Features of Micro-credential Platforms in Higher Education

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Keywords: Micro-credentials, Digital Credentials, Adoption, Features, Micro-Credential Platforms, Higher Education Institutions.

Abstract: Interest in and demand for micro-credentials in higher education institutions is on the rise. Although the concept of micro-credentials is still evolving, they can be seen as short learning opportunities that are accompanied by digital credentials that capture the proofs of the learning. These digital proofs of learning range from skills and competences acquired to information whether such skills were acquired via formal or non-formal learning activities. Micro-credential platforms are used for multiple purposes including issuing, viewing, and storing the digital credentials. Despite the growth in the number of micro-credential platforms in the recent years, literature is limited on the features offered by the platforms and how they are helpful for higher education institutions and learners. To address this gap in research, we employed a qualitative approach by semi-structured interviews and group discussions with platform providers and education experts. Our findings resulted in 38 features that can help higher education institutions, learners, and providers understand what kind of features are emphasized in micro-credential platforms and how they can be helpful for different use purposes. As practical implications, the findings of this study can help higher education institutions in considering adoption and usage of micro-credential platform.

1 INTRODUCTION

As the need for upskilling and reskilling gains importance, micro-credentials are becoming instrumental in the discourse of employability in 21st century (Wheelahan and Moodie, 2021). Accordingly, one of the top priorities of the European higher commission is that governments should aim for a paradigm-shift on skills and lifelong learning to drive Europe's competitiveness and innovation (European Commission, 2020). Micro-credentials are positioned within this paradigm shift and can be defined as "a qualification evidencing learning outcomes acquired through a short, transparently-assessed course or module" (European Commission, 2020).

Micro-credentials, as described by the European Commission, include digital proofs of the short and assessed learning opportunities such as course or module. These proofs are currently discussed as digital credentials which can include evidence of the skills and competences acquired through the learning opportunities. These digital credentials can relate to both formal and non-formal learning. In higher education institutions the learning opportunities range from short (micro) tor long (macro), and digital credentials can be awarded to any of these learning opportunities. Hence, the term "micro-credentials" has multiple meanings related to the short learning opportunities and the proofs. Accordingly, when discussing digital proofs, we are specifically referring to digital credentials in the remainder of the paper.

A supporting ecosystem for micro-credentials consists of the following: (a) an issuing organization such as an educational institution; (b) learners receiving them, (c) a verifying organization, such as another educational institution (Oliver, 2019) and (d) a micro-credential platform to issue the ensuing digital credentials. Many micro-credential platforms have emerged over the past years (Dimitrijevic, et al., 2016) and their numbers are growing still. Higher education institutions are progressively adopting micro-credentials and are establishing micro-credentials initiatives for them (Resei, et al., 2019). There are at least two large initiatives occurring in Europe that involve digital credentials. The European Digital Credentials for Learning (EDCL) programme offers higher education institutions an infrastructure (or components) that can be used to manage digital credentials. These are digital statements issued by an

Kiiskilä, P., Hanafy, A. and Pirkkalainen, H.
Features of Micro-credential Platforms in Higher Education.
DOI: 10.5220/0011030600003182
In *Proceedings of the 14th International Conference on Computer Supported Education (CSEDU 2022) - Volume 1*, pages 81-91
ISBN: 978-989-758-562-3; ISSN: 2184-5026

organization to a learner, documenting their learning (EDCL, 2021). This includes digital credentials for individual learning offerings, such as degrees, and diplomas awarded by educational institutions. The second initiative is the European Blockchain Services Infrastructure (EBSI) whose vision is "to leverage blockchain to the creation of cross-border services for public administrations and their ecosystems to verify information and make services trustworthy" (EBSI, 2021). This initiative includes higher education systems issuing digital credentials that are tamper-proof and verifiable by other educational institutions.

The adoption of micro-credential platforms could potentially support the unbundling of higher education degree programs to address the four issues: changing demographics, increasing the number of opportunities for learners (Hope, 2018), countering the decrease in popularity of academic degrees (Ehlers, 2018) and providing learners with an effective form of recognition for their skills and competences (Hall-Ellis, 2016). Micro-credential platforms play a pivotal role in facilitating the issuing, managing, and storing of digital credentials and the transfer of data between different stakeholders of the ecosystem (Araújo, et al., 2017).

Although there are many micro-credential platforms available, there is a lack of research about how they operate and what they offer for higher education institutions and their learners (Young, et al., 2019). Accordingly, these institutions need a comprehensive overview of these platforms to enable informed decisions about which one to adopt. The aim of this paper is to fill that research gap.

To address this issue, we asked the following research questions: "*What are the features of micro-credential platforms and how are they helpful for higher education institutions and learners?"* This paper presents a qualitative study based on conducting semi-structured interviews and group discussions with micro-credential platform providers and educational experts. The data were collected in the context of European Consortium of Innovative Universities (ECIU) project. The ECIU University is an initiative to establish a challenge-based European university where learners can earn micro-credentials from successfully taking part in real-life challenges and learning offerings. One of the main objectives of the project is to adopt a suitable platform for managing and issuing micro-credentials.

As a key contribution, we identify 38 micro-credential platform features in 12 categories that can help higher education institutions, learners and providers understand the types of features that are emphasized in micro-credential platforms and how they can be helpful for different use purposes.

The remainder of the article is structured as follows. Section 2 presents the theoretical background related to micro-credentials and platforms issuing them. Section 3 provides a description of the research methodology and the findings on the features of micro-credential platforms are presented in section 4. Finally, section 5 presents a discussion on how higher education institutions and learners can benefit from micro-credential platforms, followed by the contributions, limitations, and future research topics.

2 MICRO-CREDENTIALS

2.1 Overview of Micro-credentials

Micro-credentials have been the subject of broad and current interest in higher education over the course of the last decade (Kilsby & Fountain, 2019). Moreover, many higher education institutions around the world are experimenting with micro-credentials and are establishing micro-credentialing programs (Milligan & Kennedy, 2017). One major issue that arises when establishing these programs is the confusion and lack of common understanding around the concept of micro-credentials (Rossiter & Tynan, 2019).

As described by the European Commission micro-credentials can be seen as a combination of the following: (a) short learning experiences (i.e., micro learning opportunities) and (b) digital credentials issued for the short learning experiences that highlight the skills and competences acquired. Based on this perspective, digital credentials are considered as the certified skills, competences and achievements that prove that learners completed the necessary activities and met the required. In this paper, we focus on 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 credentials irrespective of whether they relate to learning opportunities that are short (micro) or long (macro).

According to one study (Fong et.al., 2016), micro-credentials initiatives have almost doubled between 2016 and 2017. Further, three in every four higher education institutions regard micro-credentials as strategically important for their future (Fong, et al., 2016). Higher education institutions have realized that employers need to know the specific skills and competences that a potential employee possesses (Hope, 2018). While traditional degrees, certificates,

and transcripts fail to convey this information, micro-credentials render this possible and manageable.

The diversity of learners' demographical composition and needs, in addition to the rise of non-traditional learners makes it nearly impossible for higher education institutions to adopt one model that fits all learners (Soares, 2013). For example, some learners prefer to take part in competence-based courses where they acquire very specific skills that are recognized, as opposed to traditional degrees. Further, some learners might prefer to obtain a traditional degree while others might prefer to attend university part-time. This is why higher education institutions need to have different offerings for different learners (Beilby, 2018). Micro-credentials increase the opportunities available for learners and provide increased flexibility within education (Bradley, et al., 2018; Hope, 2018). In particular, they provide learners the flexibility to individualize their experience and learn at their own pace (Crow, 2016).

Digital credentials facilitate the unbundling of higher education by providing an efficient alternative to traditional credentials (Ehlers, 2018). By awarding learners with digital credentials that specifically describe the skills, competences, and achievements they acquired using relevant metadata, higher education institutions can empower learners to demonstrate their abilities effectively to potential employers. (Hope, 2018).

Driven by digitalization and the need for faster and more secure ways of sharing credentials, the European Commission is co-creating infrastructures that will allow institutions to issue digital, tamper-proof credentials. These include diplomas, proofs from both formal and non-formal education, and certificates of participation. As mentioned previously, the EDCL and EBSI represent some of the latest examples of such new major initiatives to enable large-scale adoption of digital credentials. As the demand to issue digital credentials increases, it will be imperative for higher education institutions to take a much closer look at the available platforms and their features to make informed decisions on their adoption.

2.2 Features of Micro-credential Platforms

Over the last few years, multiple micro-credential platforms have surfaced. Further, their number and the variety of features offered are constantly increasing. However, the literature regarding the platforms is limited and many of the insights related to them only exist only in white papers, and blogs.

Table1 presents a compiled list of features from the current literature. The list includes platforms that can issue badges related to non-formal or extracurricular learning as well as platforms that can associate with formal learning, such as the European Credit Transfer and Accumulation System (ECTS) bearing courses from accredited study programs or institutions. The platforms discussed in the literature vary in both the number and depth of features.

Table 1: Features of micro-credential platforms in the literature.

Features	Author
Create templates for credentials	(AK Rottmann, 2021)
Visual development of badges	(Casilli, 2013)
Support standard frameworks	(Rehak & Hickey, 2013)
Search and view existing micro-credentials	(Devedzic & Jovanovic, 2015; Goligoski, 2012)
Register to available learning offerings	(SCLDA, 2014)
Integrity verification	(Grant, 2016)
Store and manage micro-credentials	(Glover, 2013)
Importing micro-credentials from other platforms	(Dimitrevic et.al, 2016)
Interactive visualization of micro-credentials	(Charleer et.al, 2013)
Validating micro-credentials	(Hickey & Otto, 2017)
Assessment (both automatic and expert)	(Carey and Stefaniak, 2018; Grant 2016))
Peer awarded credentials	(O'Connor, 2013)

Common features discussed in the literature include creating, storing, and managing digital credentials. Some platforms offer search functionality in addition to the ability to view all the credentials learners accrue (Devedzic & Jovanovic, 2015; Glover and Latif, 2013). In addition, some platforms offer extensions to these features, including the ability to customize credentials, support standard frameworks (Openbadges), and import credentials from other platforms. In the future, they might expand to offer recommendations of relevant study offerings and courses to students (Dimitrevic et.al, 2016; Rehak&Hickey, 2013; Rottmann, 2021)

Features for validating micro-credentials (by a trusted source) and integrity verification are also discussed in the literature. The concept of integrity verification is to ensure that the content of credentials is not tampered with in any way. The literature also highlights types of features that are conceptually new and have not yet been implemented and/or validated, such as badges awarded by peers and built-in assessment tools for the autonomous assessment of competences (Carey & Stefaniak, 2018; Grant, 2016; O'Connor, 2013).

Overall, the literature on digital credentials relies heavily on insights from non-formal settings, such as the use of badges to recognize extra curricula activities. However, literature on the different forms of digital credentialing for formal learning settings, such as recognizing proofs systematically from accredited study programs or institutions is largely missing.

3 RESEARCH METHOD

We sought to understand the features of micro-credential platforms by analyzing the platforms in detail. This was accomplished using walkthroughs of the solutions and by understanding their use through interviews with platform providers and educational experts. The data for this study were collected in the context of ECIU university which is an EU-funded project comprising of 12 European higher education institutions. One of the main objectives of the ECIU university initiative is to develop new ways of issuing micro-credentials to learners partaking in learning offerings from partner universities.

Literature and online searches were done to identify relevant platforms to be included in the study. Ten platforms were reviewed (eight based in Europe and two in the United States), and representatives of each company were interviewed either individually or in groups. The 10 studied platforms were EDCL (formerly Europass), Credentify, BadgeCollect, Digitary, VerifiEd, DiploMe, Accredible, BC Diploma, LinkedIn Learning and, Gataca. Additionally, the researchers took part in the EBSI early adopter program to examine its capabilities for managing digital credentials for learning.

Data were collected using semi-structured interviews and focus group discussions. Two key stakeholder groups were addressed for the research: (1) individuals with high expertise in micro-credentials and (2) micro-credential platform providers. The respondents were identified by using the snowballing sampling technique where initial respondents help to identify future study subjects from their acquaintances or based on their personal knowledge (Secor, 2010). Overall, 19 respondents took part in a total of 13 interviews, and 3 focus group discussions. Each of the three group discussions involved platform providers (two from Europe and one from the United Kingdom). One of the group discussions had two platform representatives and the other two group discussions had three representatives. Of the interviews, eight interviews were with platform providers and five were with digital credential experts. One platform provider and one expert were interviewed twice (and counted as separate interviews) to clarify and deepen some of the views regarding the features and the way they are used. Three of the experts interviewed were university lecturers from Europe and one was a primary consultant on micro-credentials from an education innovation consultancy firm in Australia. Most of the platform provider interviews were with the founders, account executives and chief operating officers. The interviews were mainly conducted online using Zoom and lasted between 41 and 122 minutes. The interviews and group discussions were all recorded and transcribed.

The first step of the analysis was to pinpoint the features of micro-credential platforms, followed by identifying any conceptual similarities between the features to categorize them. The next step was to name these categories and compare them with the literature. The findings of these three steps are discussed in Chapter 4. The final step was to identify how these features could be useful to both higher education institutions and learners. Here, we especially focused on the purposes for which the micro-credentials platforms were used and collected experts' insights on the benefits of using them.

4 FINDINGS

Our investigation of features offered by micro-credential platforms resulted in 12 categories and 38 features (Tables 2a and 2b). We acknowledge that all the platforms are evolving, each supporting an increasing number of features. This is why the aim of our analysis was to present a comprehensive overview of which features that are essential for micro-credential platforms, instead of simply indicating the features that are currently supported by specific platforms. Intrinsically, the results pinpoint the features that platforms offer for both the institutions and learners.

The micro-credential platforms and features offered differ depending on the target audience. Three main stakeholder groups were identified: issuing organizations, learners who receive the credentials and recognizers who verify the credentials (such as employers or other institutions). The research findings are divided into two sections. In the first (Table 2a), basic features such as user interface, types of digital credentials, and portfolio management are presented. The following section (Table 2b) refers to advanced features such as learning pathways, verification, and the validation of digital credentials.

User interfaces are the first and foremost feature offered to all users. Most platforms offer user interfaces designed for issuers, although learners and recognizers are allowed to view the digital credentials. Very few platforms (e.g., VerifiEd) offer user interfaces specifically for recognizers. While the interfaces are simple for learners, they can become complex for those platforms issuing digital credentials for formal learning. This is because of the proofs and assessments that are typically required to recognize formal learning activities in higher education.

The types of digital credentials issued depend on their purpose. All the platform providers realize the importance of digital credentials and how they add value to traditional degrees and diplomas. Digital credentials such as badges are used more for non-formal learning, to indicate a task that has been completed or an achievement. Within formal learning settings, they can also be used to indicate finishing a task or to identify a level that has been reached. Importantly, issuing a badge when a particular level is reached, or a skill is acquired would not require major changes to formal learning processes. Instead, it adds awareness and builds up work competences needed for the 21st century. E-certificates can be considered a simple change of medium (from paper to digital) when recognizing the completion of a course. It is also a common feature to allow issuers to customize the digital credentials, both visually and in terms of data included.

Viewing the digital credentials (including associated metadata) remains a crucial basic feature of any platform, especially for learners. Further, searchability of the credentials becomes especially critical as their number increases, such as when learners collect them from the majority of their studies.

All the platforms have more than one way of issuing the digital credentials. Even though issuing a credential to a single learner is possible as a manual feature on the web interface, more common ways of issuing seem to be semi-automatic, using tools such as Microsoft Excel to gather lists of learners to be issued the same credential. To issue credentials for larger groups, such as an entire class (bulk), the most common method is API integration into local systems (such as student management systems). This also includes automatic issuing at the end of learning periods to all students, in addition to automatic issuing when a request is received.

Portfolio management is a category that is still evolving. Moreover, although all the platforms offer a way of collecting digital credentials, only a few provide a way of importing them from other sources. Platforms are realizing that there is a greater need to provide different paths for organizing credentials and for visualizing the skills acquired while they were being earned.

The ability to share digital credentials on social media (especially on professional media such as LinkedIn) is offered by most of the platforms. Further, most platforms realize the value of being able to share credentials on social media and other formats (such as emails) for potential employers or educational institutions as proof of learning.

Visualizing the pathways is currently associated with bundled learning opportunities towards a larger credential and visually shows how these learning opportunities are connected. Bundled learning opportunities can be a group of learning offerings specific to a particular field or skill, and the pathway will show the order to complete the offerings to obtain larger credentials. These larger credentials might also include the badges or certificates from individual learning offerings within the bundle.

There are a wide range of proof types associated with digital credential, from simply adding viewable and searchable issuer-related data to adding formal learning related data. Most digital credentials can incorporate multiple types of proofs. Platforms that offer formal learning credentials include proofs of learning outcome related data, grading scheme data, and data regarding any standard frameworks used. Some platforms have started using competence frameworks such as European Skills, Competences, Qualifications and Occupations (ESCO) to support the addition of skills and competences into the digital credentials. Awards and achievements associated with a learning offering are captured and included by all the platforms. Moreover, allowing different types of proofs of learning to be submitted increases the credibility of the digital credentials, especially in higher education.

Table 2a: Basic features of digital credential platforms.

Category	Feature	Description	Emphasis by Platforms
User Interface	User interface for issuer	Interface for administrators and teachers	Supported by all the platforms
	User interface for earners	Interface for earners such as students in higher education	Supported by the majority of the platforms
	User interface for recognizers	Interface for recognizers such as institutions that verify credentials	Not supported by the majority of the platforms
"*The vision that we have for the future is that people can collect their certificates initially and then, we start to add in the metadata, and link them back to the courses that they have done.*" - *CEO*			
Types of Digital Credentials	Badges	Awarded for the completion of task or learning offering	Emphasized for non-formal learning
	E-certificates	Certificate of completion including diplomas	Emphasized for formal and non-formal learning
	Proofs with browsable data	Digital credential is text based and includes metadata	Only supported by a few platforms
	Custom digital credentials	Customize the content and look (AK Rottmann, 2021)	Supported by the majority of the platforms
	Peer awarded credentials	Awarded by Peers as part of the learning (O'connor, 2013)	Not supported by the majority of the platforms
View and search	Search function for learners	Search based on issuers (Devedzic & Jovanovic, 2015)	Supported by the majority of the platforms
	View metadata	View all the metadata associated with a credential	Supported by all platforms
	Custom display	Customizing how the digital credentials are displayed	Only supported by a few platforms
"Our platform can be used in two ways, we have a public version and a white label version for several institutes where we limit the search functionalities to the badges in their ecosystem" – Co-founder			
Issuing Digital credentials	Manually via web interfaces	Create and/or issue credentials for a single learner	
	Semi-automatic issue	Use tools to create list of users to issue digital credentials	Only supported by a few platforms
Bulk issuing	Automated awarding of digital credentials	Award digital credentials automatically when requested	Supported by the majority of the platforms
	Via API integrations	Issue digital credentials in bulk	Supported by all the platforms
Portfolio management	Collecting digital credentials	Portfolio of all earned digital credentials (Glover,2013)	Supported by the majority of the platforms
	Importing digital credentials	Importing from other sources (Dimitrevic et.al, 2016)	Only supported by a few platforms
	Organizing digital credentials	Organize by specific category (such as badges, diplomas)	Only supported by a few platforms
	Stackability	Ability to display collection of credentials for particular skills/field	Platforms understand the importance but don't have any concrete implementations yet.
"On the student's profile, they should see their basic data wallet and achievements, but we are still trying to understand what people should see and in what order and in what design" - COO			
Share digital credentials	Social media platforms	Share digital credentials on various social media platforms such as LinkedIn	Supported by the majority of the platforms
	With industry/institutions	Share digital credentials with potential employers and others	Supported by the majority of the platforms
"It is about being shared, secured and also as being rich in terms of data which enables cool things like job matching algorithms, predicted analytics when it comes to admissions and more streamlined admission flows" - ESO			

Table 2b: Advanced features of digital credential platforms.

Category	Feature	Description	Emphasis by Platforms
Pathways of Digital Credentials	Visualizing and documenting pathways for digital credentials	Collection of learning offerings that need to be completed to earn a larger degree or skill.	Only supported by a few platforms
"This is something everyone has been discussing that some credentials should be stackable and maybe build up to some sort of micro-degree depending on the objectives of the issuing institution"- COO			
Types of proofs attached with the digital credential	Issuer-related data	Allowing users to browse proof related to issuers	Supported by all platforms
	Skill-related data	Use standard frameworks as taxonomy for skills	Only supported by a few platforms
	Educational standards and frameworks	(e.g. EQF, NQF) (Rehak & Hickey, 2013)	Supported by the majority of the platforms
	Awards and achievements	Meta data specific to achievements and awards	Supported by all the platforms
	Learning outcome related data	Commonly associated with formal learning, includes skills learners will acquire	All the platforms associated with formal learning offer this feature.
	Formal learning related data	Commonly associated with formal learning, includes data such as ECTS and learning hours	All the platforms associated with formal learning offer this feature
	Grading scheme related data	Commonly associated with formal learning, includes data on scale applied to grades	All the platforms associated with formal learning offer this feature.
	Supplementary evidence of learning	Attaching appendices and supplementary evidence to the credential (Grant, 2014)	Supported by the majority of the platforms
	Support of learning assessment	Different versions of digital credentials for different levels of mastery	Only supported by a few platforms
	View metadata	View all the metadata associated with a digital credential	Supported by all the platforms
	Custom display	Customizing how the digital credentials are displayed	Only supported by a few platforms
"*Our platform is used by companies, consortiums and schools. So, we have a lot of different contexts and if we, prescribed one template for skills within our system, then it doesn't work for everyone" – Co-founder*			
Link with Learning offerings	Registration for learning offering	Search for learning offerings and register (SCLDA, 2014)	Only supported by a few platforms
Verification of authenticity	Blockchain	Use blockchain technology for authenticity of data	Emphasized by EBSI
	Electronic seal	An authenticator signature to ensure data origin and integrity	Emphasized by EDCL
"The fake degrees market is increasing and we have more and more false information. We need to check the authenticity of data and we need to find the best ways to share very valuable credentials, more easily" – Co-founder			
Validation features	Reviewing metadata	Review metadata digital credential submitted by the learner	Supported by all platforms
	Validating the digital credential	Validate the evidence of achieving the digital credential	Supported by majority of the platforms

Another feature that is gathering momentum (although still in its infancy) is a way of linking learning offerings from the platform based on various factors such as interests and learning offerings learners have completed. LinkedIn Learning seems to be offering something similar to this feature, although it is definitely not a common feature for most platforms.

One of the main features that every higher education institution pays special attention in a digital credentialing platform is verification method used to
make the credentials tamper-proof when they are about formal learning. Some platforms use blockchain technology for security authentication and data sharing. Although blockchain technology is recognized as an effective tool, platforms acknowledge a level of uncertainty due to its lack of widespread adoption. However, all the stakeholders admit there is a need for verification technology to ensure secure data transfer at all levels. Currently EDCL uses eSeal (electronic seal) as a security measure to verify the authenticity. Further, EBSI is working with different stakeholders (including higher education institutions) to use blockchain technology with standard data models such as EDCL for different types of digital credentials. The EBSI also enables verification of the digital credential and all involved stakeholders (i.e., the issuing organization and learner) seamlessly. Through EBSI, learners can create a "verifiable presentation" of any of the digital credentials to share. This verifiable presentation contains required proofs that can be signed with cryptographic keys to ensure the authenticity.

While the verification of digital credentials involves authenticating the credentials and the issuing organization (for example), the contents of the credentials should also be validated. This includes validating the evidence of achieving the digital credential. The EBSI model of viewer presentation specifically addresses this issue with standard data models and verification methods.

5 DISCUSSION AND CONCLUSION

This research focused on the features of micro-credential platforms that will benefit institutions as well as learners. Some of these features are recognized in the literature while others were drawn out from the interviews and group discussions held as part of this study. Based on the findings of this research, the aim of the next section is to answer the second research question pertaining to how the micro-credential platforms are helpful for both institutions and learners.

5.1 The Benefits of Micro-credential Platforms for Institutions and Learners

5.1.1 Institutional View

Micro-credential platforms help institutions in two key ways: (a) issuing digital credentials to learners and (b) verifying digital credentials issued by others. To issue digital credentials to learners, institutions might use websites or applications provided by the platform providers or they could integrate such applications into their IT infrastructure directly. They can issue the credentials for the following: (a) non-formal learning offerings such as extra-curricular activities (including hackathons), (b) formal learning offerings from study programs, which can also be credit bearing and count towards the formal degree program, and (c) diplomas related to the degree programs.

Different types of proofs can reside in different learning management systems, which need to be aggregated before attaching to the digital credential. Levels of proof depend on whether the learning offering is a non-formal or formal activity, such as recognizing ECTS or learning activities. Similar to the issuing of different types of credentials, platforms offer different ways of verifying credentials. However, this is not a common way of using digital credential platforms. The verification of credentials can be divided into two subtypes :(a) validating the issued credentials and, (b) verifying credentials issued by other institutions. Similar to the issuing of credentials, institutions might use platform websites or IT integration for verification and validation. The validation of the digital credentials could also include checking for proofs of learning and grading schemes.

Digital credentials can be applied to recognize both micro and macro learning offerings. By issuing digital credentials for all learning opportunities, institutions can provide a comprehensive view of skills and competences learnt for all students. When a digital credential is awarded for a longer program (such as a degree), it can contain a list of individual learning offerings and all the learning outcomes, skills, and competences associated with each of those learning offerings.

Issuing digital credentials will also help higher education institutions to unbundle and offer smaller group of offerings for larger credentials with a different focus such as field or skill specific. Unbundling also makes it easier for institutions to offer learning opportunities for "lifelong learners". These learners can be described as a learner who

might have enrolled full-time in an educational institution or are interested in upskilling or reskilling for other reasons (such as career path, change of career).

As more educational institutions start issuing digital credentials, it will make validating them easier and render the entire admission process more streamlined.

5.1.2 Learner View

Learners can currently use the platforms to (a) view and (b) share the digital credentials they received. They can use either the platform websites or the platforms' mobile apps to view these credentials. The learners view of credentials also includes information on the issuing organization, awards, and achievements from the learning offering. In the case of formal learning, the view might also include grading schemes, learning outcomes and assessment criteria. With digital credentials, learners can accumulate all the individual learning offerings and show proof of what they have learnt.

Using the platforms in this manner help learners in at least two key ways. First, by taking ownership of educational credentials. The platforms enable them to collect, store and choose the credentials to share. This means that learners can share them on social media and with others (such as potential employers and other institutions). This essentially follows the principles of self-sovereign identity (i.e., the main objective of EBSI) and the national and European agendas of digitalizing educational credentials. Second, the platforms enable learners to prove the skills and competences they possess. Such proofs are becoming increasingly more important in job searching and during upskilling and reskilling. Additionally, this will enable educational opportunities to be more open and portable from one institution to another. Here, the types of credentials and proofs are critical features for realizing this function. On some platforms, learners can view their progress towards a larger credential or bundled learning opportunity. The visualization of accumulated data (e.g., competences or learning activity data from earned digital credentials) and categorization become highly critical features.

The interoperability of the systems was raised as a critical factor, as learners are unlikely to be tied to one system only. The portability of digital credentials (e.g., through common data models) is a critical upcoming development for realizing the benefits, especially for learners.

5.2 Contributions of the Study

The findings of this study can add significant value to the literature in these early stages of studying digital credentials. The relevant literature often discusses the challenges and potential benefits of digital credential implementation in higher education (Barnett, 2017; Clayton, et al., 2014; Halavais, 2018). The research around digital credentials remain scarce, especially from the perspectives of platforms and features. Through expert interviews, group discussions, and interviews with platform providers, our study identified categories and features that address these gaps in the literature.

This study contributed to filling these research gaps through two key theoretical contributions. First, by categorizing the features of micro-credential platforms and proceeding further into understanding what platforms emphasize the features. Second, we also identified the categories and features that are not yet fully understood and developed.

The findings of this study can help higher education institutions gain a broader understanding of the digital credential platforms and the features offered today. Based on experts' views, the study also provides a list of features that align with formal learning offerings of higher education institutions. Based on these findings, these institutions can make informed decisions about which platforms to adopt, depending on how they align with their vision, operations, and stakeholders' perspectives.

This study can also help digital credential platforms to assess their own offerings and solutions based on the needs of higher education institutions. As elaborated in the institutional and learner views, the required proofs are highly dependent on the context of use (formal to non-formal) and use purposes. For instance, a learner may require in-depth proofs from specific modules or study programs to showcase to a potential employer. This is why it is critical to understand the expectations and upcoming use purposes of micro-credential platforms which might not be identifiable as initial requirements the institutions might raise for such platforms.

5.3 Research Limitation and Future Research

We acknowledge certain limitations to our study. First, we acknowledge that platforms other than those reviewed for the study might have emerged after the data were collected. Such potential platforms should be included in future research. Second, the features identified in the study might already have changed as

the platforms are continuously evolving and the study's findings need to be revisited in further research. Third, we used a relatively small sample size due to a lack of experts in digital credentials. Finding experts to participate in our study proved difficult, as most of the people contacted only had expertise in planning, designing, and managing study programs instead of the digital proofs and digital credential systems. With the major new initiatives such as the EDCL and the EBSI, awareness of digital credentials is likely to increase rapidly, and new expertise will emerge in the field. Fourth, the distribution of samples between providers and other experts is not even. This limitation relates strongly to the previous one and to the challenge of finding relevant experts for the study. Fifth, we did not account for the views of the end users, such as learners, administrators, and teachers. We chose to limit our sample to the providers and digital credential experts to gain an initial understanding of what these platforms have to offer. Further research should soon evaluate these platforms with end users, especially since major digital credential initiatives are emerging nationally and internationally. Despite these limitations, we consider this study to be relevant and valuable to both the research community and higher education institutions that are considering the adoption and use of digital credentials.

Based on the findings of this study, we suggest some areas that should be examined in the future. In general, more research is needed on micro-credential platforms from the higher education institution perspective to examine factors that enable or inhibits their adoption. Further research is also required to study some of the less developed features such as learning pathways, verification methods and how higher education institutions can adopt them in the future. In our study, experts also elaborated on features that do not yet exist. One of these is stackability of credentials and skills. The stackability of skill-related data refers to how skills and competences accrued in digital credentials over time can be represented in a meaningful way to help learner present a more complete picture of their skills and knowledge. Our investigation shows a need for further research on the ways of searching and presenting the credential information especially when the learners have multiple digital credentials with similar skills and competences. Finally, the insights from our findings show that the use of micro-credential platforms requires consideration of the technical, organizational, and even cultural aspects of higher education. Therefore, we encourage researchers to examine how institutions need to change to facilitate the adoption of digital credentials, such as invoking new administrative or technical roles to manage the digital credentials related to formal and non-formal learning opportunities.

ACKNOWLEDGEMENTS

This research was co-funded by ECIU University project (612521-EPP-1-2019-1-NL-EPPKA2-EURUNIV), European Universities funding and MicroBlock-project (2020-FI-IA-0096), CEF-TC-2020-1–Blockchain-funding.

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