

Implementing European Digital Credentials in Non-Formal Education: A Prototype for the Digital Learning Campus

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Keywords: European Digital Credentials, Europass, Digital Learning Campus, Non-Formal Education, Moodle Badges, Open Educational Resources, Micro-Credentials, European Learning Model, Educational Technology.

Abstract: The Digital Learning Campus (DLC) provides an innovative educational environment that combines digital and physical learning opportunities. This paper presents a prototype for issuing European Digital Credentials (EDC) within the DLC framework, aligning with the Europass system to enhance the recognition of non-formal learning. The study explores the integration of Moodle Badges with EDCI standards, focusing on overcoming technical and organizational challenges. The implementation leverages Moodle's native badge functionalities and extends them with additional metadata to meet the European Learning Model (ELM) requirements. Findings indicate that the developed solution can securely issue digital credentials, ensuring their interoperability and recognition across Europe. Future work aims to refine the integration, improve user experience, and expand the scope of recognized competencies. This research contributes to the ongoing efforts of creating a robust digital credentialing ecosystem that supports lifelong learning and professional development.


1 INTRODUCTION


In the modern educational landscape, the digital certification of competencies and qualifications is playing an increasingly important role. The Europass Wallet provides a platform to securely store and manage educational credentials (Rentzsch, 2021).

Buchem (2024) discusses the possibilities offered by the digital development of micro-credentials, badges and data wallets as the future of recognition. This thesis presents a further digital development, which can advance the proof of non-formally acquired competences.

The Digital Learning Campus (DLC) offers an open learning opportunity for all citizens and is not a formal education or training institution. Learning thus takes place in the non-formal sector outside the main education and training systems. Nevertheless, some courses are organized in such a way that they can be very close to the formal system, although the scope of education of a course of study, for example, will not be covered in one offer.

Bliesmer & Komorek (2022, p. 493) describe learning processes as non-formal learning that have been deliberately developed in structured arrangements where educational offers such as experiments, exhibits, excursions, etc. have been deliberately developed in order to trigger learning processes in users. However, we assume that stimulating the learning process in non-formal learning cannot be evaluated by examinations and therefore cannot be certified. Especially in the context of Open Educational Resources, the allocation of micro-credentials for recognition of non-formal learning has emerged. Tillmann et al. (2019) confirm the issuance of certificates for non-formal learning in the form of badges for learning activities completed online but describe non-formal learning as learning embedded in planned activities that are not explicitly referred to as learning. According to the Commission of the European Communities (2000), non-formal learning takes place outside the main education and training systems and does not necessarily lead to the acquisition of a formal qualification. Organizations or services set up to complement formal systems can act

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as a place of non-formal learning. The DLC should be understood as such a place.

The aim is to create a solution that makes it possible to issue digital certificates for non-formal educational offerings that meet the standards of the European Commission and are thus recognized throughout Europe. These digital credentials provide a flexible way to granularly document and validate acquired skills, which is particularly beneficial for lifelong learning and professional development.

The motivation here is to offer added value for the educational offerings in the Digital Learning Campus and comparable training providers that goes beyond the added value for personal education. Graduation should be recognized wherever competencies are a decision-making criterion. Be it with employers, team compositions, training measures and the like.

The European Commission has created an infrastructure. It includes Europass and electronic seals, which serve as the digital equivalent of institutional stamps. According to Griffiths et al. (2024), there is no direct way to store badges as mentioned by Tillmann et al. (2019) in the Europass Wallet, but there are developments that could enable future integration. The European Digital Credential Infrastructure could create a basis for the automatic transfer of badges to the Europass system (Griffiths et al., 2024). A prototype for this is presented in this paper.

2 BACKGROUND AND FRAMEWORK

2.1 Digital Learning Campus

The Digital Learning Campus offers an innovative educational environment in Schleswig-Holstein in Germany that combines both digital and physical learning opportunities. The digital learning and collaboration platform allows users to create personal profiles and access a wide range of educational offerings. This is complemented by a network of physical learning venues at different university locations, which are connected via the platform, thus promoting exchange and collaboration between learners.

Particular attention is paid to interdisciplinary cooperation with partners from business, science and society. The aim is to provide participants with practical and application-oriented learning content that is taught both in self-directed online courses and in practical face-to-face events (Filik, 2024).

A central feature of the Digital Learning Campus is also its accessibility and free use, which enables broad participation in educational offerings.

2.1.1 Offer and Target Group

The educational offerings of the Digital Learning Campus include both online courses and face-to-face events that are specifically designed to teach future skills. These offers are aimed at various target groups, including students, professionals, companies, job seekers and simply educated citizens who want to expand their skills or prepare for the requirements of a constantly changing labor market.

2.1.2 Offering

The events at the Digital Learning Campus in Schleswig-Holstein are carried out by a large number of providers who include different educational and cultural institutions. Universities, universities of applied sciences and regional learning venue networks are actively involved in the design of the programs.

In addition, media institutions are involved in the teaching of digital skills. Foundations and non-governmental organizations as well as technical institutions also expand the range of topics offered. Freelance trainers are also trained and can generate offers.

2.1.3 Structure

A digital platform serves as a central point of contact for networking providers and learners. Those responsible for learning regions and learning zones of the physical learning locations have a content management system available for administration. Offers are realized via the specification of metadata on the platform. The DLC's online courses are created and delivered in a seamlessly linked Moodle instance (Moodle, n.d.), but are linked to the platform via the metadata. In addition to the course or event title, location, time, the metadata for each offer also includes information on the future skills from the Framework "Future Skills 2021" (Stifterverband für die Deutsche Wissenschaft e.V., 2021) to be taught, the level of learning objectives, and the learning objectives and scope of learning can be specified. It also records whether an offer offers a certificate or not.

2.2 Digital Certificates and Micro-Credentials

According to Griffiths et al. (2024), micro-credentials offer a flexible and targeted way to recognize

knowledge and skills. They are important for both formal education and professional development. According to the European Commission, micro-credentials are not intended to replace traditional degrees, but to complement them. However, their integration into open educational resources requires significant investment in defining learning objectives and assessment mechanisms. Experts emphasize that the success of these digital certificates depends largely on the quality of the assessment processes, as many open educational offers do not include their own assessment materials.

2.2.1 Moodles Role

Moodle plays an important role in the delivery of online learning opportunities and is often used for Massive Open Online Courses that can issue certificates. However, there are only a few examples in which Moodle repositories directly issue certificates for the use of open educational resources. Universities often use Moodle as part of their micro-credential strategies, relying on content from open educational resources.

2.2.2 Electronic Signatures

The implementation of open credentials brings various challenges. Technologically, there is often a lack of capacity to use existing digital certificates efficiently, even though technical solutions are available. Standards for electronic signatures play a central role in building trust. Organizational challenges are separating instructional content and assessments, as open educational content is available free of charge, while assessments involve financial outlays. Institutions are faced with the task of developing business models to make valuations economically viable. In addition, financial challenges must be overcome, as open education initiatives and their certification require sustained government support. A sensible financing mix of state subsidies, institutional contributions and fees from learners is necessary.

2.2.3 Combinability of Micro-Credentials

An important aspect for the further development of micro-credentials is their combinability to incorporate them into larger academic or professional qualifications. This requires standardized qualifications frameworks, which are supported in Europe by the European Qualifications Framework. Pilot projects show that such combinations are

possible, but administrative and organizational hurdles still need to be overcome.

2.2.4 Trust and Acceptance

Trust in digital certificates can be strengthened through transparent assessment processes and digital security mechanisms, such as digital signatures. The European Commission has created a trustworthy infrastructure with Europass (Ivanovna, 2014; Bopp, 2020). Nevertheless, the challenge remains to further increase the acceptance of such digital certificates in the world of work.

Europass is considered an essential tool to promote the transparency and transferability of qualifications within the European Union. The European Qualifications Framework and the ESCO Classification, which systematically record skills, qualifications and occupations, contribute to standardization (European Commission, Directorate-General for Employment, Social Affairs and Inclusion 2019). Availability in 29 European languages means that educational qualifications can be made understandable throughout Europe. However, one challenge is that there is no central infrastructure for the national recognition of these digital certificates.

In summary, Europass and the European Digital Credentials Infrastructure are important tools for promoting digital certificates in Europe. Moodle plays a supporting role in delivering course content, while micro-credentials provide a customizable way to recognize skills.

2.3 Europass Wallet in the EDCI

The Europass Wallet as a digital tool that allows users to securely store and manage their educational credentials and qualifications (Erasmus+ Education Office, 2018). Users can share their wallet address with institutions to obtain digital Europass certificates and store them securely. The wallet facilitates the sharing of qualifications with potential employers or educational institutions and ensures the authenticity of the stored documents.

The European Learning Model (ELM), the European Digital Credentials Infrastructure and Europass together form a system for standardizing, issuing and managing educational credentials in Europe. The European Learning Model serves as a comprehensive data model to describe learning opportunities, qualifications, accreditations and certificates in a uniform format. European Digital Credentials Infrastructure (EDCI) is an infrastructure for issuing authentic, tamper-proof digital credentials

and uses the ELM as a data model for the certificates issued (Gottlieb & Bacharach, 2023). A European Digital Credential is such a digital certificate.

EDCI is an essential part of the Europass framework and allows the issued digital certificates to be stored and managed in the Europass Wallet. In this interaction, the European Learning Model forms the basis for the data format of the digital certificates, while the EDCI takes care of their issuance and validation.

2.4 European Learning Model

The European Learning Model (ELM) is a semantic data model. It provides a standardized basis for the collection and exchange of educational data and ensures interoperability between different educational institutions and platforms. With over 480 properties, the model enables a detailed collection of all relevant educational data and covers formal as well as non-formal and informal learning.

The ELM structures educational processes based on central entities such as organizations, certificate holders, qualifications, accreditations and personal identity. This allows educational offers and awarded certificates with learning activities and assessments to be precisely documented. The model also supports the licensing of courses and programs as well as the recognition of qualifications.

A particular advantage lies in the clear assignment of learners and their educational achievements. This improves the traceability of student memberships and facilitates the recognition of acquired competences.

By using a common vocabulary, the ELM improves interoperability between educational institutions and promotes consistent processing of educational data. It forms the basis for a transparent and uniform certification that makes digital educational certificates accessible throughout Europe.

2.5 Moodle Badges

Moodle Badges are digital awards given within Moodle courses to document and recognize the progress and special achievements of participants. They serve as visual validation of acquired knowledge, skills, or competencies and provide a flexible way to engage learners and incorporate gamification elements into courses. There are two main types of badges: course-specific badges, which are awarded for accomplishments within a specific course, and global badges, which are available system-wide and recognize cross-achievement achievements. Badges can be awarded based on a

variety of criteria, including completion of specific activities such as tests or assignments, completion of the course, or manual awarding by trainers.

From Jovanovic & Devedzic (2014) technically, they are based on the Open Badge Standard, a free format that makes it possible to purchase badges from various educational institutions worldwide and to organize and share them in a personal collection, the so-called "Backpack". The metadata contained in the badges complies with the W3C Verifiable Credentials Data Model and ensures that it can be read and validated by other platforms. However, they do not meet the criteria according to the EDCI, in which the data must follow the ELM.

3 METHOD

Micro-credentials for Open Educational Resources from the Moodle learning platform but also credentials for completing a course or series of events in person, are to be made available in the Europass Wallet as European Digital Credential. In the framework of the Digital Learning Campus, the functionality of the native badges in Moodle is a good starting point for this. In addition, the European Digital Credential Infrastructure and the associated services and documentation are used to implement an interface between Moodle badges and European Digital Credential. The European Learning Model specifies the data structure of the content. Figure 1 outlines the necessary technical components and the workflow.

3.1 Use Moodle Native Badge Functionality

Moodle already provides all interfaces for the creation of awards depending on performance. The Moodle native interface for badges is fully used.

In concrete terms, this means that the conditions that must be met for a badge to be shown are configured directly in Moodle. Especially in the context of the Digital Learning Campus, it will be necessary to create and use creative conditions. Standard conditions are activity completion, course completion, completion of several courses, but also the completion of the user profile or membership in a global group. Since the badges in this thesis distinguish achievements, the latter conditions are rather not applicable. However, in addition to all the conditions, the activities or courses complete and the manual assignment by users of a certain role are very interesting. In this case, it is conceivable that face-to-

face courses led by a teacher, or a trainer can award such a manual badge based on the performance of a learner in the respective course. Automatic activity tracking as with course completions is not possible in this context. A self-disclosure would be conceivable at this point, but the badge should retain its value through the external assessment.

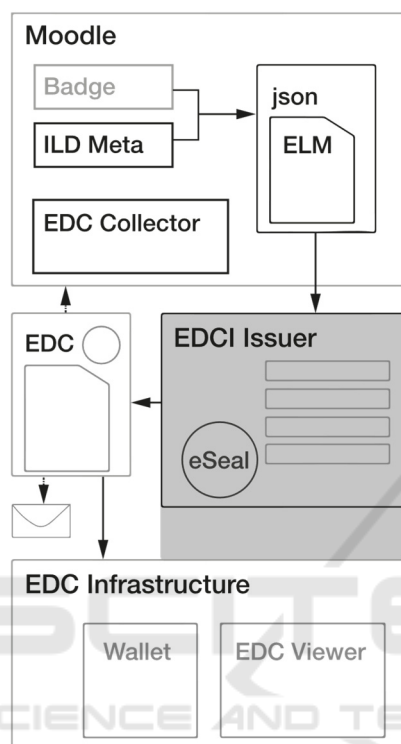


Figure 1: Technical components and workflow for the creation of an EDC in Moodle. Gray squares mark areas that are given as software, function or from the infrastructure and the black squares mark areas in which own work has been incorporated.

3.2 From Badge to EDC

As can be seen from section 2.5, there are different types of badges for different achievements. For technical reasons, among other things, the creation of EDC for global badges, which are available system-wide and recognize overall successes, has been implemented. System-wide badges can be easily managed across platforms and offer a great deal of design freedom in the DLC framework for the issuance of digital certificates for face-to-face events. In addition, the distinction between badges as a gamification element can thus be well differentiated from a kind of certificate.

The check for completion of the requirements for a badge is handled by the badge functionality in Moodle and the global badge is issued via native

functions. Badges can therefore continue to be used as gamification. The only important thing for the European Digital Credential is the data contained in the badge.

A Moodle Badge does not follow the ELM nor does it contain all the information necessary to issue a valid EDC. Additional necessary information is therefore obtained from the metadata of the course. For the online courses, additional course data is already requested when entering and creating the course via a Moodle extension ILD Meta (THL-ILD, 2025a). The collected data is processed as entities of the European Learning Model in a json data format. At this point, the format requirements for a European Digital Credential are met. The data is now signed with the EDCI issuer and forwarded to the recipient.

3.3 EDCI Issuer

The EDCI Issuer is a web application provided by the European Commission that enables educational institutions to issue digital, tamper-proof qualifications and other learning certificates within the European Education Area. The European Commission provides the EDCI Issuer as an open-source software solution that educational institutions can install and operate on their own servers. The prototype of an EDCI issuer has therefore been added to the DLC ecosystem.

The signing process in the EDCI issuer starts with validating the received JSON file to ensure that it complies with the European Learning Model (ELM) and that all the required information is structured correctly. The EDCI issuer then generates a digital credential based on the validated data. To ensure the authenticity and integrity of this certificate, a qualified electronic seal (eSeal) of the issuing institution is applied. This eSeal acts as the digital equivalent of a physical stamp and confirms the origin of the document. The application of the eSeal is carried out via the integration of the Connecting Europe Facility Digital Signature Service (CEF DSS), a Java library for the creation and validation of electronic signatures. Finally, the signed digital certificate is either sent directly to the learner by e-mail or deposited in their Europass wallet.

The electronic seal had to be purchased from a third-party provider for the DLC.

4 RESULT

If all requirements for the technical infrastructure are met, a European Digital Credential can be created

based on an issued Moodle badge for achievements in non-formal learning with the help of the developed Moodle plugin Moodle local ISY credentials (ILD-THL, 2025) and stored in the Europass Wallet and displayed in the Europass Viewer (as shown in Figure 2).

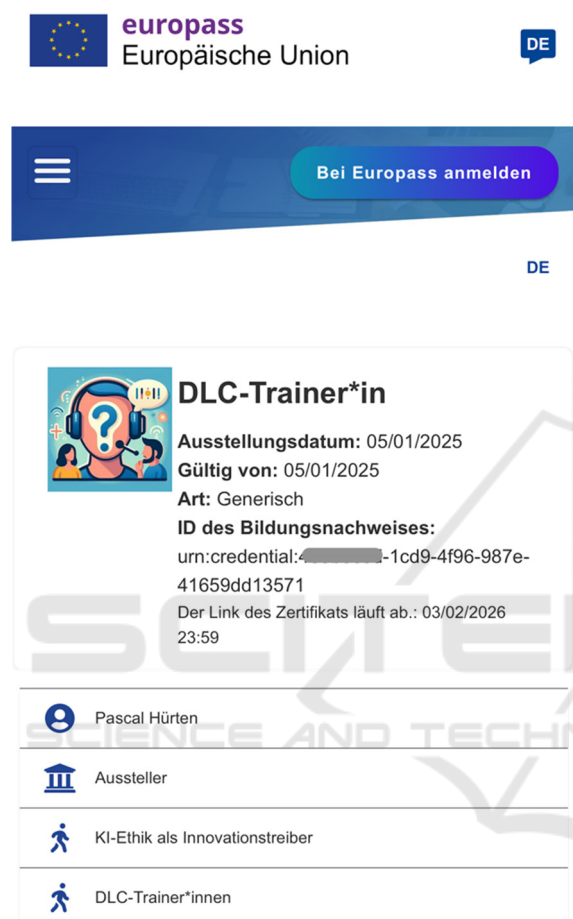


Figure 2: An example of a European Digital Credential in the Europass Viewer obtained by completing several online courses in the DLC.

By using an electronic seal, the certificate is validatable (see Figure 3) and tamper-proof. The holder has full control over the storage and sharing of the certificates in the wallet. The certificates are accessible in the wallet at any time and the standardized format facilitates recognition throughout Europe.

5 DISCUSSION

Moodle uses native badges in the technical sense of the Open Badges (section 2.5) as certificates of

learning success, which contains almost enough information for a minimal viable product of a European Digital Credential, but for direct use that does not output information in the correct format. For better acceptance and to increase the added value of an EDC, further entities of the ELM must be filled, which must be done through alternative data collection and the associated data extraction.

Authentifizierung und Überprüfung

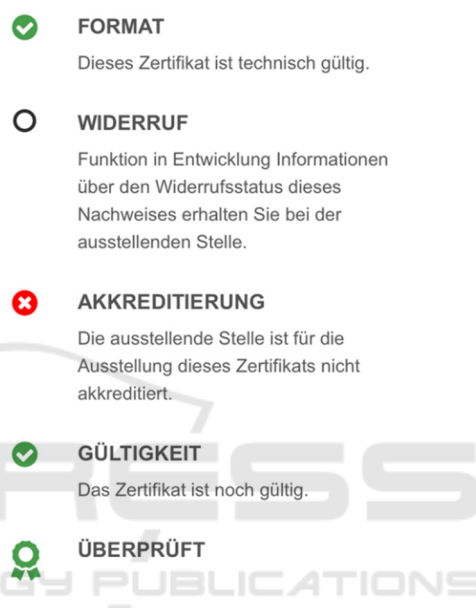


Figure 3: An example of a European Digital Credential in the Europass Viewer with the verification of the credential.

As part of the European Digital Credential Infrastructure, the European Commission provides all the necessary documentation and the necessary software open source, which creates a signed json with data that follows the ELM from a data set. These were used to create the prototype that can successfully create EDC. Even when using the prototype, it is necessary to set up an EDCI issuer for every educational institution. In the framework of the DLC, the biggest problem is that the issuer himself can only manage one seal. This is a bigger problem for the DLC ecosystem, as each institution that has its own seal would have to be provided with its own issuer.

Another major hurdle is the use of the electronic seal to ensure the integrity and authenticity of credentials. The necessity is obvious. It creates trust and protects against counterfeiting. Nevertheless, obtaining a seal and the associated costs must be seen as a challenge. Europass classifies seals into different

categories. For comparability in value to a signature and a stamp on a document, a qualified seal is seen as a prerequisite. Qualified seals are electronic seals that are connected to the issuing server on servers with a special chip with a hardware security module or a sealing device, a kind of USB stick. This poses a challenge for an asynchronous implementation of the sealing process as provided for in the DLC framework, which does not operate its own physical server. Providers of remote sealing services could be a solution for this, but this is also associated with calculable costs.

The value of the EDCs created by the prototype and further developments is not foreseeable now. On the one hand, there is the question of accreditation, but also to what extent micro-credentials, which do not award full-fledged degrees and have also been acquired through non-formal learning, are accepted by society. Here, both exhibitors, recipients and examiners must be addressed in the discussion. Micro-credentials could come closer to formal learning qualifications in terms of the implementation and exploitation of the concept of combinability in terms of the learning time spent.

However, the question and the benefits of the combinability of micro-credentials may not be seriously addressed until micro-credentials are recognized at all. But perhaps micro-credentials first must prove their combinability to gain recognition at a macro level.

As discussed in detail in Griffiths et al. (2024), Rentzsch (2023) and Tillman et al. (2019), the acceptance of micro-credentials depends not only on the technical implementation but also on how learning content is tested and on various other factors that must be created beyond the technical possibilities and requirements.

Griffiths et al. (2024) expects that the ongoing development in the areas of digital education and certification standards could lead to a closer integration between Moodle and Europass in the future. The presented prototype, which was implemented as a proof of concept, is to be further developed into a fully functional part of the ecosystem of the Digital Learning Campus.

6 FUTURE WORK

For the future development and optimization of the integration of Moodle certificates into the Europass Wallet, there are several important aspects that will be considered. First, Moodle does not provide any

bucket for storing EDCs, thus the EDC Collector in Figure 2 needs to be implemented.

A central challenge will be the mapping of the entities of the European Learning Model (see the ELM Browser in Europass (n.d.) for all the entities and attributes) within the Moodle platform. For example, the learning activity type is defined by a predefined vocabulary that is currently not fully mapped in Moodle. One possible solution could be to provide this vocabulary via a drop-down menu in the user interface to enable consistent and standardized data entry. In addition, it must be analyzed how and from where the relevant data can be retrieved in Moodle to ensure consistent assignment to the ELM entities. This task must work equally well for both face-to-face and online offerings.

The Digital Learning Campus aligns the offers with the expected "Future Skills 2021" (see section 2.1.3), which are already part of the DLC as a competency framework and are to be linked to the competencies of the ESCO Taxonomy (see section 2.2). One priority in the development is to also show these competencies in the certificate.

Another important aspect is the handling of further entries in Moodle. Since not all possible entities of the ELM are implemented in Moodle and the Moodle extension ILD Meta, an extension of the platform would be necessary to enable users to enter further possible data directly via the user interface. This should be done considering intuitive user guidance and an optimized user experience to ensure a high level of acceptance and ease of use.

In addition, the question arises to what extent the possibility of a verifiable presentation provided by ELM should be considered in future developments. This view limits the information in the certificate to essential points.

Another area for future developments is the mapping of badge issues within the existing ELM entities. For example, permissions such as the "You are a trainer" entitlement could be granted based on submitted evidence or completion of additional courses. This requires a detailed analysis of how such permissions can be realized in Moodle and seamlessly synchronized with the Europass Wallet.

Future work will focus on overcoming the technical and organizational challenges of this integration, developing standardized interfaces and adapting the existing structures in Moodle to the requirements of the European Learning Model.

7 CONCLUSION

The Digital Learning Campus makes a significant contribution to the digitization of the educational landscape. A structured combination of formal and non-formal learning opportunities promotes learner autonomy and creates new opportunities for lifelong learning.

The link to the Europass Wallet also ensures that acquired qualifications can be digitally certified, securely stored and recognized throughout Europe. The campus thus offers a platform that combines open educational offerings with signed certificates that are validated by the European Digital Credentials Infrastructure. This enables learners to prove their skills transparently and in a forgery-proof manner.

Future challenges are to further increase the acceptance of digital certificates and to optimize their integration into existing education and qualification systems, especially in the area of non-formal learning.

ACKNOWLEDGEMENTS

This study was funded by the Schleswig-Holstein Ministry of Education, Vocational Training, Science, Research and Culture, which is leading the DLC project, which is supported by 40% funding from the European Regional Development Fund (ERDF).

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