

WIP: ECO CredGT Implementing Digital Credentials in Continuous Training for the Labour Market

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Abstract— This work-in-progress paper explores the integration of Digital Credentials in the context of engineering and STEAM education, offering insights into their evolving role within the future educational landscape. In a brief literature overview, current trends and legislative considerations relevant to Digital Credentials are highlighted, emphasizing their anticipated significance in shaping the educational environment. Digital Credentials, a manifestation of individuals' skills, achievements, and qualifications in electronic format, serve as verifiable and portable representations of educational accomplishments. Unlike traditional paper-based certificates, Digital Credentials harness the power of technology to encapsulate a comprehensive range of information, including specific skills, competencies, and the context in which they were acquired.

The focal point of this study is the practical experience of incorporating Digital Credentials into a Virtual Learning Environment. In a first experience 1496 digital diplomas were generated to certify four STEAM courses. Findings from the initial implementation within diverse engineering-focused continuous education programs are presented, shedding light on participant responses and the potential influence of Digital Credentials on motivation and engagement. This practical insight contributes to the ongoing discourse on innovative educational practices, showcasing the transformative potential of Digital Credentials.

Looking ahead, the paper advocates for the establishment of a common space or observatory dedicated to Digital Credentials in education. This call is rooted in the recognition of the need for ongoing dialogue and collaboration among educators, researchers, and policymakers to collectively navigate the evolving landscape of Digital Credentials and harness their potential in shaping the future of education.

Keywords— *Digital Credentials, STEAM Education, Educational Innovation*

I. INTRODUCTION

Recognition within the educational sphere [1] refers to the process of acknowledging student accomplishments and affirming the outcomes of their learning experiences. This recognition can be categorized as either formal or informal. Formal recognition typically involves the official certification of completed educational programs or the acquisition of specific skills and competencies, which are often prerequisites for advancing in academic pursuits or professional certifications. Such formal recognition is granted through diplomas,

certificates, and micro-credentials issued by recognized institutions. These official credentials serve as evidence that the learner has met established standards and are vital for validating qualifications to external stakeholders, including employers and academic institutions.

Conversely, informal recognition is more focused on encouraging and engaging students by acknowledging their efforts and progress in less formal ways. A widely adopted method of informal recognition includes the issuance of digital badges [2], which serve as a symbol of achievement and motivation.

Digital Credentials have emerged as a transformative tool with the potential to reshape education. Their characteristics—granularity, portability, validity, international recognition, authenticity, and cost-effectiveness—contribute to a more adaptive and responsive educational system, aligning with the evolving needs of learners and the demands of a dynamic job market. This work-in-progress paper explores the practical aspects of designing, implementing, and assessing the impact of Digital Credentials within the context of continuous engineering education.

Globally, many countries have begun integrating digital credentials at various levels of higher education. For instance, European nations have designed digital platforms for issuing and verifying undergraduate and postgraduate degrees. These initiatives reflect a global shift towards digitalization in education and underscore the potential of digital credentials to enhance cross-border educational mobility and recognition.

The theoretical foundations of digital credentials are examined through a literature review that discusses their influence on engineering education. This review highlights the transformation of learning paradigms to better align with the dynamic needs of the workplace. Key design considerations, such as security, interoperability, and maintaining academic rigor, are vital to emphasize the practical implications of implementing digital credential systems.

The relevance of digital credentials in engineering-focused continuing education is explored, with a focus on how digital credentials may help engineers stay updated with technological advancements. This emphasis highlights the unique benefits of digital credentials in enabling engineers to continuously update their skills and knowledge, essential for maintaining competitiveness in their field.

II. LITERATURE REVIEW ON DIGITAL CREDENTIALS

The rise of digital credentials in both higher education and vocational training can be attributed, in part, to the broader evolution of the education sector, which increasingly emphasizes the delivery of high-quality vocational education. This shift has been driven by new demands and standards, as well as the changing needs of both learners and employers in educational and professional settings. These factors have spurred technological advancements, the creation of more flexible learning pathways, and the establishment of alternative learning environments.

Within this context, digital credentials have emerged as a viable solution to the limitations of traditional, paper-based certificates, gradually gaining recognition in the early 21st century as a modern alternative [3]. Initially, digital credentials gained traction primarily within informal learning communities and online educational platforms, where they served as tools for recognizing the completion of tasks, courses, or specific learning achievements.

In recent years, however, their role has expanded significantly. Institutions of higher education have started to acknowledge the value of digital credentials as complementary tools to traditional degrees and certificates [4]. By facilitating the recognition of smaller units of learning, digital credentials empower learners to acquire targeted skills that directly enhance their employability and support career progression. This shift has also made digital credentials increasingly relevant in vocational training programs, where the focus is often on developing specialized skills essential for adapting to rapidly evolving work environments and addressing the dynamic needs of the global labor market. The integration of digital credentials in these settings underscores their potential to bridge the gap between educational outcomes and labor market requirements, providing a more agile and responsive credentialing system.

Digital credentials have recently gained prominence in the educational and vocational training sectors, representing a relatively new development in these fields. Although digital badges first emerged within the online gaming community in the mid-2000s, their application in micro-credentialing and digital badging within educational contexts remained limited until the early 2010s [5]. This shift in focus reflects a growing recognition of the potential these credentials hold within formal education settings, as institutions and educators seek to leverage their benefits.

The advantages of digital credentials extend far beyond simply motivating learners to engage in educational activities. They also promote a sense of community engagement and interaction. Numerous studies have demonstrated that the online sharing of badges and micro-credentials not only encourages learners but also provides a platform for instructors and educators to interact with a broader community of learners. This dynamic exchange fosters a more collaborative and interactive learning environment. Furthermore, digital badges contribute to the standardization of credentialing criteria and curricula, helping to create a cohesive instructional community that supports consistent educational outcomes across different learning platforms and institutions [6-7].

The integration of digital credentials into both educational and vocational settings signifies a substantial shift towards aligning education systems with the needs of contemporary learners and the demands of an evolving job market. By offering more flexible, scalable, and accessible forms of recognition, digital credentials are instrumental in the ongoing transformation of education. They contribute to the creation of a more adaptable, inclusive, and effective learning environment that is better equipped to meet the challenges of a rapidly changing world.

III. EXPLORATION ON DIGITAL CREDENTIALS

When addressing the complexities and common confusions surrounding the terminology in the field of credentials, it is crucial to provide precise definitions for "credentials" and related concepts. In both academic and professional literature, the term "credential" is frequently associated with certification documents that validate an individual's qualifications. However, the term is also employed to describe mechanisms for storing and transporting credentials, such as digital wallets and credentialing platforms. A 2022 report by the American Association of Collegiate Registrars and Admissions Officers (AACRAO) [8] highlights that terms like: "micro-credentials" and "micro-credential programs" are often used interchangeably, despite representing distinct concepts: the former refers to specific competencies or skills, while the latter pertains to the structured programs designed to impart these competencies. Experiences in [9-10] present the approach of Micro-credentials in the form of "MicroMasters" for the edX platform in the modality of Massive Open Online Courses (MOOCs) as a full-path programs involving more than two courses.

In the context of higher education, "credentials" typically refer to documents that certify the attainment of a significant level of knowledge or skill, authenticated by a recognized third party [8]. These documents, whether in electronic or paper format, often take the form of transcripts [11] and encompass a wide range of learning outcomes achieved by the individual [12].

The concept of "alternative credentials" has gained prominence, particularly in the United States, although it remains without a universally accepted definition. As articulated in [13], "alternative" implies a deviation from traditional credentials awarded in higher education, such as bachelor's, master's, and doctoral degrees. Researchers categorize "alternative credentials" as those that are not recognized as formal educational qualifications by national education authorities. This category includes certificates, digital badges, and micro-credentials, each of which serves distinct purposes and offers unique opportunities for learners.

Furthermore, alternative credentials encompass a broad spectrum of learning activities, emphasizing the attainment of skills and competencies crucial for lifelong learning and professional upskilling [14]. This adaptability makes alternative credentials increasingly relevant not only within academic realms but also in vocational training, where they enhance employability and meet contemporary job market demands [15].

IV. EXPERIENCE DESCRIPTION

Digital credentials are electronic representations of achievements, skills, and competencies, typically managed and shared in digital formats. The electronic nature of these credentials allows for efficient storage, transmission, and utilization across various platforms, enhancing their accessibility and portability [16-17]. This format facilitates easier sharing by individuals, making digital credentials an integral part of modern educational and professional ecosystems.

The security of digital credentials is crucial for maintaining their reliability and authenticity. Technologies such as blockchain, cryptography, and digital signatures are commonly employed to safeguard these credentials. These technologies ensure that digital credentials are secure and tamper-evident, thereby enhancing trust in their validity [17].

One significant advantage of digital credentials is their portability. They can be easily transported and recognized across different systems and platforms. This is supported by standards such as the Open Badges specification, which provides a framework for representing and transmitting digital credentials. This framework ensures compatibility and interoperability within diverse credentialing ecosystems, promoting a seamless exchange of credentials across borders and institutions [18].

In the Latin America and Caribbean (LAC) region, the Inter-American Development Bank has introduced a Digital Credential Framework that outlines principles and guidelines for creating and issuing credentials. This framework extends beyond traditional academic recognition, embracing a broader application of digital credentials to include professional and vocational achievements [19].

Verifiable credentials represent another layer of digital credentialing. These are digital representations that are issued, stored, and transmitted electronically, with the key feature being their verifiability. "Verifiable" refers to the ability of the credential to be confirmed by a verifier, though it does not automatically imply that the accuracy of the claims encoded can be assessed and evaluated. The integration of technologies like digital signatures enhances the tamper-evident nature and trustworthiness of these credentials, making them as reliable as, if not more so than, their physical counterparts [20].

Overall, digital credentials are transforming the way credentials are issued and recognized, offering a flexible, secure, and efficient alternative to traditional methods. This evolution supports a more dynamic and accessible framework for recognizing professional and academic achievement in the digital age.

Considering the initial literature review, in this work-in-progress a system was implemented for the issuance of digital diplomas using Open Badges 3.0 [18] and openPGP library, specifically version 4.10.8. The process involved creating an unencrypted PDF for each diploma and using a unique public and private key pair to encrypt and digitally sign the document. This setup ensures that each diploma has a unique key, allowing for future decryption or validation if necessary.

The public key used for encrypting the PDFs is uniquely generated with openPGP. A user-friendly interface was developed to facilitate the large-scale generation of diplomas. This interface also supports the distribution of diplomas via email, which includes a link to a webpage where the validity of the diplomas can be verified. This system streamlines the administrative process and enhances the security and credibility of the credentials issued.

The practical application of this digital credentialing system was tested through four courses, covering diverse topics such as "Biosecurity and Protective Equipment for COVID-19 Prevention," "Biological Risk and Biosecurity in the Workplace," "Energy Efficiency in Micro and Small Enterprises," and "Modern Teaching Techniques for the 21st Century Educator." Each course diploma was meticulously prepared with associated metadata, including the number of hours spent and competencies acquired, to provide a comprehensive record of the learner's achievements. These courses leveraged prior experience in course preparation in Latin America, particularly focusing on enhancing students' skills for employment, as highlighted in relevant studies [21-22]. The course preparation process was further supported by the integration of artificial intelligence tools, which played a crucial role in the design, production, and pedagogical decision-making for these massive open online courses (MOOCs) [23]. Additionally, the educators involved in the production process provided valuable insights into their perceptions of using AI tools [24], shedding light on both the advantages and challenges encountered in this innovative approach to course development. This integration of technology and education not only streamlined the course creation process but also enhanced the overall quality and effectiveness of the courses delivered.

The results of this initial implementation were promising, with a total of 1,496 digital diplomas issued to date. This not only demonstrates the feasibility and efficiency of the digital credentialing system but also highlights its potential scalability and impact on educational certification processes. The positive reception and functionality suggest a strong foundation for future expansions of digital credentialing initiatives.

In light of the initial implementation of digital credentials, several research questions can be articulated to guide further study in this area. The first question, RQ1, asks: "How do digital credentials impact employability and career progression across different sectors?" This explores the practical benefits and potential enhancements that digital credentials provide to individuals in the workforce. Another pivotal question, RQ2, seeks to understand: "What are the perceptions of employers and educational institutions regarding the validity and reliability of digital credentials as compared to traditional paper-based certifications?"

Further investigation is warranted to explore the technological underpinnings and acceptance of digital credentials. RQ3 examines: "How do the security technologies used in digital credentials, such as blockchain and digital signatures, influence their trustworthiness and acceptance in professional and academic settings?" Additionally, RQ4 addresses the operational challenges, asking: "What are the primary challenges and limitations encountered by educational

institutions when integrating digital credential systems, and what strategies can be employed to enhance their scalability and interoperability?" These research questions aim to delve deeper into the dynamics of digital credentialing systems and their broader implications in educational and professional landscapes.

As a future work to explore on the aforementioned questions, this work-in-progress presents an initiative with the aim to build capacities in Vocational Education and Training (VET) institutions to create an ecosystem of Digital Credentials, designed to enhance employability. This ecosystem is anticipated to lay a strong foundation for the future issuance of Digital Credentials for undergraduate and graduate degrees within a validated framework. The capacity building efforts within this project are crucial for establishing a sustainable and recognized digital credential system.

The project's specific objectives include enhancing the digital transformation capabilities of VET institutions, establishing a model digital credential issuing center that can be replicated across other VET institutions, and conducting pilot projects for vocational and professional micro-courses aimed at boosting employability.

In the short term, the initiative seeks to bolster employability by promoting the effective use of Digital Credentials and assessing the perceptions of recruiting agencies and human resources specialists regarding these credentials. This effort includes creating an observatory of digital credential issuing centers to foster a community that shares best practices, success stories, and training resources.

V. FINDINGS AND DISCUSSION

Preliminary findings from the implementation of digital credentials in engineering and STEAM education reveal several key insights. First, the adoption of digital credentials has significantly increased accessibility and flexibility for learners. Participants in the study from the 1496 generated digital diplomas reported an enhanced ability to manage their learning pathways and credentials effectively, using digital platforms that streamline the process of acquiring, storing, and sharing their achievements. This has been particularly beneficial for continuous education participants, who often balance professional responsibilities with educational pursuits, demonstrating the practical utility of digital credentials in accommodating diverse learning schedules and career needs.

Secondly, the introduction of blockchain technology and digital signatures will improve in the future the security and authenticity of digital credentials. These technologies will provide a robust framework for verifying the integrity and origin of credentials, thereby increasing trust among employers and other educational institutions. The reliability of digital credentials has encouraged more institutions to consider their broader adoption, pointing towards a growing acceptance within the academic and professional landscapes.

In terms of learner engagement and motivation, the study indicates that digital credentials have a positive impact. Learners expressed a high level of satisfaction with the granularity and specificity of digital credentials, which allow them to showcase particular skills and competencies to potential employers. This specificity not only enhances employability but also motivates

learners to engage in further educational activities to accumulate credentials that are valued in the job market. This finding underscores the potential of digital credentials to foster a culture of lifelong learning and continuous professional development.

However, the findings also highlight some challenges in the implementation of digital credentials, such as the need for greater interoperability between different credentialing platforms and systems. As an example, it is evident the existence of difficulties in transferring credentials between platforms, which can hinder their universal recognition and value. Addressing these interoperability issues is critical for ensuring that digital credentials achieve their full potential in facilitating seamless educational and professional transitions for learners across various sectors.

VI. CONCLUSION

The integration of digital credentials into engineering and STEAM education represents a significant shift towards a more adaptable, responsive, and learner-centric educational framework. This study has highlighted the many benefits of digital credentials, including enhanced accessibility, flexibility, and the ability to provide secure, verifiable records of learning. By facilitating easier management and sharing of achievements, digital credentials empower learners to tailor their educational pathways to meet specific career goals and industry demands. Furthermore, the adoption of technologies such as blockchain will ensure the authenticity and security of these credentials, increasing their acceptance and value in the professional world.

Despite the promising advantages, the implementation of digital credentials also presents challenges. The issues of interoperability and universal acceptance remain significant hurdles that require ongoing attention. The study revealed that while digital credentials are gaining traction, there is a critical need for standardized frameworks that can support widespread adoption and facilitate seamless transfers between different systems and platforms. Addressing these challenges is essential for realizing the full potential of digital credentials in transforming educational and professional landscapes.

Looking forward, this work-in-progress suggests the establishment of a dedicated observatory or forum for digital credentials, the name of the observatory will be ECOcredGT. This entity would focus on fostering collaboration among educators, technology providers, industry stakeholders, and policymakers.

In conclusion, digital credentials are poised to play a pivotal role in the future of education, particularly in fields that demand continual learning and adaptation. Future research should continue to explore these themes, focusing on longitudinal impacts of digital credentials on engineering educational outcomes and career progression, thereby providing deeper insights into their long-term value and effectiveness.

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