission. Directorate General for Education,

Youth, Sport and Culture., 2020a). The same conclusion reaches the OECD. As noted, despite the growing number of these new credentials, there is still remarkable uncertainty. There is little consensus on definitions and taxonomies to organise these new qualifications. The scope of their offer is still unknown, there is little proof of their effectiveness, and governments' reactions to these new initiatives are not well recorded (Kato et al., 2020).

As soon as the meaning of different types of digital (micro-)credentials is not clear, their value cannot be fully recognised by students who want to have their lifelong learning recognised, employees who want to remain competitive in the job market through upskilling and reskilling, and employers who strive to tackle the skill demands they face. In recent years, competency-based hiring has become a recruitment approach that prioritises applicants' skills and knowledge over their academic background or work experience. With technology constantly evolving and the job market becoming increasingly competitive, employers are looking for candidates with the necessary skills to perform the job and adapt to new challenges. Consequently, competency-based hiring has gained widespread popularity and is now considered a leading trend in the field of recruitment. In this context, micro-credentials can be utilised by more learner groups, especially those from underprivileged backgrounds, and make it easier for them to participate in lifelong learning. Micro-credentials, which have a low entry barrier, might be the first step for students who have traditionally been dissuaded from enrolling in school. They can also be a tool to make learning pathways more flexible, which will help realise lifelong learning goals (T. Anderson et al., 2020).

The complexity and ambiguity surrounding the terminology associated with digital (micro-)credentials become particularly salient given the plethora of terms employed to describe the same meaning as certificates for short learning formats in digital or physical environments in formal, non-formal or informal learning procedures. Apart from micro-credentials, several other terms are used, also interchangeably, such as nano degrees, open badges, digital badges, open digital badges, digital credentials, online certificates, micro-masters or alternative credentials. This thesis aims to examine the commonalities and differences of the four most prominent terms based on our search in Scopus.

The Cedefop (2022a) stresses the need to define micro-credentials, presenting their strengths and weaknesses. They are considered a source of uncertainty for stakeholders regarding their benefits, as they proliferate unregulated, confound users with their

complexity and variety, obscure the source of their quality assurance, pose difficulties for recognition, and frequently fail to reach the most disadvantaged or vulnerable learner groups.

From the above, it is evident that it is necessary to agree upon a standard definition to unlock the true potential of micro-credentials and create the policies needed worldwide for their recognition. To contribute to the knowledge base on the definition of digital (micro-)credentials, we systematically reviewed the literature review published last decade.

The literature review revealed a great range of definitions and a lack of consistency in the terms used since not all of them are universally understood in the same way. In addition, different groups of stakeholders within the digital (micro-)credentials ecosystem adopt different definitions and perceptions of them. Finally, we noticed that the micro-credential research focuses mainly on higher education. Since the reference is non-formal and informal education, and there is a gap in the developments closer to the labour market in VET and work-based learning.

1.2   Purpose and research questions

The purpose of the current thesis is to conduct a systematic literature review of the definitions proposed during the last decade for the concept and the meaning of micro-credentials, compare them to the definitions used for the terms open badges, digital badges, and digital credentials, and compare those definitions through several key dimensions. The aim is to contribute to better conceptualising these terms and, hopefully, establish a standard definition.

Specifically, the research questions that we attempted to answer are:

1. How are micro-credentials, digital badges, digital credentials and open badges defined in academic and grey literature? How many of those definitions are original?

2. 2.   Which are the key elements (building blocks) of the original definitions?

3. Where do these definitions converge, and where do they diverge?

1.3   Structure of present thesis

Chapter 2 presents the methodology followed and explains the process of selecting the publications analysed to locate definitions, the research method, the data collection, and the

tools used in the analysis. A structured literature review was conducted following the PRISMA 2020 statement. The period in which we selected the documents examined from March to July 2023. The main goal was to locate as many records and definitions as possible for the terms micro-credentials, digital credentials, open badges, and digital badges from two digital repositories. The selected period in which we located the definitions of the terms was during the last decade, since the terms coined when the e-learning gained momentum.

Chapter 3 presents the definitions found for the four terms and the main results of their analysis, the key elements of the original definition and the points of convergence and divergence among them.

Chapter 4 summarizes the outcomes of the master thesis, presenting conclusions, limitations, and suggestions for possible future extensions.

2: METHODOLOGY

2.1 Method

A systematic literature review is characterised by a criterion-based, structured, consistent, and strict approach to gathering available information and data on the subject of investigation and identifying areas needing additional research (Xiao & Watson, 2019).

Following the PRISMA 2020 Statement, we gradually defined strict and clear criteria for the inclusion and exclusion of research works in the systematic review. The review process was divided into three steps, starting with defining the search strings to be used in detail so that the systematic review could be replicated to confirm its validity.

Identification. At this step, we used search words/phrases and the inclusion/exclusion criteria to identify potential relevant publications.

Screening. Screening the title, abstract, and keywords against the inclusion/exclusion criteria determined which publications will be retrieved for full-text analysis. Next, the full-text analysis revealed the publications that fall within the study's scope. Every time the researcher included or excluded a publication, the flow chart (Figure 1) was updated, and the criteria in the accompanying record report were described.

Reports included. In this step, the researcher examined the publications that remained after applying the criteria set in the previous steps and synthesised them to answer the research questions.

2.2 The PRISMA 2020 Statement

This chapter explains the process we followed to select the publications we analysed to locate definitions.

We conducted a structured literature review in four different sets of digital documents to locate, identify, contrast, classify, and analyse different definitions of micro-credentials, digital credentials, open badges, and digital badges.

We selected two digital repositories, one for academic literature (Scopus) and one for grey literature (Google Scholar), to identify and select the publications to be analysed in-depth. We also located documents in the National Archive of PhD Theses and used our collection of

publications on the topic. The PRISMA 2020 statement (Page et al., 2021) was utilised to improve the reliability of the data gathered and processed. The identification, screening, and eligibility processes that were carried out and the number of records processed in each step are visualised in the PRISMA 2020 workflow (Figure 1).

Identification of studies via databases and registers

Identification of studies via other methods

Records identified from:
Scopus (n = 688)

Records removed *before screening*:
Duplicate records removed (n = 985)

Records identified from:
Google Scholar (n = 506)
National Archive of Ph.D. Thesis (n = 1081)
Citation mining (n = 135)

Records screened based on keywords/abstract/title. (n = 685)

Records excluded:
Exclusion criterion 1 (n = 391)
Exclusion criterion 2 (n = 463)
Exclusion criterion 3 (n = 305)

Total excluded: 1159

Records screened based on keywords/abstract/title. (n = 740)

Records sought for retrieval (n = 259)

Records not retrieved (n = 0)

Records sought for retrieval (n = 402)

Records not retrieved (n = 0)

Full text records assessed for eligibility (n = 259)

Records excluded:
Reason 1 (n = 380)

Full text records assessed for eligibility (n = 402)

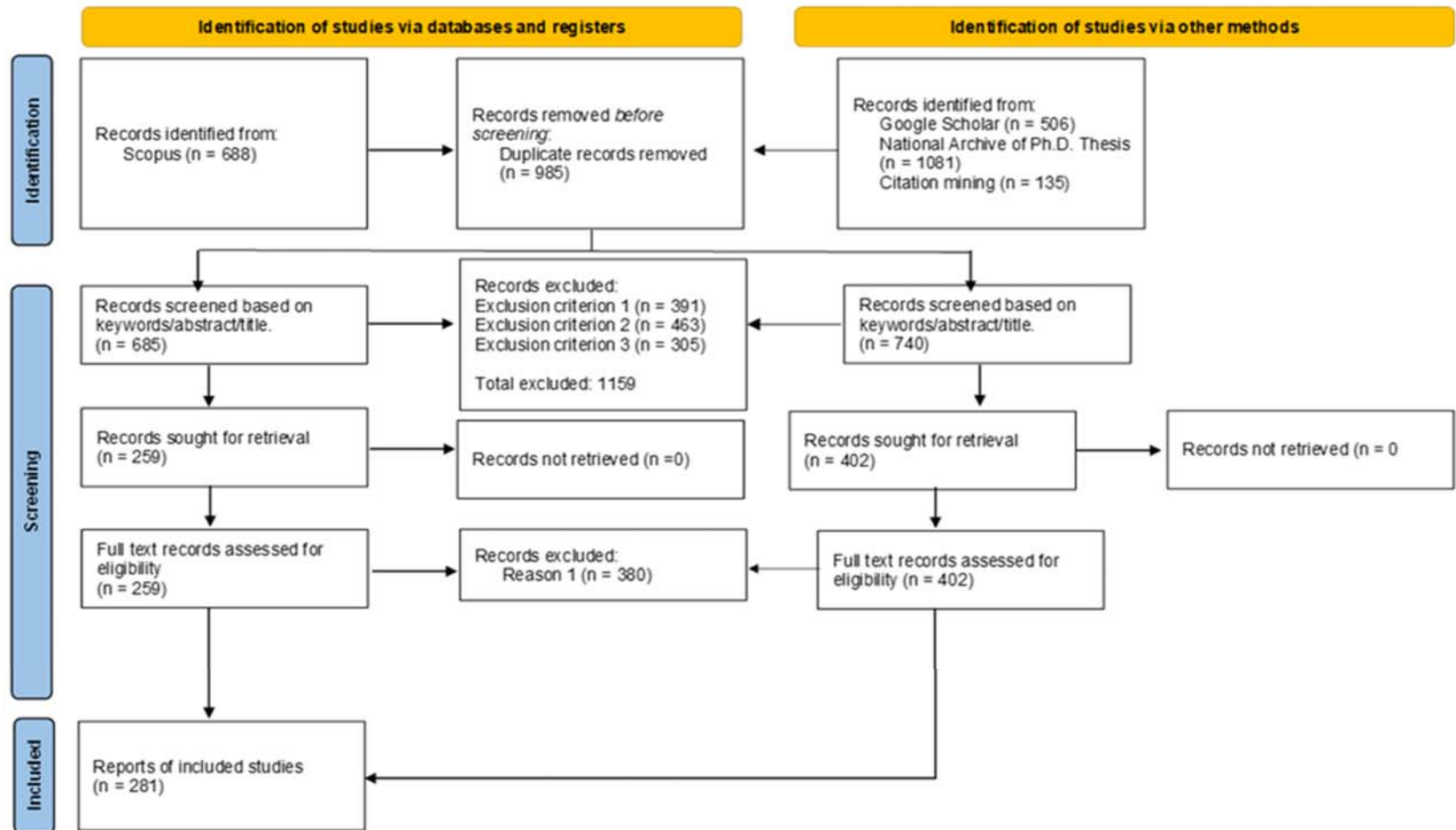Reports of included studies (n = 281)

Identification

Screening

Included

Figure 1 PRISMA 2020 Flow Diagram literature review. Adopted from Page et al. (2021)

2.3 Identification process

A total of 2.410 publications were gathered, 688 from Scopus, 506 from Google Scholar, 1081 from the National Archive of Ph.D. Thesis and 135 from the citation mining. All records were imported into the Zotero reference management tool, where duplicates were removed (n = 985), resulting in 1.425 publications being screened during the first phase.

2.3.1 Academic literature

The search for academic literature was implemented in the Scopus database in April 2023 based on the following search strings:

- TITLE-ABS-KEY("digital credential*" OR "microcredential*" OR "micro-credential*") AND PUBYEAR > 2013 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE,"English"))

- TITLE-ABS-KEY("open bagde*" OR "digital badge*" OR "digital-badge*" OR "open-badge*") AND PUBYEAR > 2013 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE, "English"))

2.3.2 Grey literature

The search for grey literature was implemented in the Google Scholar database based on the keywords:

"micro-credential", "microcredential", "micro-credentials", "microcredentials", "digital credential", "digital credentials", "open badge", "open-badge", "open badges", "open-badges", "digital badge", "digital badges", "digital-badge", "digital badges"

We implemented an advanced search in English pages where at least one of the above keywords occurred in the article's title.

In addition, an additional search for grey literature was conducted at the Greek National Archive of PhD Theses, searching for the following keywords in the title, the abstract and/or the keywords of the theses: "digital credential*", "microcredential*", "micro-credential*", "open bagde*", "digital badge*", "digital-badge*" and "open-badge*".

2.3.3 Citation mining

We also carried out a literature review of our collection of academic and grey literature. The supervisors provided several related publications; others were found through citation mining in selected academic and grey literature publications located in the previous steps.

2.4 Screening and eligibility procedure

Following systematic literature review principles, we determined the inclusion and exclusion criteria for collecting publications and data. The criteria were segregated, and the screening procedure was implemented in two phases.

During the first phase, we read the title and the abstract and included those that followed the following principles:

- The publication is from specific subject area.
- The publication must offer insights on micro-credential, digital credentials, digital badges, or open badges.
- The full-text of the publication must be available through the University of Piraeus library membership.

A total of 661 publications were identified and included in the Zotero library for screening.

During the second phase, we determined further exclusion criteria to identify the relevant publications for our research. To include a publication in the final phase, it must include the words define / definition / identify near to our keywords or should have a section or subsection dedicated to the scope of our research.

A total of 281 academic and grey publications were left for in-depth analysis through a review matrix.

2.5 Data coding, analysis, and limitations

The aim of the review matrix, which was developed in an excel file, was to collect and organise all the available definitions of the four terms and their constituent elements. The analysis of the key elements (building blocks) of the collected definitions was based on UNESCO's definition, which includes the aspects of certification, relation to other credentials, outcomes and assessment, standards and quality assurance, providers of micro-

credentials, and security. Those key elements were enriched by others derived from other definitions.

As with any systematic review, the one presented in the current thesis has its limitations. As the selected period in which we gathered the documents that were then analysed is the last decade, since the e-learning gained momentum, publications before that period were not included.

Furthermore, considering the scope and focus of the research, only publications in the arts and humanities and social sciences fields were identified and included in the analysis. Therefore, other potentially relevant publications from different subject areas, such as computer science, were not included. Finally, the search followed a rigorous procedure for the identification, screening, and eligibility of the publications included. The initial screening for the publications was conducted using concrete keywords in either the title, the keywords, or the publication's abstract. This approach may have resulted in excluding relevant publications that do not include the search terms in their title, abstract or keywords. Last but not least, a limitation of the study was that only one researcher conducted the identification, screening and inclusion process. The inclusion of more researchers would allow to check for interrater reliability and improve the results of the study.

Further research conducted by more than one researcher could eliminate a number of those limitations.

3: RESULTS AND DISCUSSION

The outcomes of the systematic literature review and the qualitative content analysis of the collected definitions are presented in this chapter. The findings are provided per research question.

3.1 Original and adopted definitions

The collected definitions were divided into original and adopted ones (see Annex 1 and Annex 2). In those 281 articles we analysed in-depth through the review matrix, we located 230 definitions, 139 originals and 91 adopted. As can be seen in Table 1, most of the definitions refer to micro-credentials and digital badges. Although we searched for definitions of micro-credentials, digital credentials, digital badges and open badges, we located the term alternative credentials in 2 policy documents. We noticed that one of those definitions is used in an OECD policy document. This led us to keep recording, include and analyse the term.

Those have been recorded in Table 1.

Table 1 Number of definitions per term

Original definitions per term	Adopted definitions per term
67 of the term micro-credentials	65 of the term micro-credentials
38 of the term digital badges	19 of the term digital badges
8 of the term digital credentials	1 of the term digital credentials
24 of the term open badges	5 of the term open badges
2 of the term alternative credentials	1 of the term alternative credentials

For the needs of our research, we considered original definitions the ones that do not provide a reference to another publication as the source of the definition. Consequently, we assumed that the publication's author(s) has/have the authorship of the definition provided. Furthermore, we considered as originals all those definitions constructed by combining different definitions and mentioning their sources. On the other hand, we considered as

adopted the definitions for which there is an explicit reference to the source, namely to another publication.

The number of original definitions of each term in the literature review confirms that there is no standard definition of the search terms and that their definitions vary and depend on who uses the term and in what context.

Among the 281 publications we examined in the in-depth analysis, we located 230 definitions. The vast majority of the analysed publications included definitions and 60% of them were original ones. Moreover, among the publications examined, it is shown that almost 60% of the given definitions are original, and 40% are adopted and support an existing definition. The results confirm that even though the definitions are based on a theoretical and scientific point of view, most are created within different frameworks of educational projects and for other purposes. Table 2 presents the number of definitions located in different types of publications showing that micro-credentials are more prevalent in policy documents but also used widely in research documents while digital badges and open badges are used mainly in research papers.

Table 2 Number of definitions per publication type

	policy documents	research papers	other
micro-credentials	37	23	7
digital badges	1	35	2
open badges	4	20	
digital credentials	2	6	-
alternative credentials	2	-	-

Analysing the adopted definitions, we noticed 46 different references among the 91 adopted definitions for all the examined terms.

In specific, there are:

- 25 different references of the term micro-credential

- 14 different references of the term digital badges

- 1 reference of the term digital credentials

- 5 different references of the term open badges

- 1 reference of the term alternative credentials

Most of those adopted definitions are included in the original ones that are examined in our research.

When examining the term micro-credential, the most commonly used definitions within the adopted ones are the working definitions provided by the European Commission. However, there is no consistency since the European Commission's working definitions are presented with differences and paraphrased in those publications. Each author adopts and uses the parts and the elements of the definition that fit their scopes and needs.

Table 2 presents two European Commission's working definitions and an example of their variations in different documents. Those two original working definitions are themselves an example of the evolution towards the establishment and adoption of a standard definition for the European Commission within the EHEA together with the 2024 Communiqué of the Bologna Process Ministerial Conference (T. Anderson et al., 2020), and the variation among the different definitions of the term micro-credentials.

Both working definitions focus on micro-credentials as small learning modules while mentioning transparent standards. Both mention that they are owned by the learner, as if only individuals can gain them, they are sharable, portable and can form part of a greater credential. While micro-credentials can be shareable and enable people to share their information about what they know and can do, it is not clear, in both definitions, the digital credentialing ecosystem in which they form part or are recognized.

None of those working definitions specifies the different formats, including that of a digital badge or a verified credential, that a micro-credential may be documented, even if both mention portability as a main characteristic of micro-credentials. The reference that micro-credentials are portable implies that the learner can share and translate them from one context to another and represent them within different combinations for different audiences. If we accept that portability means a digital form, that can cause problems for higher education institutes which are not entirely digitized. The absence of the different

forms can also mean that both formats are accepted, or the deployment of specific portfolios may cause implications for recognition and quality assurance processes. Among the differences between those two working definitions is that the second definition focuses on courses leading to micro-credentials that provide the learner with skills and competences that fit societal, personal, cultural or labour market needs. In contrast, the first one focuses on the elements that are mentioned in the format that micro-credentials are documented, which are "the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained". There are other differences among those two definitions, which are relevant to the absence or the addition of one or more words.

When comparing those two definitions with their variations, one can notice that both definitions are being mixed, words and meanings are used without consistency, and one can understand that the small ones can hardly be considered appropriate or operational since they cannot be used in recognition as they do not provide indications to quality assurance processes, portability or shareability, levelling or documentation of learning outcomes.

Table 3 European Commission's working definitions variations

European Commission's working definitions	Variation 1	Variation 2	Variation 3
"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be	"A micro-credential is a recognised proof of the learning outcomes that a learner has achieved following a short learning experience, according to transparent standards and requirements and upon assessment. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, are shareable, portable and may be	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards."	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards."

combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards." **European Commission, 2020**	combined into larger credentials or qualifications."		
Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-	"a micro-credential is the record of the learning outcomes that a learner has acquired following a small volume of learning."	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or

credentials are owned by the learner, can be shared and are portable. They may be standalone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity. **European Commission, 2021**		to societal, personal, cultural or labour market needs."	labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."

Hence, as Brown and Mhichil (Brown & Mhichil, 2021) note, the definition of micro-credentials (and the ones of the other terms examined) varies depending on who uses the term and in what context. All those differences are evidence of the importance and need to create a common vocabulary and meaning of the term and to agree on its key dimensions. These key dimensions can be used as building blocks, as a set of Lego bricks, from which someone can pick the dimensions that most fit their needs to create a commonly accepted micro-credential.

3.2 Micro-credentials / Digital credentials / Digital badges / Open badges original definitions

Table 3 presents the key elements of the original definitions that were analysed for the purposes of the current thesis. Those can be used as must have key elements in creating a common language and meaning of the term micro-credentials, useful in every situation in order to define micro-credentials and separate them from the other terms that are used interchangeably.

Table 4 Micro-credentials: clustering the key elements

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Elliott et al., 2014)	Research paper	-	√	√	-	-	√	√	√	√	-	-	-	-
(Berry & Cator, 2016)	Policy document	-	-	√	-	-	√	-	√	√	√	√	-	√
(DeMonte, 2017)	Other	-	-	√	-	√	-	-	-	√	-	-	√	√

(French & Berry, 2017)	Research paper	-	-	√	-	-	√	-	√	√	-	√	-	√
(Maxwell et al., 2017)	Policy document	√	-	-	-	-	√	-	√	√	-	-	-	√
(Lim et al., 2018)	Research paper	√	-	√	√	-	√	-	√	√	√	-	√	√
(Pickard, 2018)	Other	√	√	-	-	-	-	-	√	-	-	-	-	-
(Pickard et al., 2018)	Research paper	√	-	-	-	-	-	-	√	-	-	-	-	-
(The State University of New York, 2018)	Policy document	-	-	√	√	-	√	-	√	-	-	-	-	-
(Ehlers, 2018)	Research paper	√	-	√	-	-	√	√	-	-	-	-	-	-
(National Centre for	Policy document	√	√	√	-	-	-	√	√	-	-	-	√	-

Vocational Education Research (NCVER), 2018)														
(International Council for Open and Distance Education (ICDE), 2019)	Policy document	√	√	√	-	-	-	-	√	-	-	-	-	√
(Rossiter & Tynan, 2019)	Other	√	√	√	-	√	√	-	√	-	√	-	√	-
(European MOOC Consortium, 2019)	Policy document	-	-	√	√	-	√	-	√	-	-	-	-	-
(Wilson & Hay, 2019)	Research paper	-	-	√	-	-	-	√	√	-	-	-	-	-

Reference	Type													
(Oliver, 2019)	Policy document	√	√	√	-	-	-	-	-	-	-	-	-	-
(Uggeri & Barlassina, 2019)	Policy document	√	√	√	√	√	√	-	√	-	√	-	-	√
(South Australia. Training and Skills Commission (TASC), 2020)	Policy document	√	-	√	-	-	√	√	√	-	-	-	-	√
(American Institutes for Research, Center on Great Teachers and	Policy document	√	-	√	-	√	-	√	-	√	√	-	√	-

Leaders, 2020)														
(Cirlan & Loukkola, 2020)	Policy document	√	-	√	√	√	-	-	√	√	-	-	-	√
(Clements et al., 2020)	Research paper	√	-	√	-	-	√	-	-	√	-	-	-	√
(Duklas, 2020)	Research paper	√	√	√	-	-	√	√	√	-	-	-	-	√
(European Commission. Directorate General for Education, Youth, Sport and Culture., 2020b)	Policy document	√	√	√	√	√	√	-	√	-	√	-	-	-
(Hanafy, 2020)	Research paper	√	-	√	-	-	-	-	-	-	-	-	-	-

Reference	Type													
(Malaysian Qualifications Agency, 2020)	Policy document	√	√	√	-	-	√	-	√	√	-	-	√	-
(Reiners, 2020)	Other	√	-	√	-	-	√	-	√	-	√	-	√	√
(The European Consortium for In-vative Universities (ECIU), 2020)	Policy document	√	√	√	-	-	√	-	-	-	-	-	-	-
(BloomBoard, 2021)	Other	√	-	√	-	√	√	-	√	√	-	-	-	√
(Colleges and Institutes Canada, 2021)	Policy document	√	√	√	√	√	√	-	√	√	√	-	-	√

(Credential Engine, 2021)	Policy document	√	√	-	-	-	-	-	√	-	-	-	√	-
(Mhichíl Nic Giolla et al., 2021)	Research paper	√	-	√	-	-	√	-	√	-	-	-	-	-
(The Quality Assurance Agency for Higher Education, 2021)	Policy document	√	√	√	√	-	-	-	√	-	-	-	-	-
(Australia. Department of Education, Skills and Employment , 2021)	Policy document	√	√	√	-	-	-	-	√	-	-	-	-	-
(Bjornavold, 2021)	Policy document	√	-	√	-	-	-	-	√	-	-	-	-	-

(Colleges and Institutes Canada (CICan), 2021)	Policy document	√	√	√	-	-	-	-	-	-	-	-	-	-
(European Commission, 2021b)	Policy document	√	√	√	√	-	√	-	√	√	√	-	-	-
(McKnight, 2021)	Policy document	√	-	√	-	-	√	√	√	-	-	-	-	-
(Meyer et al., 2021)	Policy document	√	√	√	-	-	-	√	√	√	√	-	-	-
(*Micro-Credentialing in -thern Alberta*, 2021)	Policy document	-	-	√	-	-	-	√	√	-	-	-	-	-

(Oliver, 2021)	Research paper	√	-	√	-	√	-	-	-	-	-	-	-	√
(Pichette, Rizk, et al., 2021)	Research paper	√	√	√	-	-	-	-	√	√	-	-	-	-
(Quality and Qualifications Ireland (QQI), 2021)	Policy document	√	√	√	-	-	-	√	√	-	-	-	-	-
(Tooley & Hood, 2021b)	Policy document	√	-	√	-	-	√	-	√	√	-	-	-	-
(Universities Australia. Deputy Vice-Chancellors (Academic) Working Group on	Policy document	√	√	√	-	-	-	√	√	-	-	-	-	√

Microcredentials, 2021)														
(Wolz et al., 2021)	Research paper	√	√	√	-	-	-	-	√	-	-	-	-	-
(ECIU, 2021)	Policy document	-	-	√	-	-	-	-	-	-	-	-	-	-
(Wheelahan & Moodie, 2021)	Research paper	√	√	√	-	-	-	-	-	-	-	-	-	-
(Bigelow et al., 2022)	Policy document	√	√	√	-	√	√	√	√	-	√	-	√	-
(Credential Engine, 2022)	Policy document	√	-	√	-	-	√	√	√	-	√	-	-	-
(Kässi & Lehdonvirta, 2022)	Research paper	√	√	√	-	-	√	√	√	√	√	-	√	√
(McGreal & Olcott, 2022)	Research paper	√	√	√	-	-	√	√	√	-	-	-	-	√

Citation	Type													
(Wheelahan & Moodie, 2022)	Research paper	√	-	-	-	-	√	√	-	-	-	-	-	√
(Foreman et al., 2022)	Research paper	-	√	√	-	√	√	√	√	-	-	-	-	√
(Shariman & Damian, 2022)	Research paper	-	√	√	-	-	-	√	√	-	-	-	√	-
(American Association of Collegiate Registrars and Admissions Officers, 2022)	Policy document	√	-	√	-	√	√	-	√	√	-	-	-	√
(European Training	Policy document	√	√	√	√	√	√	√	√	√	-	-	-	√

Foundation, 2022b)														
(McDiarmid et al., 2022)	Policy document	√	-	√	√	-	√	-	√	√	-	-	-	√
(McGreal et al., 2022)	Policy document	√	√	√	-	-	√	-	√	√	-	-	√	-
(Navanitha et al., 2022)	Research paper	√	√	√	-	-	-	√	√	-	-	-	√	√
(Neal et al., 2022)	Policy document	√	-	√	-	-	-	√	√	-	√	-	-	-
(UNESCO, 2022)	Policy document	√	√	√	√	√	√	-	√	-	-	-	-	-
(Wheat, 2022)	Policy document	-	√	√	-	-	-	√	√	-	-	-	-	-
(Tamoliune et al., 2023)	Research paper	√	-	√	-	-	√	-	√	-	-	-	-	-

(Alsobhi et al., 2023)	Research paper	-	-	√	-	-	-	-	√	-	-	-	-	-
(West & Cheng, 2023)	Research paper	-	-	√	-	-	-	-	√	-	-	-	-	-
(National Education Association (NEA), n.d.)	Other	√	-	√	-	-	-	-	√	√	√	√	-	-
(Bajor, n.d.)	Other	√	-	√	-	√	-	√	√	-	√	-	√	-

Table 5 Digital badges: clustering the key elements

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Brandon, 2013)	Research paper	√	-	-	-	-	-	-	-	-	-	-	-	-

(Liao et al., 2014)	Research paper	√	-	-	-	-	√	-	-	-	√	-	-	-
(Davis & Singh, 2015)	Research paper	√	√	√	-	√	-	√	-	-	-	-	√	-
(L. Yu et al., 2015)	Research paper	√	√	√	-	-	-	√	-	-	√	-	-	-
(D. M. Anderson & Staub, 2015)	Research paper	√	-	√	-	-	-	-	-	-	√	-	√	-
(Gibson et al., 2015)	Research paper	√	-	√	-	-	√	-	-	-	√	-	-	-
(Buchem et al., 2016)	Research paper	√	-	√	√	√	√	-	-	√	-	√	-	√
(Farmer & West, 2016)	Research paper	√	-	-	√	-	√	-	-	-	-	-	√	-
(Peck et al., 2016)	Research paper	√	-	-	-	-	√	-	-	-	-	-	√	-
(LaMagna, 2017)	Research paper	√	-	-	-	-	√	-	√	√	√	-	-	-
(Pitt & Davis, 2017)	Research paper	√	-	√	-	-	-	√	-	-	-	-	√	-

(Shields & Chugh, 2017)	Research paper	√	-	√	√	√	√	-	-	-	√	-	√	√
(Auh & Sim, 2018)	Research paper	√	-	√	-	-	√	-	-	√	-	-	√	-
(Borras-Gene, 2018)	Research paper	√	-	-	-	-	√	√	-	-	√	-	√	-
(Cheng et al., 2018)	Research paper	√	-	√	-	-	√	-	-	√	√	-	√	-
(Lim et al., 2018)	Research paper	√	-	√	-	√	-	-	-	√	√	-	√	-
(S. Yu & Zheng, 2018)	Research paper	√	-	√	-	-	√	-	-	-	-	-	√	-
(Pothier, 2019)	Research paper	√	-	√	-	√	√	-	-	√	√	-	-	√
(Brauer, 2019)	Research paper	-	-	-	-	-	√	-	-	√	-	-	-	√
(Cheema et al., 2019)	Research paper	√	-	-	-	√	-	√	-	√	-	-	-	-
(Kullaslahti et al., 2019)	Research paper	-	-	-	√	√	√	-	-	√	√	-	-	√

(McGee et al., 2019)	Other	√	-	-	-	-	√	-	-	√	√	-	√	-
(Ponte & Saray, 2019)	Research paper	√	-	-	-	-	√	√	-	-	-	-	√	-
(Ziegler, 2019)	Research paper	√	-	-	-	-	-	√	-	-	-	-	-	-
(Pothier, 2020)	Research paper	-	-	√	-	√	-	-	-	√	-	-	√	√
(Fanfarelli, 2020)	Research paper	√	√	-	√	-	-	-	-	-	-	-	√	-
(Reiners, 2020)	Other	√	-	-	-	-	√	-	-	√	√	-	-	√
(Wolfenden et al., 2020)	Research paper	√	√	-	-	√	√	-	-	√	-	-	-	-
(Gamrat & Zimmerman, 2021)	Research paper	-	-	√	-	-	-	√	-	-	-	-	-	-
(Perkins & Pryor, 2021)	Research paper	√	-	√	-	-	√	-	√	√	√	-	√	-
(Chukowry et al., 2021)	Research paper	√	-	√	-	-	-	√	-	-	-	-	√	-

(Gregg et al., 2021)	Research paper	√	√	-	-	-	√	-	-	-	√	-	√	√
(Wolz et al., 2021)	Research paper	√	√	√	-	-	-	-	-	-	-	-	-	-
(Schürmann & Quaiser-Pohl, 2022)	Research paper	√	-	√	-	-	√	-	√	√	√	-	√	√
(American Association of Collegiate Registrars and Admissions Officers, 2022)	Policy document	√	-	-	-	-	-	√	-	-	-	-	√	-
(Flynn et al., 2023b)	Research paper	√	√	√	√	-	√	-	√	-	-	-	-	√
(Ahsan et al., 2023)	Research paper	√	-	-	-	-	√	-	-	-	-	-	-	-
(The university of	Research paper	-	-	√	-	-	-	-	-	-	√	-	-	-

Texas at Dallas, 2023)														

Table 6 Digital credentials: clustering the key elements

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Lang, 2016)	Research paper	√	-	√	-	-	-	-	-	-	-	-	√	-
(Ponte & Saray, 2019)	Research paper	-	√	√	√	-	√	-	-	√	√	-	√	-

(Ehrenreich & Trepulė, 2020)	Research paper	√	-	√	-	√	√	-	√	-	-	-	√	-
(European Commission, 2021d)	Policy document	√	√	√	-	-	√	-	-	√	-	-	√	√
(Wolz et al., 2021)	Research paper	√	-	√	-	-	-	-	√	-	-	-	√	-
(Bruno & Morgado, 2022)	Policy document	√	-	√	√	√	√	-	-	-	-	-	-	-
(Camilleri et al., 2022)	Research paper	√	-	-	-	-	-	-	-	-	-	-	√	-

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Kiiskila et al., 2022)	Research paper	-	-	√	-	√	-	-	√	-	-	-	-	-

Table 7 Open badges: clustering the key elements

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Brandon, 2013)	Research paper	√	-	-	√	√	-	-	√	-	-	-	-	-
(Glover & Latif, 2013)	Research paper	√	-	√	-	-	√	-	-	-	√	-	√	-
(Myllymäki & Hakala, 2014)	Research paper	-	√	-	-	√	-	-	-	-	-	-	-	-

(Ravet, 2014)	Research paper	√	-	-	-	-	√	√	-	√	√	-	√	-
(Booth et al., 2015)	Research paper	√	-	√	√	-	-	-	-	√	√	√	√	-
(Fields, 2015)	Research paper	√	-	-	-	-	√	√	-	-	√	-	√	-
(Ma, 2015)	Research paper	√	√	√	-	-	-	-	-	-	√	-	-	-
(Farmer & West, 2016)	Research paper	√	-	-	√	-	-	-	-	-	√	-	√	-
(Konert et al., 2017)	Research paper	√	√	√	-	-	√	√	-	-	-	-	√	-
(Chakroun & Keevy, 2018)	Policy document	√	√	-	-	-	-	√	-	-	√	-	√	-
(Clements, 2018)	Research paper	√	√	√	-	-	-	-	-	-	√	-	-	-

(Hennah, 2018)	Research paper	√	-	-	-	√	-	-	-	-	-	-	√	-
(Tátrai & Mihályi, 2018)	Research paper	√	-	√	-	-	-	-	-	-	-	-	-	√
(Young et al., 2019)	Research paper	√	-	√	-	√	-	√	-	-	√	-	-	√
(Korhonen et al., 2020)	Research paper	√	-	√	-	-	√	√	-	√	√	-	√	-
(Hunsaker & West, 2020)	Research paper	√	-	-	-	-	√	-	-	√	-	-	√	-
(Zhang & West, 2020)	Research paper	-	√	-	√	-	√	√	-	-	-	-	-	-
(Spencer, 2020)	Research paper	√	-	√	-	√	√	-	-	√	√	-	√	-

(Ravaioli, S. & Ferrell, G, 2021)	Research paper	√	-	√	√	-	-	-	-	√	√	-	√	-
(Camilleri & Ardie, 2022)	Policy document	√	-	√	√	-	√	-	-	-	√	-	√	-
(American Association of Collegiate Registrars and Admissions Officers, 2022)	Policy document	-	-	-	-	-	-	-	-	-	-	-	√	-
(Clausen, 2022)	Research paper	√	√	√	-	√	-	√	-	-	√	-	√	-
(Randall et al., n.d.)	Research paper	-	√	-	-	√	√	-	-	√	√	-	√	√

Table 8 Alternative credentials: clustering the key elements

Citation	Kind of paper	Certification	Relation to other credentials / Stackability	Outcomes and assessment	Standards and quality assurance	Provider of micro-credentials	Security	Purpose	Duration	Competency-based	Ownership, portability, shareability	Personalized	Mode of delivery	Settings
(Fong, UPCEA et al., 2016)	Policy document	-	-	√	-	-	-	√	√	√	-	-	-	-
(Kato et al., 2020)	Policy document	√	√	√	√	-	-	-	-	-	-	-	-	-

3.3   Key elements of the original definitions

The number of definitions listed above represents the focus of researchers and policy makers to improve and scale up the micro-credentials' movement and its understanding. At the same time, the large number is a big challenge towards a shared understanding of the term.

Typically, the proposed definitions presented in the previous section have been created in the context of a project to serve its purpose. Nevertheless, there are key elements which are repeated in those definitions and elements that are used less. Identifying those elements could be useful towards a better understanding of the term micro-credential and, possibly, a comprehensive definition that could be adopted by all and in all environments. Also, it can contribute to understanding the core differences between the different terms investigated (namely, micro-/digital/alternative credentials, open/digital badges), which are often used interchangeably.

The analysis and the comparison of the collected definitions reveal that elements that are repeated even in different words exist among the examined terms.

To locate the key elements of each definition for each term, the master thesis followed the analysis of the elements that should be included in a definition given by version 1 of the proposed definition by UNESCO (UNESCO, 2022). Among those elements are the aspects of:

- Certification
- Relation to other credentials
- Outcomes and assessment
- Standards and quality assurance
- Purpose
- Duration
- Ownership, portability, shareability
- Providers of micro-credentials
- Security
- Mode of delivery

Those aspects were enriched by others used in the analysis or presentation of other definitions for the ecosystem of the definition to be more transparent and detailed.

For the term **micro-credential**, the most common elements are the outcomes, assessment, and duration.

Among the 67 original definitions of the term, there is a reference to the element outcomes and assessment in 62, while the (small) duration is mentioned in 55.

The other elements that are included in the definitions examined are presented below in descending order:

- Certification, in 53 out of 67 original definitions

- Security, in 35 out of 67 original definitions

- Relation to other credentials and stickability, in 33 out of 67 original definitions

- Purpose, in 24 out of 67 original definitions

- Formal, non-formal or informal settings, in 24 out of 67 original definitions

- Competency-based, in 22 out of 67 original definitions

- Ownership, portability, and shareability, in 16 out of 67 original definitions

- Providers of micro-credentials, in 15 out of 67 original definitions

- Mode of delivery, in 14 out of 67 original definitions

- Standards and quality assurance, in 12 out of 67 original definitions

- ECTS credit point, in 7 out of 67 original definitions

- NQF Level, in 5 out of 67 original definitions

- Personalized, in 3 out of 67 original definitions

The mode of delivery is mentioned in a digital form in different words. When referring to formal settings, it is higher education and the informal settings the personal, professional learning and development.

Another element used in some definitions is the nature of the micro-credential, which, when included, refers to the learning activity leading to it and the qualification earned.

Out of the 67 original definitions in:

- 8 micro-credentials are considered as the learning activity.

- 37 micro-credentials are considered as the qualification earned after the learning activity.

- 18 micro-credentials are considered as both the above.

- 4 do not explicitly mentioned whether the reference is related to the learning activity, the qualification earned or both.

For the term **digital badges**, the most common elements are the ones of certification and security.

Among the 38 original definitions of the term, there is a reference to the element certification in 33 of them, while security is mentioned in 23.

The other elements that are included in the definitions examined are presented below in descending order:

- Outcomes and assessment, in 20 out of 38 original definitions

- Mode of delivery, in 20 out of 38 original definitions

- Ownership, portability, shareability, in 17 out of 38 original definitions

- Competency-based, in 15 out of 38 original definitions

- Purpose, in 10 out of 38 original definitions

- Formal, non-formal or informal settings, in 10 out of 38 original definitions

- Providers of micro-credentials, in 9 out of 38 original definitions

- Relation to other credentials and stickability, in 7 out of 38 original definitions

- Standards and quality assurance, in 6 out of 38 original definitions

- Duration, in 4 out of 38 original definitions

- Personalized, in 1 out of 38 original definitions

It is worth noting that when analysing the definitions of the term digital badges, we found that among those definitions is mentioned the software used in issuing the digital badge and the icon used for its recognition and differentiation of the other credentials and qualifications.

Regarding the nature of digital badges and whether they refer to the learning activity leading to it, the qualification earned, both or not mentioned at all, it is clear that digital badges are considered as the qualifications gained.

For the term **digital credentials**, the most common elements are the ones of certification, and outcomes and assessment.

Among the eight original definitions of the term, there is a reference to the element certification in 6 of them, while the outcomes and assessment are mentioned in the 7.

The other elements that are included in the definitions examined and their numbers are:

- Mode of delivery, in 6 out of 8 original definitions

- Security, in 4 out of 8 original definitions

- Providers of micro-credentials, in 3 out of 8 original definitions

- Duration, in 3 out of 8 original definitions

- Relation to other credentials and stickability, in 2 out of 8 original definitions

- Standards and quality assurance, in 2 out of 8 original definitions

- Competency-based, in 2 out of 8 original definitions

- Ownership, portability, shareability, in 1 out of 8 original definitions

- Personalized, in 1 out of 8 original definitions

- Formal, non-formal or informal settings, in 1 out of 8 original definitions

Regarding the nature of digital credentials and whether they refer to the learning activity leading to it, the qualification earned, both of them, or it is not mentioned at all, it is clear that the digital credentials are considered as the qualifications gained.

Ehrenreich and Trepulė (Ehrenreich & Trepulė, 2020) relate digital credentials to the learning experience, which leads to a digital credential as an experience that can involve online or face-to-face learning or both - in this sense, they relate digital credentials to the learning activities leading to them. Finally, Kiiskila, Hanafy and Pirkka (Kiiskila et al., 2022) relate digital credentials to the corresponding micro-credential platforms used to manage digital credentials.

For the term **open badges**, the most common elements are certification, ownership, portability, and shareability along the mode of delivery.

Among the 24 original definitions of the term, there is a reference to the element certification in 20 of them, while the ownership, portability, shareability and mode of delivery are mentioned in 16.

The other elements that are included in the definitions examined and their numbers are:

- Outcomes and assessment, in 12 out of 24 original definitions

- Security, in 10 out of 24 original definitions

- Relation to other credentials and stickability, in 9 out of 24 original definitions

- Purpose, in 8 out of 24 original definitions

- Providers of micro-credentials, in 7 out of 24 original definitions

- Competency-based, in 7 out of 24 original definitions

- Standards and quality assurance, in 6 out of 24 original definitions

- Formal, non-formal or informal settings, in 3 out of 24 original definitions

- Duration, in 1 out of 24 original definitions

- Personalized, in 1 out of 24 original definitions

Regarding the nature of digital badges and whether they refer to the learning activity leading to it, the qualification earned, both of them, or it is not mentioned at all, it is clear that the digital credentials are considered as the qualifications gained.

For the term **alternative credentials**, there is a reference in both original definitions of the element outcomes and assessment. Both definitions are too narrow to sufficiently enhance our understanding and guide the interests of researchers and the concerns of policymakers.

Regarding the element of the nature of the alternative credentials, the definition given in the Demographic Shifts in Educational Demand and the Rise of Alternative Credentials (Fong, UPCEA et al., 2016) considers the alternative credentials as both learning activity and qualification. In contrast, the definition given in the emergence of Alternative Credentials (Kato et al., 2020) consider them as qualifications.

From the above, it is evident that all the micro-credentials that can or will be created are essential to clearly reference the learning outcomes, whether they are outcomes of a learning procedure that took place in a formal or a non-formal educational environment. Also, it is crucial for a qualification to be considered micro-credential to include a specific and small amount of time that the individual will have to dedicate to achieve the targeted learning outcome.

Though no standard recognition definition exists, learning outcomes and duration are key elements of a widely accepted definition since those elements support the social basis of skills recognition. As noted in "Micro-credentials for labour market education and training" (Cedefop, 2023), micro-credentials "*are gaining space within qualification systems on the basis that they offer certain advantages over traditional qualifications, principally their greater flexibility and their suitability for building sector- or occupation-specific skills (reskilling/upskilling) in order to respond to the changing needs of industry*" and "*are viewed as being both part of formal education and training and operating outside of it in the labour market*".

The social basis of the term micro-credential is supported by the fact that most of the elements examined refer to the social contribution of micro-credentials.

They are complementary to other credentials or qualifications; they can be stacked towards larger units of competence or capability and may be combined into larger credentials, contributing to the need of the labour market for upskilled and reskilled employees while opening up new possibilities to them through their professional development (useful to record the acquisition of specific skills needed by individual (Quality and Qualifications Ireland (QQI), 2021)). The organisations that validate them are awarded, even if they do not belong to the higher education sector, and when following agreed standards, those micro-credentials can be recognised at the NQF level and gain ECTS credit points.

We continued our literature review by tracking the alternative expressions used in those definitions for each key element. The following table presents the alternative expressions of the term micro-credential for each key element.

All those alternative expressions may contribute to the development of a common language and meaning of micro-credentials since it is almost impossible to get a standard definition

across all fields as a regulator for the essence and meaning of micro-credentials as a means for documenting lifelong learning.

Table 9 Alternative expression of the basic elements of the term micro-credentials

Basic elements	Alternative expressions
Certification	a certification; a / any credential; a documented statement; a form of certification; a form of credentials; a proof contained in a certified document; a qualification; a recognised credential; a record; a representation; a strategic tool; a verification; alternative or additional form of qualification; any one of a number of new certifications; attestations; award; award-types; certification-style qualifications; certified documents; digital certification; educational awards; educational credential; evidence; form of certificate or digital badge; gig credentials; mini qualifications; mini-certifications; more specific credentials; proof; recognition; smaller units; the record; tool; verification
Relation to other credentials / Stackability	may or may not be stacked towards larger units of accreditation; compared to the full-fledged, wide range of skills previously delivered through both extensive and intensive training programmes; a stand-alone certificate, that could accumulate into a larger credential or be part of a portfolio'; additional, alternate, complementary to, or a component of a formal qualification; a component of an accredited programme or stand-alone courses; are not studied as part of a larger whole (or degree) even if they are, for example, a module which might sit within an approved degree programme; can accumulate into a larger credential or degree; be part of a portfolio that demonstrates individuals' proof of learning, or have a value in itself; can be a complement to traditional credentials (certificate, diploma, degree or post-graduate certificate) or stand alone; additional, alternate, complementary to, or a component of a formal qualification; can be offered as stand-alone courses or as a component of a program that has been approved; can be stacked towards larger units of competence or capability; They can also help fill skill gaps; offer students a pathway to higher education and help employees develop specific skills; stackable credentials; differ from other

	professional development designs in that educators can actively develop and demonstrate competency in complex skills through their work, and educators have a choice in which skills to address; distinct from longer traditional qualifications such as diplomas and degrees; don't necessarily need to be part of a larger volume qualification though they can be aggregated and potentially used in RPL processes to gain exemptions from parts of, and advanced entry to programmes leading to NFQ qualifications from around 10% to up to a full academic year but less than a conventional educational award or credential; Has standalone value and may also contribute to or complement other microcredentials or macro-credentials; here is a related credential of greater scope, is additional, alternate, complementary to or a component part of an AQF award qualification; is less than a full degree; is sometimes related to other credentials; is additional, alternate, complementary to or a component part of a formal qualification; May be combined into larger credentials or qualifications; may or may not be stacked towards larger units of accreditation; may represent not only a discrete skill or competence, but also a combination of skills or competences; Stacked together in a coherent way, micro-credentials can form a substantial award on their own or can be aggregated towards a qualification; could be stand-alone credentials, or they could be part of a series of micro-credentials that make up a program or certificate; They are in many ways analogous to conventional educational qualifications and training certificates; they could be regarded as a "summative" award; They differ from traditional degrees and certificates in that they are generally offered for accomplishments achieved in shorter or more flexible timespans; They may be standalone or combined into larger credentials, within and beyond the traditional realm of certificates, diplomas, and degrees, within study programs;

Outcomes and assessment	aligned with a valid rubric; an assessment of a particular skill or competency; are awarded based on demonstrated mastery of the subject matter, not just for showing up; assessed; assessed competencies; are based on assessed proficiency of a competency, not on time spent learning; assessed learning; breaks complex professional practices into "subtasks" or "micro-tasks," which are written in observable and measurable terms along with a list of competencies for learners; can be earned in different ways but often through completing courses that incorporate structured learning designs with clearly evidenced outcomes; communicate how it aims to provide value to learners; competencies, skills, and learning outcomes derived from assessment-based, non-degree activities; defined learning outcomes; evidence assessed; evidence assessed via a validated rubric; focus on assessing; focus on the validation of competency-based skills, outcomes and/or knowledge using transparent standards and reliable assessments; Focused learning achievement; Includes assessment based on clearly defined standards; for learning; have assessment methods and criteria; In other words, skills or knowledge gained through a micro-credential will not be as comprehensive but are more focussed and specific; learning of a defined set of skills, knowledge and attributes; learning outcomes; Learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards; f assessed learning or competency, Of skills and competences that students have achieved in their learning experiences, Provide a summative assessment that enables the award of academic credit, either directly following successful completion of a micro-credential or via recognition of prior learning upon enrolment as a student on a university's course of study, Referring to successfully participated courses, Represent the skill or competence standards used for assessing an individual's learning achievements, Represents assessed achievement of a subset of learning, They can also be outcome-based

	with measurable learning objectives, Industry-focused with assessments to support learners with retraining, upskilling, or pursuing a career change, Through assessment -based activities, Upon assessment, Will also enable students to demonstrate the information and skills they have acquired through assessment-based activities, Assessed knowledge, abilities, and competences in a particular area or field
Standards and quality assurance	against given standards and in compliance with agreed quality assurance principles; are subject to a robust and rigorous quality assurance process; are subject to quality assurance in line with the ESG; Be levelled at Levels 6–7 in the European Qualification Framework or the equivalent levels in the university's national qualification framework, or be levelled at Levels 4–5 and fulfil the criteria of the European Credit Transfer and Accumulation System; evidence of the work that they have done or their achievement which will be evaluated at an agreed level and standard; have been assessed against transparent and clearly defined standards; They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity; having been developed through established faculty governance processes and designed to be meaningful and high quality; It is subject to standard quality assurance mechanisms; Meets the standards required by relevant quality assurance; These competence standards may need to be validated by external bodies (e.g. industry partners, a quality assurance agency); They are underpinned by quality assurance following agreed standards; via defined evaluation criteria
Provider of micro-credentials	are offered on platforms that also provide access to MOOCs. Some companies offer microcredentials in partnership with educational platforms such as Udacity and edX.In some instances, nanodegrees come with job guarantees [3]. Micro-credentials are also offered in a variety of fields in colleges and universities

	around the world. Many are offered through intensive workshops, online learning or in a blended learning (combining face to face and online learning) [5]; are to follow institutional approval processes; awarded by a trusted body; based on research, and designed to meaningfully improve teachers' instructional practices; certify achievement at a more granular, sub-course level; Developed and designed with industry experts to ensure that retraining and upskilling accurately reflect industry needs and are recognized with some form of certificate or digital badge outlining the learning outcomes or competencies that learners achieved; education provider; indicating that an educator has demonstrated a specific competency; is awarded by a trusted provider; it can be offered by higher education institutions or recognised by them using recognition procedures in line with the Lisbon Recognition Convention or recognition of prior learning, where applicable; Micro-credentials can be earned through online courses, MOOCs, or other learning experiences; offered by an institution of higher learning should be asserted by a recognized campus authority; Organisations that award micro-credentials are responsible for developing skill/competence standards, and they have a responsibility to ensure that the assessment of an individual's learning achievements meets these standards; provides teachers with the opportunity to learn and demonstrate competency in new skills, while also getting feedback from an outside evaluator and earning recognition for mastery by earning the micro-credential; The proof is contained in a certified document that lists the awarding body.
Security	aligned with a valid rubric; allows a learner to demonstrate mastery and learning in a particular area; certifies the assessed learning of a defined set of skills, knowledge and attributes; certify learning outcomes rather than methods of delivery; Developed and designed with industry experts to ensure that retraining and upskilling accurately reflect industry needs; earned by demonstrating competency in one

	specific area at a time; focus on evidence of educators' actual skills and abilities; illustrating the proficiency in a particular skill; learning certified; may or may not be certified by an accrediting institution or association; earner can demonstrate prior skills and learning achievement from work or life experience — assessable, for example, through a portfolio of evidence of learning; Operate a reliable method of ID verification at the point of assessment that complies with the university's policies and/or is widely adopted across the platforms authorized to use the CMF; proof of the learning outcomes that a learner has acquired following a short learning experience; provide recognised proofs of the achievement of learning outcomes; provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs; recognise the achievement of learning outcomes related to a specific skill or competence; recognised by higher education institutions and other trusted credential-bearing agencies or professional bodies; recognizing a distinct skill or accomplishment; represent competencies, skills, and learning outcomes derived from assessment-based, non-degree activities; secure; should represent competencies identified by employers/industry sectors to meet employer needs; show what they can do, not only what they know; shows a mastery of one or more job competencies; signify that a learner has achieved learning outcomes; supporting the professional, technical, academic and personal development of the learners; that an educator has demonstrated through the submission; These micro-credentials will then make a student stands out in comparison to his peers to the prospective employers. Employers can source their new hires based on relevant micro-credentials earned by specific students; These provide credential recognition for what a person knows and can do at a modular level; they contribute to the privatisation of education by unbundling the curriculum and blurring the line between public and private provision in higher education; they provide public recognition and signaling of

	knowledge and/or skills held; validate competence for a specific need; validated by recognised professional bodies or educational institutions; verify, validate and attest that specific skills and/or competencies have been achieved and are endorsed by the issuing institution; Verifying what the learner knows, understands or can do.
Duration	are delivered in small sized units; a small volume of learning; a subset of learning; a subset of learning achievements or outcomes that is less than a full degree or certificate; brief certificates in a particular subject of study or professional development; typically involve much smaller packages of learning that may only take days or weeks; covers more than a single course but is less than a full degree, smaller elements of learning, gained by participating in short, free or low-cost online courses; Have a total study time of no less than 100 hours and no more than 150 hours; in specific area; more specialized and focused than a traditional academic degree; not the amount of "seat time" they have logged in their learning; one specific area at a time; one very small, specific competency in practice; practical, flexible, on-demand, and short learning experiences; quick; relatively small learning project; short course; a much narrower scope; more focussed and specific; bite-size courses; short learning experience; short program; short, discrete format; short, specific and focused training; Shorter learning experiences that home in on a specific topic or identified skill gap; shorter than a qualification; shorter than an award course but can represent from one to 100 hours of learning; are shorter; shorter, learning interventions; shorter, less duration, educational or training activities; significantly smaller in volume; small units of learning; small volume of learning; smaller than diplomas; smaller units of learning than the typical Charles Sturt eight credit; small-scale professional development modules; Just in time learning; they are awarded in recognition of much narrower skills or skill sets; They are short, low-cost online courses; bite-sized chunks; while there are no

	upper or lower limits on the amount of credit that a micro-credential carries, it should not normally constitute an award in its own right on the qualifications frameworks; with a minimum volume of learning of one hour and less than an AQF award qualification.
Competency-based	a distinct skill or accomplishment; addresses a fine-grained, discrete set of educational practices; allowing teachers to submit evidence from their own classroom practice to demonstrate their skills; competency or skills based; competency-based certifications that illustrate mastery of a skill; competency-based recognition that allows an educator to demonstrate mastery in a particular area; competency-based skills; discrete skill or competency that a teacher has demonstrated through the submission of evidence; is designed to provide the learner with specific knowledge, skills or competences; knowledge, skills and competences; knowledge, skills and competencies in a specific area or field; one or more competencies; professional growth; provide clear and seamless pathways across different credentials (both non-credit and credit) and may be stackable; require educators to demonstrate their competence in discrete skills in their practice—either inside or outside the classroom; skill; skill or competency; specific competency; specific skill or competence; that is focused on a discrete set of competencies; they indicate competency and compliance; will help to recognise the student's skills
Ownership, portability, shareability	Are owned by the learner, can be shared, are portable; may also be sequenced or "stacked" to allow learners to organize skill acquisition and see a learning progression toward competency in highly complex practices; can be stored on a blockchain; can share their microcredentials across social media platforms, via email, and on blogs and résumés. As a result, microcredentials are portable currency for professional learning that educators can take with them no matter where they go; flexible and readily accessible for

	learners; in a format that is verified, secure and shareable with peers, employers and educational providers; can be personalised and provide distinctive just-in-time value; More flexible in its delivery than traditional higher education; portable form; privately administered skill; Stackable microcredentials offer learners more flexible pathways to achieve full qualifications, which may help support equity of educational outcomes for underserved learners; that individuals choose to study to improve a skill found in a particular industry area; This new approach to professional development is personalised and generally transferrable; trackable, portable and competency is documented in students' academic records; will provide students with the opportunity to demonstrate their knowledge and skills earned and align to specific and timely needs of the modules and the workforce; You can study when it's convenient for you, alone or with your peers
Personalized	Personalized; move away from one-sizefits-all efforts to customized, just-in-time learning that leverages personal desires for professional growth; select micro-credentials to pursue—based on their own needs, their students' challenges and strengths, school goals, district priorities, or instructional shifts. And they can identify the specific activities that will support them in developing each competency—including, but not limited to, traditional professional learning activities; You can create your own learning journey, based on your interests and career goals; gaps in your skills; and the specific needs of your students, school, and district
Mode of delivery	by submitting evidence; digital certification; may be taken online or as a face-to-face experience; digital; typically awarded based on voluntary computer-administered online tests; leads to the award of digital credentials or certifications; online educational credential; provide learners with a digital certification or a

	digital badge when complete; the technology can capture and communicate what skills and knowledge a student has attained, micro-credentials are also a valuable tool for people to demonstrate both what they can do today and their future potential; They are often digital; They may or may not be digital; This means there is variety of ways to offer and design micro-credentials.
Formal, non-formal or informal settings	a cheap, fast, and accessible way for job-seekers to reduce employers' uncertainty about their abilities and thus attain better labour market outcomes for themselves; across higher education, vocational education, and training; an approach to professional learning; are responsive to teachers' schedules. Educators can opt to explore new competencies or receive recognition for existing ones on their own time, using an agile online system to identify competencies, submit evidence, and earn micro-credentials; can be accepted for credit by an institution or organization or be an attestation for employers; educational or training activities; can occur within a recognized post-secondary program, in the workplace, in other settings, or be a blend of two or more of these; in a job-embedded; include "nano-degrees," "micromasters qualifications," "certificates," "badges," "licenses," and "endorsements," among other types of credentials; is used by an education provider; job competencies; learning outcomes, training provider delivery standards, and evidence of current or anticipated need by industry, business or the community; may be offered independent of the method of provision (face-to-face, online or blended learning) or the nature of learning (formal, non-formal, informal; may provide clear and seamless pathways across different credentials (both non-credit and credit); Micro credentials are also known to be called: Digital badges Nano degrees Micro-certifications Web badges Mini degrees Open badges; Microcredentials come in a variety of formats including certificates, nanodegrees, digital badges, and open badges; Micro-credentials contribute to 'disciplining' higher education in two ways: first by building tighter links between

	higher education and workplace requirements (rather than whole occupations), and, through ensuring universities are more 'responsive' to employer demands in a competitive market crowded with other types of providers; of studies or professional development; offered by the institution; professional development modules that are suited for anytime/ anywhere learning; should be asserted by a recognized campus authority; should focus on competences and skills that address current specific needs of a learner or an employer; that respond to societal, personal, cultural or labour market needs; They are also known as digital badges, nano degrees, web badges, mini degrees, open badges, and micro-certifications; through our learn-by-doing process
Software	A micro-credential can be accepted for credit by an institution or organisation or be an attestation for industry; are designed; are developed with its particular industry in mind; change the face of teacher professional learning to move away from one-sizefits-all efforts to customized, just-in-time learning that leverages personal desires for professional growth; Credit-bearing or non-credit-bearing;. The design of each micro-credential is contextual and should reflect the needs of specific learners, industries and professions, and institutions.
NQF level	are referenced to the national qualification framework and the EQF; Be levelled at Levels 6–7 in the European Qualification Framework or the equivalent levels in the university's national qualification framework; have explicitly defined learning outcomes at a QF-EHEA/NQF level; there are no upper or lower limits on the amount of credit that a micro-credential carries, it should not normally constitute an award in its own right on the qualifications frameworks; they can be potentially used in programmes leading to NFQ qualifications

ECTS credit points	Micro-credentials express credit volume; Be levelled at Levels 4–5 and fulfil the criteria of the European Credit Transfer and Accumulation System; have an indication of associated workload in ECTS credits; it is credit-bearing against a recognised level of the FHEQ or FQHEIS; smaller units of learning than the typical Charles Sturt eight credit; can be accepted for credit by an institution or organization

3.4   Points of convergence and divergence among the original definitions

The definitions of each term presented and analysed reveal points of convergence and divergence among the original definitions. This convergence contributes to the interchangeable use of the terms in scientific research and policy documents. In contrast, the divergence contributes to the need for those terms to have distinguished and precise definitions.

All the original definitions refer to individuals, and their purpose is to upskill and reskill learners to open new possibilities in the labour market, capture new skills, and update their competences. Some of those definitions include micro-credentials' purpose, which is relevant to the study context or the policy document within which they were created. Most of them are part of individuals' professional development and contribute to documenting their learning achievements within the formal education system. The only case where an organisation can gain a short certification is the European Commission´s SELFIE tool for schools´ digital capacity. Schools that successfully run a collective reflection exercise on their digital capacity can earn an open badge.

Among the definitions for digital badges, open badges, and digital credentials there is a clear reference to the existence of an icon, with or without digital links. Those accompanied by an icon can help employers find employees when identifying potential candidates' skills and competences needed for the position, especially when the qualifications earned are shareable on the learners' profile.

The term micro-credential, which uses the element of the duration in most of the original definitions found and examined in this master thesis, either in the context of the higher education sector or in the labour market, may help employers' need to create a more flexible and competitive labour market force since each candidate could upskill and reskill in a short duration. Also, they can contribute to lifelong learning by fostering the development of specific skills and the ability to document their learning outcomes and achievements.

Including the learning activity is more evident in the term micro-credential since there is a reference to the learning activity and its assessment in all original definitions. Most definitions of micro-credential refer to learning and teaching design solutions when focusing on learner-centred learning, where learners can support their learning by planning and monitoring it. On the other hand, terms such as digital badges, open badges, digital credentials, and even

alternative credentials focus on the platforms used to deliver the credentials and represent the qualifications earned digitally.

While it is crucial, as it is defined in most micro-credential definitions, for the issuer organisation to have credentials of its recognition, there is no particular reference in their characteristics. In the case of the open, digital badges and credentials, the issuer is easier to be identified.

Finally, none of the definitions refer to the way that those certificates are going to widen access to learning activities, which can lead to the labour market for those who belong to a vulnerable group of learners, such as refugees, immigrants, Roma, or prisoners.

4: CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

By 2030, individuals in Europe will have the opportunity to begin and complete their educational journey towards advanced education at any point during their lives. In addition to the credentials previously attained, micro-credentials will give students plenty of chances to take shorter courses to broaden their horizons and advance their education. These micro-credentials are dependent on the acquired skill and can be connected thematically. Employers, educational institutions across industries, regions, and the public will all understand and recognise them equally if they are aligned with uniform descriptions. By doing this, micro-credentials will be crucial in promoting and achieving a society of learning and lifelong learning, which will improve everyone's chances and quality of life through critical reflection on societal and corporate processes, as mentioned in A European Approach to Micro-credentials (European Commission. Directorate General for Education, Youth, Sport and Culture., 2020b)

That vision and the tremendous amount of research on the subject and the enormous production of short courses in every possible subject, either in the field of higher education or the field of VET or within industries, make it evident that a standard definition is more necessary than ever. However, a standard and universal definition used in every field and occasion is difficult, if not impossible, to be created since there are differences among fields and in the needs of the learners. Also, such a standard definition requires regulating the lifelong learning procedure and its meaning.

A great demand for different types of micro-credentials, the changing nature of teaching and learning that have become less constraints, especially with the growth of advanced technologies such as artificial intelligence, nanotechnology, and the internet of things, and the pandemic of COVID-19, are factors that contribute to a growing importance of micro-credentials. Many questions remain, however, and they all lead to the lack of a commonly accepted vocabulary or key elements about micro-credntials.

It is essential for a common language and meaning of all terms, and micro-credentials in specific, for all sectors to be established and used so that everyone -especially researchers and policymakers- understands their meaning and contributes better and specifically to their growth. The current thesis's research has revealed many definitions that can be further examined so that their elements and the alternative expressions identified can contribute to

creating a common language and the difference between micro-credentials and the other terms used.

Finally, the definitions categorised as adopted would be helpful to analyse those that are not among the original ones, using the dimensions set to find more alternative expressions or locate the need that led to their creation.

One of the key issues related to micro-credentials is their recognition for further study or employment by policymakers, institutions, and employers. Without recognition, they cannot be integrated into national and international learning ecosystems, the NQF and the EQF. We believe the recognition is linked to a common language that all parts can use to understand and work on to ensure that micro-credentials fit their purpose.

ANNEX 1: LISTS OF ORIGINAL DEFINITIONS PER TERM

The original definitions for those terms are presented in the following tables.

Table 10 Original definitions of the term micro-credential

Citation	Definition	Paper
(Elliott et al., 2014)	"micro-credentials are only awarded on the acquisition of specific knowledge or demonstrated competency of an identified skill. They are then validated by recognised professional bodies or educational institutions. In essence they indicate competency and compliance and as such they could be regarded as a "summative" award. "	Research paper
(Berry & Cator, 2016)	"Competency-based. Micro-credentials focus on evidence of educators' actual skills and abilities, not the amount of "seat time" they have logged in their learning. They require educators to demonstrate their competence in discrete skills in their practice—either inside or outside the classroom. Personalized. Teachers select micro-credentials to pursue—based on their own needs, their students' challenges and strengths, school goals, district priorities, or instructional shifts. And they can identify the specific activities that will support them in developing each competency—including, but not limited to, traditional professional learning activities. On-demand. Micro-credentials are responsive to teachers' schedules. Educators can opt to explore new competencies or receive recognition for existing ones on their own time, using an agile online system to identify competencies, submit evidence, and earn micro-credentials.	Policy document

	Shareable. Educators can share their micro-credentials across social media platforms, via email, and on blogs and résumés. As a result, micro-credentials are portable currency for professional learning that educators can take with them no matter where they go. "	
(DeMonte, 2017)	"Micro-credentials are an approach to professional learning that provides teachers with the opportunity to learn and demonstrate competency in new skills, while also getting feedback from an outside evaluator and earning recognition for mastery by earning the micro-credential. Commonly, each micro-credential addresses a fine-grained, discrete set of educational practices. "	Other
(French & Berry, 2017)	"Micro-credentials for teachers are competency-based, personalized, small-scale professional development modules that are suited for anytime/ anywhere learning and allow teachers to show what they can do, not only what they know. Micro-credentials change the face of teacher professional learning to move away from one-sizefits-all efforts to customized, just-in-time learning that leverages personal desires for professional growth. "	Research paper
(Maxwell et al., 2017)	"A credential that shows a mastery of one or more job competencies and is more specialized and focused than a traditional academic degree"	Policy document

(Lim et al., 2018)	"Micro-credentials are mini-certifications in specific area of studies or professional development that will help to recognise the student's skills. This alternative credential will provide students with the opportunity to demonstrate their knowledge and skills earned through assessment -based activities and align to specific and timely needs of the modules and the workforce. Students will have the opportunity to earn these micro-credentials by submitting evidence of the work that they have done or their achievement which will be evaluated at an agreed level and standard. These micro-credentials will then make a student stands out in comparison to his peers to the prospective employers. Employers can source their new hires based on relevant micro-credentials earned by specific students."	Research paper
(Pickard, 2018)	"A microcredential is any one of a number of new certifications that covers more than a single course but is less than a full degree."	Other
(Pickard et al., 2018)	"Any credential that covers more than a single course but is less than a full degree."	Research paper
(The State University of New York, 2018)	"Micro-credentials verify, validate and attest that specific skills and/or competencies have been achieved and are endorsed by the issuing institution, having been developed through established faculty governance processes and designed to be meaningful and high quality."	Policy document
(Ehlers, 2018)	"Microcredentials are a form of credentials which represent competencies, skills, and learning outcomes derived from assessment-based, non-degree activities and specify a location for evidence of the content of the earned achievement."	Research paper

| (National Centre for Vocational Education Research (NCVER), 2018) | "Micro-credentials are also known as digital badges, nano degrees, micro-certifications, web badges, mini degrees and open badges. Compared to a degree, diploma, certificate or other lengthy accredited training, micro-credentials focus on smaller elements of learning. They are mini qualifications often gained by participating in short, free or low-cost online courses. These smaller blocks of learning can formalise soft and hard skills attained at work, such as teamwork, critical thinking and problem solving. They can also help fill skill gaps, such as working with big data. Regular upskilling is recognised as essential for the future, making micro-credentialing an increasingly popular and accessible option for lifelong learning. Micro-credentials offer students a pathway to higher education and help employees develop specific skills. Because the technology can capture and communicate what skills and knowledge a student has attained, micro-credentials are also a valuable tool for people to demonstrate both what they can do today and their future potential. Employees may consider them more advantageous than unaccredited and inhouse training which, while popular with employers, fail to offer formal recognition of learning that can enhance an individual's career development. As they become more prevalent, micro-credentials also have the potential to be an efficient, cost-effective and flexible means for employers to use to certify learning outcomes. Thus, micro-credentials are likely to improve labour mobility to the benefit of the economy and the individual." | Policy document |
| (International Council for Open and | "Micro-credential is "a credential issued for a relatively small learning project that consists of several modules in a given subject. This term implies that there is a related credential of greater scope offered by the institution. In some cases, micro-credentials have been defined | Policy document |

Distance Education (ICDE), 2019)	by the issuing institution. These are closely associated and sometimes used interchangeably with ADCs"	
(Rossiter & Tynan, 2019)	"Micro-credentials are short, verified courses or learning experiences... with a digital certification. A micro-credential is shorter than an award course but can represent from one to 100 hours of learning, may or may not be certified by an accrediting institution or association, and may be taken online or as a face-to-face experience. Notwithstanding this, there is generally consensus that micro-credentials are short, verified courses or learning experiences providing successful candidates with a digital certification, such as a "digital badge." Micro-credentials can be stacked towards larger units of competence or capability, in a format that is verified, secure and shareable with peers, employers and educational providers. They normally certify achievement at a more granular, sub-course level and differ from traditional long-form credentials such as degrees and diplomas in that they are shorter, can be personalised and provide distinctive just-in-time value. They can be earned in different ways but often through completing courses that incorporate structured learning designs with clearly evidenced outcomes. Alternatively, a micro-credential earner can demonstrate prior skills and learning achievement from work or life experience — assessable, for example, through a portfolio of evidence."	Other

(European MOOC Consortium, 2019)	"In order to qualify as a micro-credential within this framework, a course must adhere to the following specifications: Have a total study time of no less than 100 hours and no more than 150 hours, including revision for, and completion of, the Summative Assessment; Be levelled at Levels 6–7 in the European Qualification Framework or the equivalent levels in the university's national qualification framework, or be levelled at Levels 4–5 and fulfil the criteria of the European Credit Transfer and Accumulation System; Provide a summative assessment that enables the award of academic credit, either directly following successful completion of a micro-credential or via recognition of prior learning upon enrolment as a student on a university's course of study; Operate a reliable method of ID verification at the point of assessment that complies with the university's policies and/or is widely adopted across the platforms authorized to use the CMF; Provide a transcript that sets out the learning outcomes for a micro-credential, total study hours required, EQF level and number of credit points earned."	Policy document
(Wilson & Hay, 2019)	"competency based microcredentials typically involve much smaller packages of learning that may only take days or weeks to compete while the learning required to master a set of skills and knowledge could potentially take several months."	Research paper

(Oliver, 2019)	"A micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a component part of a formal qualification."	Policy document
(Uggeri & Barlassina, 2019)	"a documented statement awarded by a trusted body to signify that a learner upon assessment has achieved learning outcomes of a small volume of learning against given standards and in compliance with agreed quality assurance principles. Micro-credentials express credit volume and they are referenced to the national qualification framework and the EQF. A micro-credential may be offered independent of the method of provision (face-to-face, online or blended learning) or the nature of learning (formal, non-formal, informal). Micro-credentials are owned by the learner and are sharable and portable in the format of a stand-alone certificate, a digital badge, or as part of a portfolio". A micro-credential is a "sub-unit of a credential or credentials (could be micro, meso, mini, etc.) that could accumulate into a larger credential or be part of a portfolio"	Policy document
(South Australia. Training and Skills Commission (TASC), 2020)	"A micro-credential is shorter than a qualification and certifies the assessed learning of a defined set of skills, knowledge and attributes. In South Australia, micro-credentials can include: • nationally accredited skill sets4 • accredited courses • skill clusters or local skill sets to meet specific industry or individual needs	Policy document

	• non-accredited training that is industry endorsed to meet specific industry or individual needs. All micro-credentials include a statement of purpose, learning outcomes, training provider delivery standards, and evidence of current or anticipated need by industry, business or the community. On successful completion of a micro-credential, learners are issued with a recognised credential by their training or education provider."	
(American Institutes for Research, Center on Great Teachers and Leaders, 2020)	"An MC is a portable form of digital certification, indicating that an educator has demonstrated a specific competency."	Policy document
(Cirlan & Loukkola, 2020)	"A micro-credential is a small volume of learning certified by a credential. In the EHEA context, it can be offered by higher education institutions or recognised by them using recognition procedures in line with the Lisbon Recognition Convention or recognition of prior learning, where applicable. A micro-credential is designed to provide the learner with specific knowledge, skills or competences that respond to societal, personal, cultural or labour market needs. Micro-credentials have explicitly defined learning outcomes at a QF-EHEA/NQF level, an indication of associated workload in ECTS credits, assessment methods and criteria, and are subject to quality assurance in line with the ESG."	Policy document

(Clements et al., 2020)	"A credential recognizing a distinct skill or accomplishment. Microcredentials come in a variety of formats including certificates, nanodegrees, digital badges, and open badges."	Research paper
(Duklas, 2020)	"a qualification that represents assessed achievement of a subset of learning within and beyond the traditional realm of certificates, diplomas, and degrees. These provide credential recognition for what a person knows and can do at a modular level. The learning experience can occur within a recognized post-secondary program, in the workplace, in other settings, or be a blend of two or more of these. Typically, the qualification is intended to present a recognized and official symbol of the assessed learning experience to enhance access to and within the workplace."	Research paper
(European Commission. Directorate General for Education, Youth, Sport and Culture., 2020b)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards"	Policy document
(Hanafy, 2020)	"proof of skills and competences that students have achieved in their learning experiences"	Research paper

(Malaysian Qualifications Agency, 2020)	"digital certification of assessed knowledge, skills and competencies in a specific area or field which can be a component of an accredited programme or stand-alone courses supporting the professional, technical, academic and personal development of the learners"	Policy document
(Reiners, 2020)	"Micro credentials are certification-style qualifications that individuals choose to study to improve a skill found in a particular industry area. They are short, low-cost online courses that provide learners with a digital certification or a "digital badge" when complete. This new learning concept continues to gain recognition and is highly sought after within the professional landscape. The key difference between microcredentialling and other qualifications offered by higher education institutions – such as certificates or bachelors – is that micro credentials are delivered as "bite-sized" chunks; illustrating the proficiency in a particular skill. They are developed with its particular industry in mind, ensuring that the qualification meets industry-specific needs, is relevant and is recognised by future employers. This new approach to professional development is personalised and generally transferrable"	Other
(The European Consortium for Innovative Universities (ECIU), 2020)	"certification of learning that can accumulate into a larger credential or degree, be part of a portfolio that demonstrates individuals' proof of learning, or have a value in itself"	Policy document

(BloomBoard, 2021)	"Micro-credentials are a form of certification earned by demonstrating competency in one specific area at a time. BloomBoard's micro-credentials are created by educators, based on research, and designed to meaningfully improve teachers' instructional practices. They are earned through our learn-by-doing process, allowing teachers to submit evidence from their own classroom practice to demonstrate their skills"	Other
(Colleges and Institutes Canada, 2021)	"A micro-credential is "a certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification. Guiding Principles: Micro-credentials can be a complement to traditional credentials (certificate, diploma, degree or post-graduate certificate) or stand alone. Microcredentials are subject to a robust and rigorous quality assurance process. Micro-credentials should represent competencies identified by employers/industry sectors to meet employer needs. Micro-credentials may provide clear and seamless pathways across different credentials (both non-credit and credit) and may be stackable. Micro-credentials are based on assessed proficiency of a competency, not on time spent learning. Micro-credentials are secure, trackable, portable and competency is documented in students' academic records. Micro-credentials are to follow institutional approval processes"	Policy document
(Credential Engine, 2021)	"A microcredential is an online educational credential that covers more than a single course but is less than a full degree"	Policy document

(Mhichíl Nic Giolla et al., 2021)	"Micro-credential is a smaller units of assessed learning recognised by higher education institutions and other trusted credential-bearing agencies or professional bodies"	Research paper
(The Quality Assurance Agency for Higher Education, 2021)	"it is credit-bearing against a recognised level of the FHEQ or FQHEIS it is subject to standard quality assurance mechanisms while there are no upper or lower limits on the amount of credit that a micro-credential carries, it should not normally constitute an award in its own right on the qualifications frameworks. This last point relates to an idea that a micro-credential does not necessarily mean a very small credit-load but, rather, that it is something being studied on a "micro" level. This means micro-credentials are not studied as part of a larger whole (or degree) even if they are, for example, a module which might sit within an approved degree programme"	Policy document
(Australia. Department of Education, Skills and Employment, 2021)	"a certification of assessed learning or competency, with a minimum volume of learning of one hour and less than an AQF award qualification, that is additional, alternate, complementary to or a component part of an AQF award qualification"	Policy document
(Bjornavold, 2021)	"Micro-credentials are evidence of practical, flexible, on-demand, and short learning experiences"	Policy document

(Colleges and Institutes Canada (CICan), 2021)	"A Micro-Credential is a certification of assessed competencies that is additional, alternate, complementary to, or a component of a formal qualification"	Policy document
(European Commission, 2021b)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be standalone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity"	Policy document
(McKnight, 2021)	"the recognition of the acquisition of a defined skill (e.g., providing effective instructional coaching feedback to peers) through the demonstration of evidence aligned with a valid rubric"	Policy document

(Meyer et al., 2021)	"Micro-credentials are quick competency-based certifications that illustrate mastery of a skill. The micro-credential design breaks complex professional practices into "subtasks" or "micro-tasks," which are written in observable and measurable terms along with a list of competencies for learners... Micro-credentials differ from other professional development designs in that educators can actively develop and demonstrate competency in complex skills through their work, and educators have a choice in which skills to address. Micro-credentials may also be sequenced or "stacked" to allow learners to organize skill acquisition and see a learning progression toward competency in highly complex practices... Micro-credential accomplishment may be tied to professional recognition"	Policy document
(*Micro-Credentialing in Nothern Alberta*, 2021)	"Micro-credentials are awarded upon the successful completion of an assessment of a particular skill or competency, associated with short, specific and focused training, and are designed to be beneficial in obtaining employment or meeting on-the-job educational requirements"	Policy document
(Oliver, 2021)	"a strategic tool that is used by an education provider to communicate how it aims to provide value to learners"	Research paper
(Pichette, Rizk, et al., 2021)	"A micro-credential is a representation of learning, awarded for completion of a short program that is focused on a discrete set of competencies (i.e., skills, knowledge, attributes), and is sometimes related to other credentials"	Research paper

(Quality and Qualifications Ireland (QQI), 2021)	"micro-credentials are similar to minor, special purpose or supplemental award-types but can be significantly smaller in volume and, in contrast with minor awards, don't necessarily need to be part of a larger volume qualification though they can be aggregated and potentially used in RPL processes to gain exemptions from parts of, and advanced entry to, programmes leading to NFQ qualifications. They are especially useful to record the acquisition of specific skills needed by individuals, e.g. for work"	Policy document
(Tooley & Hood, 2021b)	"A verification of a discrete skill or competency that a teacher has demonstrated through the submission of evidence assessed via a validated rubric. Educator MCs are similar to other credentials, like degrees or diplomas, in that they provide public recognition and signaling of knowledge and/or skills held, but they differ in their format and scope: a demonstrated application of one very small, specific competency in practice"	Policy document
(Universities Australia. Deputy Vice-Chancellors (Academic) Working Group on Microcredentials, 2021)	"Microcredentials are an expanding alternative or additional form of qualification across higher education, vocational education, and training. Microcredentials attest to skills acquired or learning undertaken in a short, discrete formats, distinct from longer traditional qualifications such as diplomas and degrees"	Policy document

(Wolz et al., 2021)	"micro-credentials are mini-certifications within study programs referring to successfully participated courses, while alternative credentials are skill achievements outside the study program"	Research paper
(ECIU, 2021)	"To achieve this flexibility, the European Degree will be supported using micro-credentials as a means to pursue versatile learning outcomes and a competence passport to store the proof of the competences and skills the learner has achieved over time. The micro-credential acquisition is based on a stacking framework where each new learning outcome updates the learning pathway and informs new learning opportunities, aligned with the European and National Qualifications Frameworks. Micro-credentials redefine the types of awards and qualifications offered by universities, allowing greater flexibility in recognising skills, both formal and informal. It also creates a tangible way for societal stakeholders to be involved in the education process, as competences from them can inform the stacking framework, co-creating learning objectives and pathways. At the same time, the framework allows the tailoring of learning pathways that can create specialists that exactly match the needs of industry. By utilising micro-credentials, the European Degree has an opportunity to fundamentally change universities' role in transforming learning and are a promising means of aligning universities with societal perspectives and values. However, we must point out that the European Degree is not just the micro-credentials and competence passport. Instead, these are the tools that enable the European Degree"	Policy document

(Wheelahan & Moodie, 2021)	"microcredentials to be educational awards for learning from around 10% to up to a full academic year but less than a conventional educational award or credential"	Research paper
(Bigelow et al., 2022)	"Micro-credentials are: • Shorter learning experiences that home in on a specific topic or identified skill gap in ways that are flexible and readily accessible for learners. This means there is variety of ways to offer and design microcredentials. • Designed to focus on a specific skill, subject, or topic area; this focus differs based on the needs of the learners, employer, and industry partners. As a result, micro-credentials can be skills-based and competency-based; they can also be outcome-based with measurable learning objectives. Offerings could be stand-alone credentials, or they could be part of a series of micro-credentials that make up a program or certificate. • Credit-bearing or non-credit-bearing. The design of each micro-credential is contextual and should reflect the needs of specific learners, industries and professions, and institutions. • Industry focused with assessments to support learners with retraining, upskilling, or pursuing a career change. For example, learners who want to enter the food service industry may take a micro-credential on preparing healthy menus. Learners who are successful in completing the micro-credential should be able to effectively prepare healthy menus and,	Policy document

	therefore, learning activities and assessments should be aligned with this competency or ability. • Developed and designed with industry experts to ensure that retraining and upskilling accurately reflect industry needs and are recognized with some form of certificate or digital badge outlining the learning outcomes or competencies that learners achieved"	
(Credential Engine, 2022)	"Is a record of focused learning achievement verifying what the learner knows, understands or can do. Smaller in terms of time or credits than a traditional academic award; More targeted in the bundle of skills or study topics than a traditional academic award; More flexible in its delivery than traditional higher education"	Policy document
(Kässi & Lehdonvirta, 2022)	"Microcredentials are loosely understood as digital, privately administered skill certificates, typically awarded based on voluntary computer-administered online tests. They are in many ways analogous to conventional educational qualifications and training certificates, except that they are awarded in recognition of much narrower skills or skill sets and typically certify learning outcomes rather than methods of delivery. These characteristics could make microcredentials a cheap, fast, and accessible way for job-seekers to reduce employers' uncertainty about their abilities and thus attain better labour market outcomes for themselves"	Research paper

(McGreal & Olcott, 2022)	"Micro-credentials are certified documents that provide recognised proofs of the achievement of learning outcomes from shorter, less duration, educational or training activities. They focus on the validation of competency-based skills, outcomes and/or knowledge using transparent standards and reliable assessments, which can enhance graduates' employability prospects. A micro-credential can be be accepted for credit by an institution or organization or be an attestation for employers. A micro-credential attests to specific knowledge or skills competencies with defined learning outcomes and may or may not be stacked towards larger units of accreditation (Brown et al., 2021; Cirlan, & Loukkola, 2020; COL, 2019; Debiais-Sainton, 2020; Fong et al., 2016; Kato et al., 2020)."	Research paper
(Wheelahan & Moodie, 2022)	"micro-credentials are gig credentials for the gig economy. Rather than presenting new opportunities for social inclusion and access to education, they contribute to the privatisation of education by unbundling the curriculum and blurring the line between public and private provision in higher education. Micro-credentials can contribute to the fragmentation of occupations by undermining the coherence of qualifications and occupations (Wheelahan, 2016). Micro-credentials contribute to 'disciplining' higher education in two ways: first by building tighter links between higher education and workplace requirements (rather than whole occupations), and, through ensuring universities are more 'responsive' to employer demands in a competitive market crowded with other types of providers"	Research paper
(Foreman et al., 2022)	"Micro-credentialing is a way of implementing competency-based learning. It offers a way to increase accessibility for lifelong learning. Many micro-credentials are offered on platforms	Research paper

	that also provide access to MOOCs. IBM, Google, Cisco, and other companies have or support micro-credentialing programs to allow students to gain competency in areas directly related to company needs. This is done using badges and micro-certification. Some companies offer microcredentials in partnership with educational platforms such as Udacity and edX. In some instances, nanodegrees come with job guarantees [3]. Other micro-credentialing educational platforms include Udemy, and Kadenze. Micro-credentials are also offered in a variety of fields in colleges and universities around the world. Many are offered through intensive workshops, online learning or in a blended learning (combining face to face and online learning) [5]. Micro-credentials are delivered in small sized units, demonstrating skill in a particular area. They validate competence for a specific need. They are also known as digital badges, nano degrees, web badges, mini degrees, open badges, and micro- certifications [18]. The ability of credentials obtained to be bundled together for higher credentialing or stacking is also increasing in prevalence [20]. This stackable system allows for a progression of credentials from certificates to degrees. Certain micro-credential offering institutions like edX and Udacity have stackable credentials"	
(Shariman & Damian, 2022)	"A micro-credential is like a short course administered for the purpose of upskilling or reskilling. It has gained much focus and attention in recent years due to the increasing demand to close the skills gap that exists in the industry. The micro-credential wave has	Research paper

	changed the training landscape in many companies and organisations today. Skills and competencies are now taught or delivered at a much narrower scope compared to the full-fledged, wide range of skills previously delivered through both extensive and intensive training programmes. In other words, skills or knowledge gained through a micro-credential will not be as comprehensive but are more focussed and specific. Successful completion of these bite-size courses leads to the award of digital credentials or certifications"	
(American Association of Collegiate Registrars and Admissions Officers, 2022)	"A competency or skills based recognition that allows a learner to demonstrate mastery and learning in a particular area (Digital Promise). A microcredential is generally a subset of learning achievements or outcomes that is less than a full degree or certificate. A micro-credential offered by an institution of higher learning should be asserted by a recognized campus authority"	Policy document
(European Training Foundation, 2022b)	"micro-credentials as a shared tool, alongside other lifelong learning instruments. The ETF survey results highlight the key characteristics of micro-credentials, listed below. Skill or competence focused The demand side of micro-credentials is important. Micro-credentials should focus on competences and skills that address current specific needs of a learner or an employer. Standards-based assessment	Policy document

	Micro-credentials recognise the achievement of learning outcomes related to a specific skill or competence. Micro-credentials thus represent the skill or competence standards used for assessing an individual's learning achievements. Quality Organisations that award micro-credentials are responsible for developing skill/competence standards, and they have a responsibility to ensure that the assessment of an individual's learning achievements meets these standards. These competence standards may need to be validated by external bodies (e.g. industry partners, a quality assurance agency). Stackability Micro-credentials may represent not only a discrete skill or competence, but also a combination of skills or competences. Stacked together in a coherent way, micro-credentials can form a substantial award on their own or can be aggregated towards a qualification"	
(McDiarmid et al., 2022)	"A high-quality micro-credential is a verification of proficiency in a job-embedded discrete skill or competency that an educator has demonstrated through the submission of evidence assessed via defined evaluation criteria"	Policy document
(McGreal et al., 2022)	"Microcredentials are ADCs that are based on shorter, learning interventions that focus on assessing and validating specific competency-based skills (ICDE, 2019; Selvaratnam & Sankey, 2020; Zanville & Ton-Quinlivan, 2020). At the most basic level, micro-credentials are attestations that verify, validate, and confirm that specific skills and/or competencies have been achieved. They may or may not be digital. They differ from traditional degrees and	Policy document

	certificates in that they are generally offered for accomplishments achieved in shorter or more flexible timespans"	
(Navanitha et al., 2022)	"Micro-credentials (MCs) are defined as digital certifications of assessed knowledge, abilities, and competences in a particular area or field. They can be offered as stand-alone courses or as a component of a program that has been approved and help learners advance their professional, technical, academic, and personal goals (Abdullah et al., 2020). Micro credentials include "nano-degrees," "micromasters qualifications," "certificates," "badges," "licenses," and "endorsements," among other types of credentials (Chakroun & Keevy, 2018). Micro-credentials assist companies recognize a student's skills because they are brief certificates in a particular subject of study or professional development (Lim et al., 2018). By aligning with the specific and contemporary demands of the modules and the workforce, this alternative certification will also enable students to demonstrate the information and skills they have acquired through assessment-based activities"	Research paper

(Neal et al., 2022)	"Micro-credentials are small units of learning, consisting of between 5 and 40 credits. Smaller than a full qualification, they are designed to allow recognition of a discrete set of skills that meet specific learner, employer, industry, or iwi needs. Micro-credentials can supplement full qualifications by rapidly responding to the evolving skills needs of industry, particularly in response to technological changes. They enable learners to upskill and reskill at different stages of their lives, which benefits learners, employers and the community. Lifelong learners benefit from official recognition of shorter programmes so that they can carry evidence of their new skills with them into existing and future jobs. Stackable microcredentials offer learners more flexible pathways to achieve full qualifications, which may help support equity of educational outcomes for underserved learners"	Policy document
(UNESCO, 2022)	"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 is awarded by a trusted provider. • Has standalone value and may also contribute to or complement other microcredentials or macro-credentials, including through recognition of prior learning. • Meets the standards required by relevant quality assurance"	Policy document

(Wheat, 2022)	"Micro-credentials are smaller units of learning than the typical Charles Sturt eight credit point subject that provide recognition of the achievement of learning outcomes from shorter duration, education, or training activities. A micro-credential can be accepted for credit by an institution or organisation or be an attestation for industry. A micro-credential attests to specific knowledge or skill competencies with defined learning outcomes and may or may not be stacked towards larger units of accreditation"	Policy document
(Tamoliune et al., 2023)	"micro-credentials are considered a small volume of learning certified by a credential"	Research paper
(Alsobhi et al., 2023)	"Before 2020, micro-credentials were available in a variety of forms, but their popularity grew as a result of the COVID-19 pandemic, which accelerated its implementation in many sectors [9]. Micro-credentials, also known as digital badges, have recently emerged as a way to verify the completion of shorter, more specific learning courses that are not shown on academic transcripts [10]. They can be combined so that students can choose where to get their education and it allows them to acquire a large base of micro-credentials with the aim of eventually receiving a degree or diploma. Micro-credentials are beneficial to both individuals and higher education providers because they allow for the grouping of small learning attributes, such as soft skills, competencies, and professional skills. This will help individuals develop their skills and experiences and provide them with a pathway to higher education so they can participate in continuous learning. They can upgrade their skills outside the classroom by completing short courses that include specific skills. Upon completion of a short	Research paper

	course, students are awarded a hardcopy certificate as proof of completion [11]. The problematic issues associated with the hard-copy certificates is that they involve a cumbersome provenance process associated with each HEI, it is easy to fraudulently make changes to a hard-copy certificate, it involves a lengthy and often cumbersome processes to replace a hard-copy certificate in case of loss etc. [12,13]. In order to facilitate community acceptance of earning online microcredentials, the creation of a trustworthy, secure, resilient, and scalable strategy using blockchain technology is essential [1]"	
(West & Cheng, 2023)	"The terms open badges and open microcredentials can describe either the same thing, or sometimes very different things – often with open badges representing smaller pieces of learning, or with microcredentials representing traditional university credit options but on a microscale, while badges represent noncredit, informal learning. Sometimes, however, the difference could be as simple as a difference in culture – for example, whether a particular society has a history of boy or girl scout merit badges for youth learning. However, in the end, both terms represent credentials supported by the Open Badge Infrastructure and are thus equivalent technologies"	Research paper
(National Education Association (NEA), n.d.)	"A micro-credential is a short, competency-based recognition that allows an educator to demonstrate mastery in a particular area. NEA microcredentials are grounded in research and best practice and designed to be: • Personalized: You can create your own learning journey, based on your interests and career goals; gaps in your skills; and the specific needs of your students, school, and district.	Other

	• Flexible: You can study when it's convenient for you, alone or with your peers. • Performance-based: Unlike "sit-and-get" certifications, NEA micro-credentials are awarded based on demonstrated mastery of the subject matter, not just for showing up"	
(Bajor, n.d.)	"Micro-credentials are smaller, more specific credentials than diplomas. They are designed to show that a student has mastered a specific skill or body of knowledge. Micro-credentials can be earned through online courses, MOOCs, or other learning experiences. They are often digital and can be stored on a blockchain"	Other

Table 11 Original definitions of the term digital badges

Citation	Definition	Paper
(Brandon, 2013)	"Digital badges are basically icons, such as those displayed on your tablet by an app (for example, to show how many unread messages are in your Mail ie) or when a game starts up on your computer"	Research paper
(Liao et al., 2014)	"digital badges are emblems to give members to display the accomplishment of various achievements. In learning environments, digital badges could be used to encourage alternative, peer-based assessment [6], and function as transformative assessment that shape existing learning or allow new ones to be created [7] [8]."	Research paper
(Davis & Singh, 2015)	"Digital badges represent a specific kind of networked technology that has the potential both to recognize and connect learning across contexts. As web-enabled digital icons containing metadata associated with specific learning goals, practices, and outcomes, digital badges are an alternative credentialing system aimed at recognizing and rewarding learning across a variety of domains, both inside and outside of formal educational contexts (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013; Grant, 2014). "	Research paper

(L. Yu et al., 2015)	"Digital badges are icons that represent skills and achievements such as the completion of a project, the mastery of a skill, or the accumulation of experience (Bowen & Thomas, 2014; EDUCAUSE, 2012). Digital badges embed information about when, where and how they were earned. Such information, or metadata, includes the name of the issuer, the date issued, and the criteria for earning the badge. Badges provide a visual record of achievement, and can be stored or shared through social media tools, platforms or networks such as Mozilla Backpack™ or LinkedIn™. Badges may also be added to personal portfolios to allow users to demonstrate learning in ways other than a traditional credit courses and transcripts (EDUCAUSE, 2012). Digital badges are a form of micro-credentialing, which is a way to recognize competencies or skills, acquired through a variety of learning experiences, at a more granular level than is captured by conventional transcripts or degrees (Gamrat, Zimmerman, Dudek & Peck, 2014). "	Research paper
(D. M. Anderson & Staub, 2015)	"Digital badges are graphical representations of an accomplishment, but in particular, they typically reflect demonstrated skills through a performance of a complex task . They are created, awarded, displayed, and stored online. "	Research paper
(Gibson et al., 2015)	"A digital badge is a representation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata including links that help explain the context, meaning, process and result of an activity. "	Research paper

(Buchem et al., 2016)	"Open digital badges as Web-enabled tokens of learning and accomplishment (Casilli & Knight 2012), enable the representation, verification, and sharing of skills and knowledge acquired in a classroom, on the job, in the community, or in any digital and non-digital learning environment (Badge Alliance Endorsement Working Group, 2014). Open Badges may be used to support (a) recognising skills, achievements, experiences, practices, memberships, engagement on individual, peer and community levels, (b) assessing learning including summative, formative and transformative assessment, (c) motivating learning and providing orientation, (d) studying learning based on the information contained in a badge such as what the badge represents, criteria, evidence, issuers, earners. "	Research paper
(Farmer & West, 2016)	"Digital badges are small digital images that represent an individual's learning within a specific domain. These images are embedded with rich metadata that increases transparency into what is actually learned"	Research paper
(Peck et al., 2016)	"A digital badge is a representation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata including links that help explain the context, meaning, process and result of an activity. "	Research paper

| (LaMagna, 2017) | "A digital badge is a form of a micro-credential that, unlike a college degree or transcript, does not display all courses completed to achieve a credential but is used to display the single course of learning usually highlighted by a specific learning activity or completed project. Digital badges and other forms of micro-credentials offer a new way of thinking about documenting what a person learns and instead transitions to specific skills, knowledge, and abilities of students that can be easily communicated with a larger audience. Digital badges are typically a graphic or image that represents specific skills, knowledge, or abilities learned by a student. The design of these graphics or image should provide the viewer with a visual representation of the specific skill, knowledge, or ability learned. Think about the badges earned by those participating in the Girl or Boy Scouts of America. The individual badges communicate the specific skills, knowledge, or abilities a scout learns to a wider audience through a visual representations of the project or task. Digital badges, however, go a step further than just a visual representation of the project or task completed and the accompanying skill, new knowledge, or ability. The value of a badge in our digital society is the ability to incorporate additional information into the graphic or image." | Research paper |
| (Pitt & Davis, 2017) | "Digital badges are web-based icons that represent components of learning trajectories and can be used to provide information about a learner's skills, achievements, and experiences [19,23]" | Research paper |

(Shields & Chugh, 2017)	"Digital badges are akin to the physical scout badges that scouts earn to express their competency, except that digital badges relate to an online environment. Essentially, digital badges are an image or an icon that is embedded with information or metadata; more precisely, the information that the digital badge contains is who has been issued the badge, what that person had to do to obtain the badge, information about the issuer of the badge and sometimes links to the assessment that the badge recipient completed as part of receiving the badge (Bowen and Thomas 2014). Digital badges help to represent skills and achievements of a person. Digital badges can be used to visually symbolise a skill, an accomplishment, an educational qualification, an interest or a certification. Digital badges can be used to recognise accomplishments in a variety of contexts such as in a learning environment, gaming, sales and marketing initiatives, employees' recognition and association with professional bodies. Digital badges can then be displayed by the user if they choose, on e-portfolios, digital badge backpacks or online social platforms such as LinkedIn, Facebook and Twitter (Bixler and Layng 2013)."	Research paper
(Auh & Sim, 2018)	"Digital badges are a type of data repository that holds data that represents the learners' skills achieved through specific projects and courses in metadata format"	Research paper

(Borras-Gene, 2018)	"Badges are elements that serve to show an achievement, an acquired skill, progress of a learning or an interest in a certain subject [6]. By adding the adjective digital will be defined achievements or learning experiences in a virtual context, in the Web. [8], inking with the evidences of having obtained them. After obtaining a digital badge may be displayed on their websites, blogs, social networking spaces [8]. These can also be stored in electronic devices or sent by email, so they highlight their portability characteristics. Within any gamified system distinguishes between three protagonists or featured roles [9]: • Issuer: person, entity or institution that issues the digital badge. It will be the one who verifies those competences or achievements acquired. • Earner: student who acquires the knowledge and skills indicated by the digital badge after successfully passing a training process. Consumer: any person, in particular an employer, who views the badge and is the recipient of a job application (or responsible for some other selection process). "	Research paper
(Cheng et al., 2018)	"Open digital badges are data rich digital badges that are sharable within an open network of organizations and individuals supported by an agreed open infrastructure (Grant 2014). Initiated by Mozilla and the MacArthur foundation, the open infrastructure is a series of agreed upon standards that define how each badge should be created, what information the badge should contain, and how it should be stored and shared (Casilli and Knight 2012). Each badge is embedded with metadata that contains content about the target skills or knowledge, the criteria for accomplishing that skill or knowledge, and links to evidence	Research paper

	showing why the badge was earned (Goligoski 2012; Peer 2 Peer University, The Mozilla Foundation, and The MacArthur Foundation n.d.). "	
(Lim et al., 2018)	"These digital badges are visual representations of knowledge and skills earned by the students and it warrants that specific learning has been achieved. It has meta-data attached to it that includes a description if the credential and criteria the recipient satisfied. Digital badges are sharable, online credentials that students can post on platforms such as email and social media networks to show skills learned and demonstrated through the completion of badge-specific criteria. Clicking on these digital badges will give information on the microcredentials earned, the criteria that have been met and institution issuing them. "	Research paper
(S. Yu & Zheng, 2018)	"Digital badges, also known as "electronic badges", are similar to electronic portfolios; digital learning authentication methods that can be shared online and used to evaluate online learning processes and outcomes [4]. It is a diversified and flexible learning technology with potential to become a supportive approach to the practice of digital citizenship education. "	Research paper
(Pothier, 2019)	"Way to document and articulate a skill • Visual representation of qualification with linked metadata • Portable and sharable credential • Offers immediate value to current employers and demonstrates mastery of in-demand business skills to potential future employers"	Research paper

(Brauer, 2019)	"Digital open badges promote the identification and recognition of personal competences while helping to plan the development of competences as a continuum from teacher training to working life. "	Research paper
(Cheema et al., 2019)	"Digital badges may be conceptualized as "visual representation[s] of an accomplishment, skill or reputation gained in the context of a specific community" (Bani & De Paoli, 2013, p. 49). According to the literature, they may take one of two forms. Whereas merit badges signify an accomplishment or mastery of a skill, participatory badges more generally signify participation in a desired behavior (Abramovich, Schunn, & Higashi, 2013) and thus are well suited to enhance reputation. As such, they serve as viable tokens of recognition. "	Research paper
(Kullaslahti et al., 2019)	"Digital badges (e.g., Mozilla Open Badges) enable the identification and recognition of different competences acquired in formal or non-formal education (Devedžić & Jovanović, 2015; Knight & Casilli, 2012). Badges contain metadata about the recipient's competence, such as learning outcomes, and the expertise criteria required (Newby et al., 2016). The issuer of the badge (i.e., the identifier and recogniser of competence) can be, for example, an educational organisation or business. It is up to the badge applicant to present the evidence to earn a badge in accordance with the badge criteria. It is important to note that not all digital badges are based on competence identification and recognition; they can also be given for participation in training or function as a certificate for a specified time period (Brauer & Ruhalahti, 2014). "	Research paper

(McGee et al., 2019)	"Electronic badge that is portable and shareable. Recognizes a particular experience. Signify accomplishments i.e. completion of a project or mastery of a skill"	Other
(Ponte & Saray, 2019)	"A digital badge is a web-based visual token or image that represents the digital credential you have earned. Each badge contains details about your digital credential and links to the evidence which support the claims of achievement. "	Research paper
(Ziegler, 2019)	"Digital badges are micro-credentials issued to show competency in a particular area. "	Research paper
(Pothier, 2020)	"Digital badges are an evolving way to articulate learned skills or experiences through digital formats (including providing detailed metadata) and are on the rise in both higher education and in professional settings. "	Research paper
(Fanfarelli, 2020)	"Digital badges are the digital correlates to scouting merit badges or military ribbons, and serve as evidence of the owner's accomplishments. "	Research paper
(Reiners, 2020)	"A Digital Badge is an authenticated, online representation of a skill, quality or ability. Digital Badges can be earned in a variety of learning environments via a micro-credential course. They are a new means of recognising and certifying peoples' skills, knowledge, capabilities and accomplishments, and allow learners to connect with recruiters and new opportunities. On successful completion of a micro-credential course, learners can then share their digital badges on their social media platforms, particularly LinkedIn. "	Other

(Wolfenden et al., 2020)	"Open digital badges are symbolic representations of skills, accomplishments, status, activities or identities that are commonly awarded by an issuer and embedded with a link to evidence that supports the learner's claim to the badge."	Research paper
(Gamrat & Zimmerman, 2021)	"digital badges can represent learning experiences to elucidate learners' education and skills while also supporting the planning of new professional development."	Research paper
(Perkins & Pryor, 2021)	"A digital badge (also referred to as an open badge or digital credential) is an online accreditation of an achievement, skill or quality, which has been accomplished by an individual who undertakes criteria-based learning activities (Dyjur & Lindstrom, 2017; Gibson et al., 2015). The online badge is a visual representation and validation of the accomplishment. Embedded metadata, within the badge image, includes the context, meaning, process and result of the learning activity (Gibson et al., 2015; Fields, 2015; Risquez, Cassidy, & O'Suilleabhain, 2020). Badges can be shared and displayed via LinkedIn, and other social media outlets, online CVs, email signatures, personal blogs and ePortfolios, to present a digital record of an individual's skills, knowledge, and achievements (Janzow, 2014). Digital badges may be used to signify the achievement of smaller units of learning and skills acquisition, so called micro-credentials."	Research paper

(Chukowry et al., 2021)	"Digital badges can be described as an image file that contains information that provides evidence about the skill, experience, and knowledge a person has acquired after complete a course or some activities online [6]. The main key factor of badges is motivation as badges can be used as a way to motivate people to complete tasks, so before creating badges the basic principle of how and why people are motivated with badges should be studied [7]. A digital badge consists of 3 components i Signifier: it is the visual part of the badge that is the image that represents the badge. It includes a unique name, a description of the badge and it can also include a hint on how to obtain the badges. ii Completion logic: that is the requirement to obtain the badge. It consists of a Trigger: indicate what the person must do to obtain the badge b Pre-requirement: the requirement that must be satisfied before activating the trigger. c Conditions to earn the badge. d Multiplier: how many times the person has to meet the requirement to obtain the badge. iii Reward: what the user will get after getting the badge. Digital badge also contains a clickable hyperlink to view more information that is metadata. Metadata consists of the date the badge was awarded, the issuer, or any other relevant data. Metadata can be added using JavaScript object notation for linked data (JSON-LD)."	Research paper

(Gregg et al., 2021)	"Digital badges exist at the intersection of advances in educational technology, a growing societal interest in alternatives to formal university credentials, and an increasing awareness of open educational resources [1]. Digital badges are images typically displaying information such as the badge name and the issuing organization. They are also clickable and can embed detailed metadata about the badge including things like learning competencies and individual learner work products. Because of this, digital badges have been promoted as being more informative than a traditional transcript. When they are produced using a certified interoperable platform enabling them to be shared across platforms, digital badges become open badges [2]."	Research paper
(Wolz et al., 2021)	"A digital badge is, in our way, understand as a distinct sign, emblem, token, or mark for a specific learning outcome within the curricula."	Research paper
(Schürmann & Quaiser-Pohl, 2022)	"Digital badges are visual representations of accomplishments, skills, knowledge, experiences, interests, or affiliations awarded in recognition of a particular action or series of actions related to specific content within a digital environment (Antin & Churchill, 2011; Fanfarelli & McDaniel, 2019; Gibson et al., 2015). Digital badges hold metadata on the badges' context (e.g., source), requirements, and meaning (Alt, 2021; Finkelstein et al., 2013; IMS Global Learning Consortium, 2021). The term digital badge is often used interchangeably with the term micro-credential. Micro-credentials typically contain metadata on the central authority (e.g., an academic institution) validating the badge (Fanfarelli & McDaniel, 2019). When digital badges use open-source technology and are therefore portable and integrable	Research paper

	into various digital environments, they are open digital badges (Fanfarelli & McDaniel, 2019; Ifenthaler et al., 2016). Badges are used in various contexts (Abramovich & Wardrip, 2016; Ifenthaler et al., 2016), e.g., business (e.g., Kumar, 2013; McGovern, 2019), health care (e.g., Heinert et al., 2020), or education (Gibson et al., 2015). Badge usage has increased immensely during the last decade (Gibson et al., 2015), especially in higher education (Roy & Clark, 2019). Badge functions typically include credentialing and rewarding, motivation, goal setting, social status, feedback, and information (de Sousa Borges et al., 2014; Fanfarelli & McDaniel, 2019; van Roy et al., 2019). Hence, badges are used to engage and shape desired behavior, modify perceptions and attitudes, and assess competencies at a more fine-grained level than regular grades or reports (Abramovich & Wardrip, 2016; Fanfarelli & McDaniel, 2019; Jovanovic & Devedzic, 2015)."	
(American Association of Collegiate Registrars and Admissions Officers, 2022)	"Online representations that recognize skills, achievements, membership affiliation, and participation."	Policy document

(Flynn et al., 2023b)	"Digital badges can been seen as having dual roles i) they can be viewed as the visual representation of a micro-credential outcome and ii) they can be used to describe short informal and non-formal learning outcomes which are not linked to formal accreditation or ECTS nor are they quality assured by a HEI. As such, digital badges do not undergo quality assurance to the same degree as micro-credentials."	Research paper
(Ahsan et al., 2023)	"Digital Badges are therefore a specific form of micro-credentials, providing a visual representation of MC completion and a proof of learning or evidence of acquired skills (European_Commission, 2020; Oliver, 2019)."	Research paper
(The university of Texas at Dallas, 2023)	"Digital badges at UT Dallas refer to the learners' successful completion of micro-credentials. These badges will include verifiable and identifiable data associated with the specific learner."	Research paper

Table 12 Original definitions of the term digital credentials

Citation	Definition	Paper
(Lang, 2016)	"digital credential is a symbol of the recipient's achievements"	Research paper
(Ponte & Saray, 2019)	"Digital credentials certify the acquisition of capabilities and skills. They are awarded in a digital format which is verifiable, secure and shareable with peers, employers and educational institutions."	Research paper
(Ehrenreich & Trepulė, 2020)	"a credential is a certificate issued by a responsible institution that attests and verifies that a person has achieved specific learning outcomes and acquired specific skills and competences. The learning experience can involve online- or face-to-face-learning, or both. Credentials can be paper-based or digital, and they can be degrees, certificates, badges, diplomas, licenses, and industry certifications, among others, testifying attained skills and competences (Connecting Credentials [Lumina Foundation], 2016; Ganzglass, 2014; SUNY, 2018)."	Research paper
(European Commission, 2021d)	"European Digital Credentials for learning (EDCs) are standardised tamperproof electronic documents describing that their owner has certain skills or has achieved certain learning outcomes through formal, non-formal or informal learning context. They can describe: activities (e.g., classes attended0, assessments (e.g., projects), achievements (e.g., skills developed), professional entitlements (e.g., registration as a medical doctor) and qualifications. EDCs are typically used to qualify for job positions, university placements and more. They are legally equivalent to paper-based certificates in all Members of the European	Policy document

	Education Area. In practice, they could be a digital version of your University diploma, course certificate, or any other type of credential."	
(Wolz et al., 2021)	"a digital credential is a general term for digitized versions of a certificate or document representing achieved learning. a digital credential can be for a whole curriculum such as a Bachelor's degree."	Research paper
(Bruno & Morgado, 2022)	"Digital credentials are a disruptive model of accreditation, more suited to the digital world we currently find, which can evidence learning through the issuance of a Badge, containing relevant information about the learner, the acquired skill, and the issuing institution. Digital credentials (badges) are the elements that can provide this certification, representing the skill acquisition, supported by an educational or business institution, whose quality is recognized and validated by society."	Policy document
(Camilleri et al., 2022)	"Digital credentials are defined as claims which are issued in a format that is both human and machine-readable."	Research paper
(Kiiskila et al., 2022)	"digital credentials as proof of learning, competences, and achievements (Oliver 2019; Tracey 2014) and the corresponding micro-credential platforms that are used to manage digital	Research paper

	credentials irrespective of whether they relate to learning opportunities that are short (micro) or long (macro)."	

Table 13 Original definitions of the term open badges

Citation	Definition	Paper
(Brandon, 2013)	"An Open Badge (or similar badged credential) on the other hand, includes metadata with value beyond the image; for example, the metadata will usually include the identity of the badge issuer, the date of issue, and the criteria the badge holder met. In spite of the super cial resemblance, and the use of the word "badge," Open Badges and credentials are not an example of gratuitous gamification."	Research paper
(Glover & Latif, 2013)	"Open Badges are visual indicators that the recipient has achieved a certain level of knowledge or demonstrated competence in a particular skill. Each badge is composed of an image with additional information invisibly inserted into it, typically the name of the badge, requirements to earn it, links to evidence, the earner's name and email address, and the name of the issuer. Online systems such as Credly, Badg.us, and a growing number of educational tools support the creation, issue and display of badges. Open Badges were devised by the Mozilla Foundation, and earners can add their badges to their Mozilla backpack (portfolio), organise them into collections and share them with others. Interested parties can easily access the information embedded within a particular badge and verify that it is genuine and awarded to the stated person. This verification process means that an Open Badge can offer more credibility than, for example, a paper certificate because it can easily be checked for authenticity."	Research paper

(Myllymäki & Hakala, 2014)	"Open Badges is a system-independent, open source code standard developed by the Mozilla Foundation. It was created to identify the learner's knowledge and skills and to display them in a modern way. On a practical level, an Open Badge is an image with metadata. The metadata indicates the earners skills. A Badge contains, among other things, a description of the skills learned, infonnation about the issuer ofthe badge, the date when the badge was issued and the date when the badge expires. [n addition, the Open Badge concept includes solutions to check the validity of the issuer organization and the contents of the badge. The duration of the validity of the badge makes it possible to take into account the temporary nature of the learned skill. The Open Badge concept is linked to three roles: issuer, earner and displayer. Typically, the issuer is an organization which arran ges education or within whose activities the competences are created. The earner of the badge mayor may not accept the badge that has been issued to him/her. The earner stores his/her badges in a personal folder of the Mozilla's cloud-based service called Mozilla Backbag. Earners may display their badges in their own social networks (Facebook, Google+, Linked[n, etc.) or for example in their ePortfolios. Sharing can take place even in the earner's own web site or for example in the earner's CV."	Research paper
(Ravet, 2014)	"Open Badges are simple digital objects made of a picture in which a set of metadata have been baked. The main metadata contained in an Open Badge provides information on: Who is the issuer? — teacher, learner, employer, organisation, etc. issuing the badge; Who is the earner — learner, school, teacher, employer, organisation, etc. receiving the badge; What are the criteria — the conditions for receiving the badge, what the receiver has done or can do	Research paper

	(or aim at); What is the evidence — the artefacts demonstrating that the awarding criteria are fully satisfied. Open Badges are issued in a wide variety of contexts to recognise: The acquisition of a competency; The achievement of a goal (personal or collective); The participation in an event (lecture, conference, trade fair, etc.); The visit to a place (museum, website, etc.); and more! Badges can also be issued to set targets (aspirational badges) or to state personal values (using self-issued badges). Understanding the wide variety of badge types is important when exploring the use of Open Badges in the context of key competency development and recognition: Key Competency Badges might not be the only option! One of the key features of Open Badges is the ability to verify whether the badge holder has really earned that badge. Within the Open Badge Infrastructure (OBI) is not possible to claim a badge issued to someone else. So, while the claims usually made in a résumé can only be verified manually (call a previous employer, check that the diploma is not a fake), Open Badges can be verified online. The reader of an Open Badge can trust its content. An Open Badge can be visualised as the representation of a trust relationship, a criterionand evidence-based trust relationship"	
(Booth et al., 2015)	"Open Badges are digital representations of an individual's skills, experience, or learning and can be awarded for any type of accomplishment or activity (e.g. mastering a skill, completing a task, or being member of a team). Badges can be awarded by individuals or organisations, and can be displayed on the earner's online profile, or shared across social media (including Facebook, Twitter, LinkedIn and WordPress)"	Research paper

(Fields, 2015)	"Open badges are a digital symbol that signifies evidence of an accomplishment, skill, quality or participation in an experience. Similar to learning portfolios that provide a more in-depth view of an individuals' ability, badges can provide proof of ability through metadata. The badge image has "baked-in" metadata that outlines the criteria and evidence required to earn the badge. The benefit of badges for the earner is the ability to share and showcase them across social networks. Mozilla has created a standard that allows badges from a variety of platforms to be stored in a single location called a "backpack." The "backpack" holds your earned badges, providing a profiled space for all your badge activity. This space also allows the earner to organize collections and share them on a variety of sites, such as LinkedIn, Facebook, Twitter, and WordPress."	Research paper
(Ma, 2015)	"Open Badges allows any learner with a unique identity collected badges from different sites, and then in the different sites in a simple way to show to other people. Open Badges is an online version of the entity insignia, some identity, some property or some kind of achievement can be identified through badges. The digital badge after produced can have the status that unverified and verified."	Research paper
(Farmer & West, 2016)	"Open badges are a unique type of digital badge with additional affordances built into the technology that allow for the credential to be integrated into any compatible learning or portfolio system."	Research paper

(Konert et al., 2017)	"Open Badges are representational digital tokens that can fulfil manifold purposes such as visualizing membership, recording learning, and recognizing learning outcomes, or communicating accomplishments. They build on a web-friendly open standard and are created, awarded and displayed in a decentralized and user-centered way (Casilli & Hickey, 2016). Open Badges are supported by the Open Source Open Badge Infrastructure (OBI) which enables anyone to create, award and display badges across the web. The Badge Alliance1 (BA) promotes badges to be used as digital indicators for credits, achievements, or skills (as witnessed based on some evidences) of the badge owner. Open Bades as microcredentials allow to record, visualize and transfer skills in a more granular and individual way as traditional certifications (Knight & Casilli, 2012). Technically, Open Badges are bound to online identities of issuers and earners, but the (open) formats behind are not bound to one authority, which allows Open Badges to drive a digital disruption of more traditional global qualification and certification systems."	Research paper
(Chakroun & Keevy, 2018)	"Visual digital tokens of achievement, affiliation, authorization or some other trust relationship sharable across the web. Open badges represent a more detailed picture than a curriculum vitae (CV) or résumé as they can be presented in ever-changing combinations, creating a constantly evolving picture of a person's lifelong learning."	Policy document

(Clements, 2018)	"Open Badges are image files embedded with metadata providing additional information about the credential (Figure 1). This information includes who issued the credential, what was required to earn it, and evidence demonstrating that the requirements were met. After an Open Badge has been issued and accepted by the earner, they control how, when, and to whom their credential is displayed. Open Badges can be stored and shared on a personal device, website, or with Open Backpacks (tools built specifically for storing and sharing Open Badges). These virtual backpacks allow learners to set their Open Badges as public or private and organize them into various collections."	Research paper
(Hennah, 2018)	"Open badges are a subset of digital badges that are built on free open-source software. Additional data are embedded within the image file and so clicking on the badges reveals information about the award criteria, the issuer and supporting evidence: in short, a verifiable audit trail of the credential."	Research paper
(Tátrai & Mihályi, 2018)	"An open badge, a novel form of digital credential consists of a badge image connected with a set of meta data - reflecting the collection of knowledge, skills, values and attitudes (in short: competences) an individual has acquired and/or is able to demonstrate after completion of a learning process. In most cases the learning process takes place in an open non-formal or in informal learning environment. It can attest a one-time or reoccurring participation at events (workshop, short-term training, conference, webinar etc.) both as participant or as a facilitator, speaker. Other type of badges may be issued to certify the	Research paper

	attendance or completion of a course, which may take place again in a non-formal or even in formal circumstances."	
(Young et al., 2019)	"In 2012 Mozilla introduced the concept of open badges as a way to recognize and communicate various types of learning experiences (Mozilla Foundation , Peer 2 Peer University, & MacArthur Foundation, 2012). While the initial focus was to provide a way to credential informal learning, the concept has been adapted for use in primary, secondary, and higher education as well as in corporate training programs by small and large companies such as Microsoft (n.d.) and IBM (n.d.).	Research paper
	Open badges go beyond simple certification by embedding metadata about what the badge holder knows or can do. When they comply with the Open Badges Specification maintained by IMS Global Learning Consortium (IMS Global Learning Consortium, n.d.), they are portable and shareable across the Web. Utilizing this open standard, these badges can represent skills and knowledge gained from open platforms and informal learning experiences, providing details about potential employees such as which specific verified skills the individual has mastered , when and how the skills were attained, and who issued the badge—information that may interest hiring committees, employers, peers, or other entities (Lockley , Derryberry, & West, 2016)."	

(Korhonen et al., 2020)	"Open badges are relatively new approach in education practices. Open badges are for identifying and promoting competences and they are in a form of digital microcredentials [1, 2]. Open badges are information storages that contain a visual image as an icon, the name of the badge, issuer, competence description, assessment criteria and evidence of badge earner's competence [3]. Figure 1 is presenting the information that an open badge is composed by. Badge criteria explains the competence by learning objects and assessment criteria, as well as the instructions for skills demonstration. It will help the applicants to demonstrate their skills and competences when badge criteria are composed with details, in addition, criteria help applicants to make a self -assessment of their own performance [4]. The open badge may include several kinds of evidence in digital format by which applicants demonstrate their competences [5]. The issued open badges are open information sources that are visible to all viewers and competence related can be recognized again (6). In order to achieve an open badge usually badge application is sent to the issuer [5]. The application includes the evidence by which the applicant demonstrates his or her competence and it is made in digital format by text, photo, figure, video, mind map or other way using digital tools and applications. The evidence is following to the issued badge and everyone who explores issued badges may take a look at the provided evidence."	Research paper
(Hunsaker & West, 2020)	"An open badge is an openly-licensed (free, adaptable) microcredential that certifies competence in a specific skill."	Research paper

(Zhang & West, 2020)	"In training settings, open badges (microcredentials) are created and issued to validate an individual's acquisition of a skill. Compared to traditional ranscripts and credentials, for which trustworthiness of grades and course or program completion dates are questionable, each open microcredential is a metadata cloud of proofs (Belshaw 2016). [They include] information about the badge issuer (institution name, date of issue, rubric and requirements for the badge) and badge earner (name, evidence of learning, and feedback from the issuer), providing a more transparent picture of what has been learned and the observable evidence of that learning" (Farmer & West, 2016, p.45)."	Research paper
(Spencer, 2020)	"Open Badges are online records of achievement which document field-specific, soft and technical skills. They consist in a visual image and a set of embedded metadata which indicate the skill gained or objective reached, the learning process and method of assessment, and provide information about the issuer. They are endorsed by the institution which issues them and recognized on an international level. The information packaged within the badge image file is provided in an open source format and can be shared on social media platforms such as Linkedin, as part of an online e-portfolio, as a link on an electronic file of the candidate's CV, and on the platform which hosts the badge."	Research paper
(Ravaioli, S. & Ferrell, G, 2021)	"Open Badges are information-rich visual records of verifiable achievements earned by recipients and easily shared on the web and via social media. Open Badges is the world's leading format for digital badges. Open Badges is not a specific product or platform, but a	Research paper

	type of digital badge that is verifiable, portable, and packed with information about skills and achievements."	
(Camilleri & Ardie, 2022)	"Open Badges is not a specific product or platform, but a type of digital badge that is verifiable, portable, and packed with information about skills and achievements. Open Badges can be issued, earned, and managed by using a certified Open Badges platform. The Open Badges specification is a free and open specification available for adoption."	Policy document
(American Association of Collegiate Registrars and Admissions Officers, 2022)	"Open Badges are a type of digital badge. A type of digital badge, open badges conform to the Open Badges standard, and can serve as portable credentials containing metadata that offer detailed information about the achievements being credentialed. Open badges contain metadata which provides additional information about the credential and how it was earned."	Policy document
(Clausen, 2022)	"open badges utilize digital technologies making them portable and shareable. "A digital badge is a representation of an accomplishment, interest, or affiliation that is visual, available online, and contains metadata including links that help explain the context, meaning, process, and result of an activity" (Gibson et al., 2015, p. 405). The embedded metadata also provides the earner with the opportunity to share the specific criteria met and artifacts they created with others (Young et al., 2019). Individuals can then store their accumulated digital badges	Research paper

	into a digital backpack and tailor collections of credentials into different collections for specific audiences. Various organizations, including professional organizations, nonprofit and for-profit organizations, companies, and educational institutions, issue micro-credentials. Issuers develop badges to align with professional standards, skills, or other criteria. Issuers set up badge constellation systems where stacked credentials create learning pathways for earners to complete (Skipper, 2018). These pathways can lead to certifications or specializations the earner wants to emphasize that highlight a specific skill set or expertise."	
(Randall et al., n.d.)	"Mozilla (n.d.) explained that "Badges provide a way for learners to get recognition for [skills gained in these settings], and display them to potential employers, schools, colleagues and their community" (Mozilla, n.d.). Open badges are an example of a disruptive innovation. Christensen, Horn, and Johnson (2011) explained that disruptive innovations are products that are able to satisfy the need of an untapped market that was not currently being served by the more established and costly products. Open Badges are marketed towards the non-consumption areas of education. For example, Open Badges reward the informal acquisition of skills and achievements that are not being recognized in today's formal educational system."	Research paper

Table 14 Original definitions of the term alternative credentials

Citation	Definition	Paper

(Fong, UPCEA et al., 2016)	"Competencies, skills, and learning outcomes derived from assessment-based, non-degree activities and align to specific, timely needs in the workforce"	Policy document
(Kato et al., 2020)	"Alternative credentials are "credentials that are not recognized as standalone formal educational qualifications by relevant national education authorities". "	Policy document

ANNEX 2: LISTS OF ADOPTED DEFINITIONS PER TERM

Table 15 Adopted definitions of the term micro-credential

Citation	Definition	Paper
(Ahsan et al., 2023)	"Micro-credentials (MCs) are competency-based learning models provided by higher education (HE) or business which issue learners with a digital badge (DB) upon completion (Alamri et al., 2021)."	Research paper
(Reynoldson, 2022)	"a certification of assessed learning or competency, with a minimum volume of learning of one hour and less than an AQF award qualification, that is additional, alternate, complementary to or a component part of an AQF award qualification" (DESE, 2021, p. 9)"	Research paper
(Digital Promise, n.d.)	"Micro-credentials provide educators with recognition for the skills they develop throughout their careers, regardless of where or how they learned them. Microcredentials are: • Competency-based: Microcredentials articulate a discrete skill to support educator practice and the specific evidence educators must submit to demonstrate their competence in that skill. • Research-backed: Each microcredential is grounded in sound research that illustrates how that competency supports student learning. • Personalized: Educators select micro-credentials from the catalogue aligned to personal goals, student needs, or schoolwide instructional priorities. • On-demand: Educators can start and continue their microcredential journeys on their own time and in their own ways."	Other

(Digital Promise, 2017)	"Four key features define educator microcredentials: They are competency-based, personalized, on-demand, and shareable. As a personalized learning design, micro-credentials allow educators to focus on a discrete skill related to their professional practice, student needs, or school goals."	Policy document
(Luke & Young, 2020)	"Micro-credentials are digital certifcations that verify an individual's competence in a specifc skill or set of skills."	Research paper
(Malaysian Qualifications Agency, 2019)	"MC is a "…term that encompasses various forms of certifications, including "nano-degrees", "micro-masters' credentials", "certificates", "badges", "licences" and "endorsements". As their name implies, micro-credentials focus on much smaller modules of learning than those covered in conventional academic awards, which often allow learners to complete the required work over a shorter period. In their most developed form, micro-credentials represent more than mere recognition of smaller modules of learning. They form part of a digital credentialing ecosystem, made possible by digital communications technologies establishing networks of interest through which people can share information about what a learner knows and can do (Milligan and Kennedy, in James et al., 2017)." (source: UNESCO, 2018). The MC outlined in this guideline primarily focuses on two important aspects: i. digital attestation (digital badges, digital, nano degrees, micro degrees) which are secure and shareable; ii. records the achievement of learning of a specified set of outcomes (knowledge, skills, attitudes)."	Policy document

(Iucu et al., 2021)	"A micro-credential is a small volume of learning certified by a credential. In the EHEA context, it can be offered by higher education institutions or recognised by them using recognition procedures in line with the Lisbon Recognition Convention or recognition of prior learning, where applicable. A micro-credential is designed to provide the learner with specific knowledge, skills or competences that respond to societal, personal, cultural, or labour market needs. Micro-credentials have explicitly defined learning outcomes at a QFEHEA/NQF level, an indication of associated workload in ECTS credits, assessment methods and criteria, and are subject to quality assurance in line with the ESG. (EUA, 2020a, p. 7)"	Policy document
(Olcott, 2022)	"A micro-credential is a recognized proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, were applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be combined intolarger credentials or qualifications. They are underpinned by quality assurance following agreed standards. (p. 6)"	Research paper
(Fischer et al., 2022)	"Micro-credentials can be considered the concept with the wider scope of the two [3] and can be defined as "… a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards " ([1], p. 10)."	Research paper

(European Centre for the Development of Vocational Training., 2023)	"Microcredential means the record of the learning outcomes that a learner has achieved following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to microcredentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Microcredentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	Policy document
(Caetano, 2022)	"According to the European Commission a Micro Credential • It is an evidence of the learning outcomes that a learner has acquired after a short learning experience. • These learning outcomes should be assessed using transparent and standardized systems. • A Micro Credential is a form of recognition of the acquisition of a competence acquired through training of a short character and not leading to a degree."	Other
(European Commission, 2021e)	"A micro-credential is the record of the learning outcomes that a learner has acquired following a small learning experience (e.g. certificate, award). Micro-credentials are already widely used in many education and training sectors, professions and labour markets. The aim of the Commission's proposal is to establish a European approach that gives a common definition for micro-credentials, provides common standards, and improves recognition across borders. Micro-credentials can support targeted, flexible upskilling and reskilling to meet new and emerging needs in society and the labour market. Given their flexibility, micro-credentials can	Other

	be designed and delivered by a variety of providers in many different settings. Micro-credentials can be used as part of targeted measures to support labour market activation and inclusion. Microcredentials are not limited to any category of the population. They are for everyone, regardless of age, employment or education level."	
(Romero-Llop et al., 2022)	"Micro-credential' means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity" (European Commission, 2022, p. 9)."	Research paper
(Antonaci et al., 2021)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Microcredentials are	Research paper

	owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards."	
(Brown & Mhichil, 2021)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards."	Research paper
(Brown, Mhichíl, et al., 2021)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards"	Policy document
(Cedefop, 2022b)	"A microcredential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Microcredentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards."	Policy document

(de Bruin et al., 2022)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards"	Policy document
(Debiais-Sainton, 2020)	"A micro-credential is a recognised proof of the learning outcomes that a learner has achieved following a short learning experience, according to transparent standards and requirements and upon assessment. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, are shareable, portable and may be combined into larger credentials or qualifications"	Policy document
(European Centre for the Development of Vocational Training., 2022a)	"A microcredential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Microcredentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards"	Policy document
(European Centre for the Development of	"A microcredential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the	Policy document

Vocational Training., 2022b)	achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Microcredentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards."	
(European Commission, 2021a)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards."	Policy document
(González Gago, 2023)	"microcredentials as a proof of learning outcomes that a learner has acquired following a short learning experience."	Policy document
(Perla et al., 2023)	"A micro-credential is a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards. The proof is contained in a certified document that lists the name of the holder, the achieved learning outcomes, the assessment method, the awarding body and, where applicable, the qualifications framework level and the credits gained. Micro-credentials are	Research paper

	owned by the learner, can be shared, are portable and may be combined into larger credentials or qualifications. They are underpinned by quality assurance following agreed standards"	
(Shanahan & Organ, 2022)	"a proof of the learning outcomes that a learner has acquired following a short learning experience. These learning outcomes have been assessed against transparent standards"	Research paper
(European Commission, 2022)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific kno wledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	Policy document
(Council of the EU, 2022)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be standalone or combined into larger credentials.	Policy document

	They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	
(Güneş & Firat, 2022)	"a micro-credential is the record of the learning outcomes that a learner has acquired following a small volume of learning"	Research paper
(Flynn et al., 2023a)	"a micro-credential can be seen as a minicertification. In line with the European Commission's (2021) recommended definition, they are usually short, and relatively low-cost courses that have a specific focus on demonstrating proficiency in a particular skill. In terms of quality, the European Commission recommends that micro-credentials be subject to internal and external quality assurance by the system producing them and that the quality assurance processes must be fit-for-purpose, be explicitly documented and accessible and satisfy the needs and expectations of learners and stakeholders (European Commission, 2021). In addition, the European Commission (2021) recommends that microcredentials be measurable, comparable and understandable containing clear information on learning outcomes, workload, content, level, and the learning offer, as relevant."	Research paper
(Ebner, 2022)	"Microcredentials certify the learning outcomes of short-term learning experiences, for example a short course or training [and] offer a flexible, targeted way to help people develop the knowledge, skills, and competences they need for their personal and professional development."	Research paper

(Mac Lochlainn et al., 2022)	"Micro-credentials certify the learning outcomes of short-term learning experiences, for example, a short course or training. They offer a flexible, targeted way to help people develop the knowledge, skills and competences they need for their personal and professional development."	Policy document
(European Training Foundation, 2022a)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	Policy document
(Longo, 2023)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning."	Other
(Pirkkalainen et al., 2023)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes have been assessed against transparent and clearly defined standards. Courses leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be standalone or combined into larger credentials.	Research paper

	They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	
(Brown et al., 2023)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity."	Research paper
(Dublin City University, 2023)	"Micro-credential means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competemces that respond to societal, personal, cultural or labour market needs."	Other
(Chukowry et al., 2021)	"A micro-credential program helps students to build skills outside the classroom by providing courses that cover specified skills. It is usually more than a single course but shorter than a full degree. A microcredential is also a "visual representation of your capability"andis awarded using a digital badge [5]."	Research paper

(Chakroun & Keevy, 2018)	"A term that encompasses various forms of credential, including "nano-degrees", "micro-masters credentials", "certificates", "badges", "licences" and "endorsements". As their name implies, micro-credentials focus on modules of learning much smaller than those covered in conventional academic awards, which often allow learners to complete the requisite work over a shorter period. In their most developed form, micro-credentials represent more than mere recognition of smaller modules of learning. They form part of a digital credentialing ecosystem, made possible by digital communications technologies establishing networks of interest through which people can share information about what a learner knows and can do (Milligan and Kennedy, in James et al., 2017)."	Policy document
(Seet & Jones, 2021)	"Like most micro-credentials, microapprenticeships are mini qualifications in smaller blocks of learning and they can formalise soft and hard skills attained at work, such as teamwork, critical thinking, creativity and problem solving (Johnson, 1997)."	Research paper
(Pollard & Vincent, 2022)	"as credentials that "are not recognised as standalone formal educational qualifications by relevant national education authorities""	Research paper
(OECD, 2021)	"credentials that are not recognised as standalone formal educational qualifications by relevant national education authorities"	Policy document
(Ahmat et al., 2022)	"Micro-credential as "much smaller modules of learning…often allow learners to complete the required work over a shorter period" (p.7) (MQA, 2019). There are many names for micro-credential (e.g., nanodegrees, micro-masters' credentials, certificates, badges)."	Research paper

(Department of academic affairs, 2020)	"According to the Malaysian Qualifications Agency or MQA (2019), MC "is a certification of learning of a smaller set of courses or modules or units which are designed to provide learners with knowledge, skills, values and competencies in a narrow area of study and/or practice" (p. 6). MQA has introduced a guideline on the principles and good practices in implementing micro-credentials for the benefits of higher education institutions and stakeholders. In the guideline, MQA highlights two important aspects which include digital attestation (digital badges, digital, nano degrees, micro degrees) that are secure and can be shared. The other aspect is recording "the achievement of learning of a specified set of outcomes (knowledge, skills and attitudes)" (p. 7)."	Policy document
(Palmer, 2021)	"Micro-credentials are blocks of learning that are smaller than the volume of learning associated with a degree, diploma, certificate or other lengthy accredited training."	Policy document
(OECD, 2022)	"Alternative credentials include academic certificates, industry certifications and digital badges. One form of alternative credentials gaining increasing policy attention is the micro-credential. Many definitions of micro-credentials are currently in use, but most denote an organised education or training programme associated with a credential, which validates a specific skill, knowledge or experience (OECD, 2021[9]). The term "micro-credential" is commonly understood to refer to both the credential itself and the education or training programme which leads to the credential award."	Policy document

(Bennett, 2020)	"short courses, offered outside formal education systems, generally designed to address a specific workplace skill or need (Oliver, 2019, pp. 18-19). "	Research paper
(Cowie & Sakui, 2022)	"digital certification of assessed knowledge, skills and competencies which is additional, alternate or complementary to or a component of formal qualifications" (Oliver, 2019, p.19). "	Research paper
(Jones, 2022)	"They are a digital form of recognition and "certification of assessed learning [emphasis added] that is additional, alternate, complementary to or a component part of a formal qualification" (Oliver, 2019, p. 19). This definition locates microcredentials partially in the realm of nonformal learning, particularly for recognition of vocational competencies [competency-based alternative digital credentials [ADCs]), but also as credits towards a formal qualification (learning-achievement ADCs) (ICDE, 2019, p. 24). "	Research paper
(R. Selvaratnam & Sankey, 2021)	"a micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification (Oliver, 2019b, p. i). "	Research paper
(Thi Ngoc Ha et al., 2022)	"A micro-credential is defined as "a certification of assessed learning that is additional, alternative, complementary to or a component part of a formal qualification" (Oliver, 2019, p. 19). "	Research paper

(Varadarajan et al., 2023)	"There is shared agreement of micro-credentials as shorter forms of a learning experience as compared to that of formal degree programmes—described by Oliver (2019) as a stackable certification of assessed learning that is additional, alternate, complementary to, or a formal component of a formal qualification that emphasises verified learning outcomes concerning traditional formal qualifications such as a bachelor's or master's degree (i.e., macro-credentials). "	Research paper
(White, 2021)	"Micro credentials are a spin off from the qualifications industry – and they operate at the intersection of education and industry. They present an excellent opportunity to achieve better work-integrated learning, and better learning-integrated work. Policy makers are well advised to provide strategic leadership in this domain, and the resources required for education systems and industries to capitalise on the opportunity that micro-credentials present to upskill and reskill for the future of work (Oliver, 2019, p. 35) "	Research paper
(*Review of the Australian Qualifications Framework*, 2019)	"A micro-credential is a certification of assessed learning that is additional, alternative, complementary to or a component part of a formal qualification."	Policy document
(R. M. Selvaratnam & Sankey, 2021)	"a micro-credential is a certification of assessed learning that is additional, alternate, complementary to or a formal component of a formal qualification (Oliver, 2019b, p. i) "	Research paper

(Conrad, 2022)	"Micro-credentialling is defined as a "representation of learning, awarded for completion of a short program that is focused on a discrete set of competencies (i.e., skills, knowledge, attributes), and is sometimes related to other credentials" (HEQCO, n.d.). "	Research paper
(Pichette, Brumwell, et al., 2021)	"A microcredential is a representation of learning, awarded for completion of a short program that is focused on a discrete set of competencies (i.e., skills, knowledge, attributes), and is sometimes related to other credentials. "	Policy document
(Stefany & garcia, 2022)	"as learning activity, consisted by more than a single course but less than a full degree"	Research paper
(Mischewski, 2017)	"packages of learning designed to meet specific learner needs that are smaller than conventional qualifications"	Research paper
(Cathrael Kazin & Clerkin, 2018)	"Microcredentials have emerged as the most commonly used way to describe credentials that do not constitute a full degree or even a certificate, but that describe a meaningful collection of courses or related learning/training. At the most basic level, microcredentials verify, validate, and attest that specific skills and/or competencies have been achieved. They differ from traditional degrees and certificates in that they are generally offered in shorter or more flexible time spans and tend to be more narrowly focused. Microcredentials can be offered online, on-campus, or via a hybrid of both. [SUNY] "	Policy document

(Tooley & Hood, 2021a)	"A verification of a discrete skill or competency that a teacher has demonstrated through the submission of evidence assessed via a validated rubric. Educator MCs are similar to other credentials, like degrees or diplomas, in that they provide public recognition and signaling of knowledge and/or skills held, but they differ in their format and scope: a demonstrated application of one very small, specific competency in practice."	Policy document
(Chandler & Perryman, 2023)	"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 is awarded by a trusted provider. Has standalone value and may also contribute to or complement other micro-credentials or macro-credentials, including through recognition of prior learning. Meets the standards required by relevant quality assurance. (UNESCO 2022: 6)"	Research paper
(Coursera, 2023)	"A microcredential focuses on a specific set of learning outcomes in a narrow field of learning and is achieved over a shorter period of time. Micro-credentials are offered by commercial entities, professional bodies, and private providers. "	Other
(Martin & Van der Hijden, 2023)	"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 is awarded by a trusted provider.	Policy document

	• Has standalone value and may also contribute to or complement other microcredentials or macro-credentials, including through recognition of prior learning. • Meets the standards required by relevant quality assurance. "	
(Ward et al., 2023)	"This work follows the UNESCO definition of microcredentials: • a record of focused learning achievement verifying what the learner knows, understands or can do. • Includes assessment based on clearly defined standards and is awarded by a trusted provider. • Has standalone value and may also contribute to or complement other micro-credentials or macro-credentials, including through recognition of prior learning. • Meets the standards required by relevant quality assurance (Oliver 2022: 6) "	Research paper
(Borland et al., 2022)	"microcredentials provide a means to certify that a skill or set of knowledge has been obtained through the completion of an online learning experience. While microcredentials are constructed by a wide array of school systems, universities, corporations, and nonprofit organizations, they have several common features or components. Microcredentials are expected to be grounded in research, emphasize a competency-based experience, and allow for access anytime and anywhere. To verify mastery of the skills obtained in the	Research paper

	microcredential, a certificate or digital badge is awarded that can be shared virtually (Yu et al., 2015). "	

Table 16 Adopted definitions of the term digital badges

Citation	Definition	Paper
(Ostashewski & Reid, 2015)	"Digital badge as "a representation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata including links that help explain the context, meaning, process and result of an activity"	Research paper
(Pedro et al., 2015)	"According to Halavais (2012), digital badges can be an effective way of improving and structuring peer-based learning communities, providing new ways of assessment and accreditation."	Research paper
(Ian O'Byrne et al., 2015)	"Digital badges are web-enabled tokens of accomplishment. They can contain specific claims and evidence about learning and are intended to circulate in social networks that badge issuers and earners participate in (Knight & Casilli, 2012)."	Research paper
(Crafford, 2015)	"A digital open badge is an online record of achievements, tracking the recipient's communities of interaction that issued the badge and the work completed to get it. (Mozilla, 2012)"	Research paper

(Motheeram et al., 2016)	"Devedžić and Jovanović (2015) argue that a badge is an image that serves as an indicator of skills, competencies, interests, achievements, or hierarchy acquired over time and across all contexts."	Research paper
(Araújo et al., 2017)	"A digital badge is a symbol, however is more than just a digital image of a symbol, it also has metadata embedded, namely information about: issuer, sandards achieved and certified, activities indertaken, artefacts created, and situations experienced, quality of the experiences, products and performances (Gibson et al 2015, p. 405)"	Research paper
(Motheeram et al., 2018)	"Devedžić and Jovanović (2015) argue that a badge is an image that serves as an indicator of skills, competencies, interests, achievements or hierarchy acquired over time and across all contexts."	Research paper
(Cheng et al., 2018)	"Digital badges have been used as an online representation for accomplishments, skills, or awards. According to Gibson et al. (2013), a digital badge is Barepresentation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata including links that help explain the context meaning, process and result of an activity^ (p. 405)."	Research paper
(Chakroun & Keevy, 2018)	"A clickable graphic that contains an online record of 1) an achievement, 2) the work required for the achievement, 3) evidence of such work, and 4) information about the organization, individual or entity that issued the badge (Lemoine and Richardson, 2015)."	Policy document

(Carey & Stefaniak, 2018)	"digital badges are electronic symbols used to document performance and achievement. Open badges are intended to provide additional information via metadata in order for viewers of badges to verify issuer details, evaluation criteria, and evidence such as the actual work product used to earn the badge (Parker 2015)."	Research paper
(Jirgensons & Kapenieks, 2018)	"a digital open badge is a shared digital artefact (Willis et al., 2016, p. 24)"	Research paper
(Duklas, 2020)	"a visual representation of a credential that is displayed and verified online. A digital badge might also represent other forms of achievement. When the badge is clicked on, a page will pop up that will typically explain what the badge represents, how it is earned, and so forth. (Association Trends, 2018)"	Research paper
(Risquez & Cassidy, 2020)	""a representation of an accomplishment, interest or affiliation that is visual, available online, and contains metadata, including links that help explain the context, meaning, process and result of an activity" (Gibson et al., 2015, p. 404)"	Research paper
(Hickey et al., 2020)	"As leading authority Sheryl Grant opened What Counts as Learning (2014), an open digital badge is "an image file embedded with information" (p. 1)"	Research paper
(Wijeratna, 2021)	"A "digital badge" is an digital record of achievements, tracking the recipient's communities of interaction that issued the badge and the work completed to get it [1]"	Research paper

Citation	Definition	Paper
(Tinsley et al., 2022)	"Awarded by an organization in accordance with the Open Badge specification ensuring verifiability, embedded metadata about skills and achievements, and portability"	Policy document
(Fischer et al., 2022)	"definition offered by LeMoine and Richardson [9]: "A digital badge is a clickable graphic that contains an online record of 1) an achievement, 2) the work required for the achievement, 3) evidence of such work, and 4) information about the organization, individual, or entity that issued the badge" (p. 39)"	Research paper
(Blakeley & Branon, 2022)	"A digital representation of a skill, learning achievement or experience. Badges can represent competencies and involvements recognized in online or offline life. Each badge is associated with an image and some metadata. The metadata provides information about what the badge represents and the evidence used to support it. (Mozilla Foundation, 2014) "	Research paper
(Alt, 2023)	"DBs are visual representations of skills, experience, knowledge, accomplishments, interests, or affiliations, which are available on virtual platforms. One kind of process, for example, might be "the peer and expert review of artifacts of work showing what someone knows and can do, and the accompanying validation and credentialing of that person "knowledge or capability" (Gibson et al., 2015,p.404). "	Research paper

Table 17 Adopted definitions of the term digital credentials

Citation	**Definition**	**Paper**

(Grech et al., 2021)	"Digital credentials are therefore not mere functional elements—a form of skill/qualification—but tangible proof of identity or self-sovereign identity (Stokkink et al., 2020), with the "value-added" significance of an educational credential unlocked when it can be effectively linked to the sovereign identity of an individual"	Research paper

Table 18 Adopted definitions of the term open badges

Citation	Definition	Paper
(Glover, 2013)	"Open Badges have recently been identified as an educational technology with significant potential to disrupt formal education"	Research paper
(Kuhmonen et al., 2018)	"Open Badges are digital credentials that visually demonstrate the competences, skills or abilities of the badge owner in specific fields. There is a strong need in our information society to recognize and demonstrate all the informal learning that happens through work, hobbies, volunteering and various other activities in our lives. The purpose of the open badges is to make the skills and competences of a person visible for others, which means that the badges should be designed visually interesting and in terms of content informative enough. As parties that issue the badges, and thus identify and acknowledge the skills and competences, could act different organizations, such as learning institutions, companies or societies. The badges can demonstrate both the hard skills, such C++ coding, and the soft skills like communication. (Brauer & Ruhalahti, 2014.)"	Research paper

(Hurley, 2017)	"Fong et al. defined alternative credentials as "competencies, skills, and learning outcomes derived from assessmentbased, non-degree activities and aligned to specific, timely needs in the workplace" (2016)"	Research paper
(Spencer & Bussi, 2020)	"Open Badges are online records of achievement which document field-specific, soft and technical skills (see, for example, All4Ed and Mozilla Foundation 2013). They consist of a visual image and a set of embedded metadata which indicate the skill gained or objective reached, the learning process and method of assessment and provide information about the issuer. They are endorsed by the institution which issues them and are recognized on an international level. The information packaged within the badge image file is provided in an open source format and can be shared on social media platforms such as Linkedin, as part of an online e-portfolio, as a link on an electronic file of the candidate's CV, and on the platform which hosts the Badge"	Research paper
(Temperman et al., 2022)	"Open Badges are a digital badge system developed by the Mozilla Foundation1. It is a form of certification of mastery of skills and participation in various training systems. They are inspired by video games and are part of a movement that promotes gamification as a modality of interactivity in learning devices (De Lièvre et al., 2017). In an educational context, the aim of badges is to enhance learners' motivation and engagement with the activities offered (Reid et al., 2015). Research often indicates a positive effect on motivation (Reid et al., 2015; Fajiculay et al., 2017). However, this effect is relative due to a novelty effect often reported by learners (De Lièvre et al., 2017)"	Research paper

Table 19 Adopted definitions of the term alternative credentials

Citation	Definition	Paper
(Matkin, 2018)	"ADCs are portable, useful, transferable, and easily understood. ADCs offer an improvement over traditional transcripts because they "can contain specific claims of competency and web-based evidence of those competencies. They can be curated, annotated, and distributed over digital networks under the earner's control"."	Other

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