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Creating seamless learner experiences: Towards achieving interoperability in European University Alliances

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Abstract

To address the technological, semantical, organisational and legal challenges that currently disrupt a seamless digital teaching and learning experience in Higher Education institutions (HEIs) in Europe, incentivised through the European Commission and embedded in the European Digital Education Hub (EDEH), HE experts have come together in a community of practice to jointly develop an interoperability framework for European University Alliances (EU-A). Access to and participation in manifold digital learning opportunities is a key element of the "Virtual Campus" that is currently under development at each EU-A. The paper has four parts. Firstly, the scene will be set to shed light on interoperability challenges at EU-A. Secondly, the collaborative development approach is explained to underline the importance of an iterative methodology with a high level of community engagement that ideally develops into a sustainable community of practice. Thirdly, a view into the architects' office illustrates the status quo of the framework development and gives an outlook on the steps to be taken until the end of the project. Finally, lessons learned are reflecting on the so far achievements and practical hurdles that need to be overcome.

1 Setting the Scene: Interoperability in European University Alliances

European University Alliances (EU-A) are transnational alliances of higher education institutions (HEIs), paving the way of the universities of the future. The European Commission has set the goal to expand to 60 EU-A involving more than 500 HEIs by mid-2024 (European Commission, 2024a). By

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creating this new type of entities, three components are important within the political architecture of the European Universities Initiative: (1) a shared long-term strategy for higher education (HE), (2) a governance system, which combines incentives and monitoring activities from the European Commission with an ideal discourse that allows the participating institutions to foster common values and a European identity. At the heart of all alliances is (3) the *European Campus*. In line with the Bologna Process, the European Campus embraces mobility and open education under a holistic point of view, with the ambition of developing a comprehensive inter-university campus on which all learners and staff could move and participate seamlessly in learning opportunities, both virtually and physically.

At present, multiple interoperability challenges disrupt a seamless teaching and learning experience in networked HEIs in Europe. Interoperability – the seamless communication between disparate systems – affects, for instance, learners transferring from one university to another one, administration staff enrolling learners, or educators collaborating and sharing teaching materials via digital platforms. While measures to promote interoperability are taken at both European [1] and national levels, inconsistencies and gaps can be constated between initiatives and approaches.

Against this backdrop, a community of practice has been established to develop an HE Interoperability Framework to address the technological, semantical, organisational and legal challenges in seamless HE experiences[2]. The endeavour is set in the context of the European Digital Education Hub (EDEH), an open online collaborative community for digital education stakeholders of all educational sectors in Europe and beyond that supports priority areas set forth in the EU's Digital Education Action Plan (European Commission, n.d.).

2 The approach taken: Collaborative Framework Development

It is not only the landscape of IT-systems at HEIs that appears fragmented; similarly, HE experts and practitioners oftentimes show excellence and focus on their specific area of expertise yet miss the overall picture. The unique strength of this endeavour is to bring experts with different expertise and perspectives together in a collaborative approach to generate real impact on the system. Development of the interoperability framework follows an iterative and agile approach that puts the HE community in the driver seat and emphasises knowledge gathering, co-creation and openness. A core group of approximately 20 experts in the field of HE was set up in September 2023 to take the steering role in drafting the reference architecture. In the composition of this core expert group, it was aimed for a wide variety in terms of the experts' geography, specialised expertise, their sectors and background, ranging from HE and research to the private sector and industry organisations, the public sector or policymaking. Furthermore, experts were drawn from various key stakeholders, for instance GEANT, European University Foundation (EUF), Open EdTech, individual universities and existing interoperability workgroups such as the Think Tank on the Digital Ecosystem for Education. To engage the key stakeholders and experts, the initiative is promoted widely and dialogue is sought with the HE community, as was the case, for instance, at *2023 1EdTech Europe conference* where a joint pre-conference think tank was held with 1EdTech and European University Information Systems EUNIS

[1] At the EU-level, interoperability is a prominent focus, for instance, as part of the Digital Education Action Plan (European Commission, n.d.), the European Education Area and the European strategy for universities (European Commission, 2022).

[2] The Higher Education Interoperability project that makes part of the European Digital Education Hub (EDEH) is conducted by the Deutscher Akademischer Austauschdienst e.V. (DAAD) jointly with Stifterverband für die Deutsche Wissenschaft, Knowledge Innovation Centre (KIC), Deloitte Consulting GmbH Germany, Deloitte Consulting S.L.U. Spain, SURF, Vereniging van European Distance Teaching Universities (EADTU), Unitatea Executivă pentru Finanțarea Învățământului Superior a Cercetării, Dezvoltării și Inovării (UEFISCDI), EDEN Digital Learning Europe Mittetulundusühing (EDEN), Educraftor Oy Ab and Hasso-Plattner-Institut für Digital Engineering gGmbH HPI School of Design Thinking.

(1EdTech, 2023). An open call for a wider expert group (European Commission, 2023) gathered around 150 additional experts from various roles in HE (as of July 2024) to critically challenge, adapt, and extend the concept. This wider group enlarges the scope of experts, being even more inclusive with regards to EU-A. Further practitioners are welcome to join the wider working group throughout the journey by registering their interest in response to the call. Finally, the even broader community of practice of the EDEH will be involved in proofing, testing and implementation of the framework.

Framework development is being conducted in an inclusive and context-based manner with extensive knowledge gathering and mapping exercises with colleagues from EU-A and from different fields of expertise (e.g., administrative staff, educators, study programme coordinators, HEI leadership etc.). Existing tools and services shall be identified that are already in place to address certain interoperability challenges and contribute to the development of truly European campuses, taking into account that there is no one-fits-all solution. Moreover, making existing software solutions and applications visible strengthens the sharing of good practices and expertise, thus taking advantage of the existing diversity.

Starting out in technology, interoperability challenges at several levels as per the New European Interoperability Framework (European Commission, 2017) shall be addressed:

- Breaks between technical systems, applications and infrastructures that are not interlinked in a rapidly evolving technology landscape and with an existing variety of standalone solutions.
- Semantic borders that might distort the format and meaning of data during transmission.
- Diverse business processes at HE institutions that are not aligned.
- Different legal frameworks, policies, and strategies, which set the frame for organisations' operations, and need to be compatible.

To align on the vision, objectives, and overarching principles for the development of the framework, the expert community first set out to co-draft a manifesto paper. In line with the agile and open approach, the manifesto was shared widely (European Commission, 2024b) and is maintained as a living document. This manifesto is a core element, fostering community building and focus. By leveraging technology, breaking down barriers, and streamlining operations and solutions, the framework to be developed aims to provide orientation and enable institutions to focus on their core mission of educating and empowering students for a learning in and shaping of the European society.

Framework development is based on existing studies and research (see, for instance, Berger, 2023; Piromalli, 2022; Ribeiro, 2016), from which an initial overview of key interoperability components was derived and drafted into a reference architecture. The learner's HEI experience is the overarching guiding journey. It is divided into four phases, each of which is supported by business capabilities proposed in the Higher Education Reference Model (HERM) (Caudit, 2022; Kennedy, 2022). The underlying phases can be described as follows:

- Orientation phase, during which the learner discovers learning options. This is supported by preparatory processes of course and resource planning from educators and administrative staff at HEIs.
- Application phase, where the learner applies for an opportunity, is admitted and enrolled.
- Education phase, which constitutes the main part of the HE experience for learners, during which learners make use of learning and teaching tools and generate content.

- Certification phase, where the learner is issued their credentials, which are subject to verification and recognition once the learner moves on to professional or further academic steps.

The phases are associated with a total of eight use cases that describe typical experiences along a learner's journey. The abstraction of the journey allows for flexibility for it to be applied to different scenarios, i.e., for instance, individual modules, courses, or whole programmes. The expert community engages with the use cases in-depth in a series of so-termed *use case squads*. Starting in February 2024 until autumn, the squads are run consecutively, engaging HE and interoperability experts in the development and refinement of the use cases.

The design thinking methodology is leveraged in two in-person workshops of the core expert group that are facilitated by the Hasso-Plattner-Institut (HPI), a pioneer in Design Thinking in Europe. The approach, grounded in open and collaborative co-creation, strengthens the development of technology-agnostic solutions (Hasso-Plattner-Institut, University of Potsdam, Germany, n.d.)

To identify gaps, adapt and rebuild the initially drafted reference architecture, has been mapped with the experiences, use cases, requirements and components operational within the European HE landscapes and in particular existing architectures in EU-A.

The framework will be accompanied by implementation guidelines for IT departments at HEIs to facilitate operationalisation, for instance with regards to the identification and selection of missing interoperability components in light of their existing ecosystem. Moreover, recommendations for policy makers on governance structures, processes, funding and other components that would be supportive of interoperability at HEIs in the alliances will be provided with a view to ensure sustainability.

3 View into the architects' office: Status quo and steps to be taken

The interoperability framework is aimed to offer a collaboratively developed common ground to the different architectures in the EU. This includes, among others, common standards, solutions, and data models to foster communication between systems. The objective is to design a framework to enhance interoperability based on the principles of accessibility, privacy, sustainability, and legal compliance. In this section, the proposed solution, use cases and the high-level flows that interconnect these use cases will be described and the expected results discussed.

1.1 Defining use cases

Eight selected use cases, associated with the four learner phases, bring a learner's experience to life and illustrate relevant interoperability challenges to be solved through the framework. Each phase includes one or more use cases that are associated with core processes. These *Core Processes* are relevant in different *Scenarios*: short/long mobility and joint degrees, each of them with their own particularities. Underlying the scenarios is an infrastructure, captured in supporting use cases.

Core Processes

The first core process is described as the *Discovery* use case, which aims to enhance the visibility and comparability of diverse learning and mobility opportunities across HEIs and emphasises the importance of machine-readable metadata for easy comparison and discovery. Following the search process for learning opportunities is the *Apply and get recognition* use case, which simplifies credit

recognition and cross-institutional enrolment, emphasising seamless data exchange to support all forms of learner mobility and academic continuity.

Furthermore, these core processes include the teaching and learning process with three defined use cases: *Access tools, Manage educational resources* and *Generate data*. The first one of which aims to streamline the management and governance of shared resources among alliance members, covering both physical and virtual assets. *Manage educational resources* is focused on promoting the accessibility and mobility of educational materials, fostering a collaborative and accessible educational environment. And finally, the *Generate data* use case establishes a standardised approach for the exchange of learners' activity data to ensure a seamless integration of various virtual learning environments.

The last use case to be considered as part of the core processes is *Earn a credential*, which affirms the achievements from diverse learning experiences (for the definition of Digital Credentials, see Europass, n.d.). The use case describes the digital management of educational credentials, i.e., the issuance, verification, and revocation of credentials.

Scenarios

The core processes can be applied to three main scenarios. The *mobility scenario* includes all situations where a learner has a 'home' institution and takes a mobility period at another institution. This encompasses short- and long-term mobilities, virtual mobilities, as well as employment-oriented mobilities, such as apprenticeships. The *joint programme scenario* describes participation of learners in true joint programmes - where a set of institutions jointly offer and award a degree. The learner is simultaneously registered as a student in all institutions and does not have a home/visiting relationship. The *open programme scenario* describes situations where a learner wants to complete learning opportunities offered by another institution outside the mobility or joint degree scenarios.

Infrastructure

The base for the core processes and scenarios is provided by two supporting use cases described as *User Identity* and *Institutional Identity*. The former aims at achieving interoperability for user identities across educational transitions, ensuring consistent identification throughout their academic journey. The latter aims at developing a cohesive framework for trusted institutional identities, thus facilitating smoother collaborations and exchanges between HEIs.

1.2 The bigger picture: High level flows

Use cases help breaking down the overall picture into smaller parts; they establish boundaries and help scoping. With this, high-level data flows can be outlined. These represent formal descriptions of the steps involved in a process, offer a general understanding of the processes and components, and establish how they interrelate. Taking into account that HEIs follow flows adapted to the tooling, protocols, and systems in use to comply with their local regulations, the flowcharts seek a common denominator. Finally, to achieve full interoperability, contact points between flows shall be identified.

For illustrative purposes, high-level flows of two use cases will be described in more detail: This includes use case 1 *Discovery*, due to its prominence and importance for HEIs, and parts of use case 4 *Manage educational resources*.

Use cases have been refined through user stories from different perspectives. For the *Discovery* use case, this includes learners who have an interest to discover learning and mobility opportunities across Europe, educators with an interest to update the contents of the catalogue offered by their HEI and administration staff who have an interest to collect requirements for each opportunity. If relevant, external points of view have also been considered. This, for instance, includes policy makers looking for data on courses skills supplied by HEIs. At the time of writing this publication, the high-level flow for this use case (scenarios open programmes and mobility) is presented as follows:

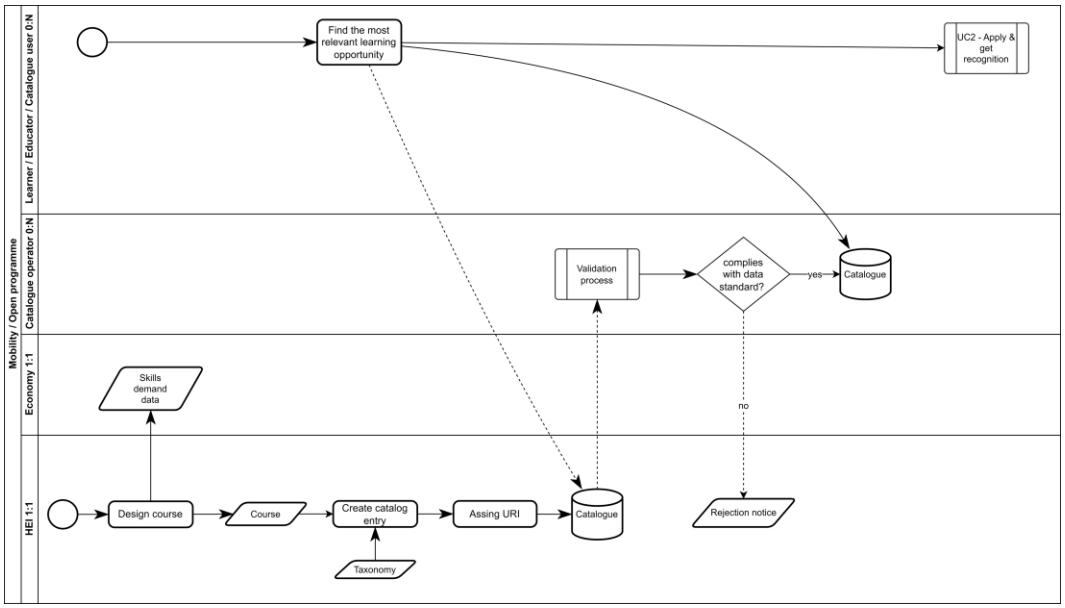

Figure 1: Steps required for the discovery of learning opportunities, mobility and open programme scenarios.

Swim lanes represent the actors in charge. The HEI swim lane groups actors, such as educators, exam committees, and administrative staff involved in the design, creation, and publication of a learning opportunity, while the economy swim lane represents a more abstract actor involved in generating a skills demand, which serves as input to the design step.

Once a learning opportunity has been stored in an institution's catalogue, interoperability comes into play. Enabling discoverability between institutions requires an aggregation service where institutions can publish their learning opportunities. Such a shared catalogue is managed by an operator who oversees the validation processes that are required to incorporate a learning opportunity into the catalogue. Learners looking for learning opportunities can use either HEI's specific system or the shared catalogue to find the most relevant ones.

The third scenario (joint programme) for this use case can be depicted as shown below. This scenario has some particularities as compared to the above flow: Opportunity creation takes place at a joint degree level; it is stored locally in every institution's catalogue prior to its publication to the shared catalogue.

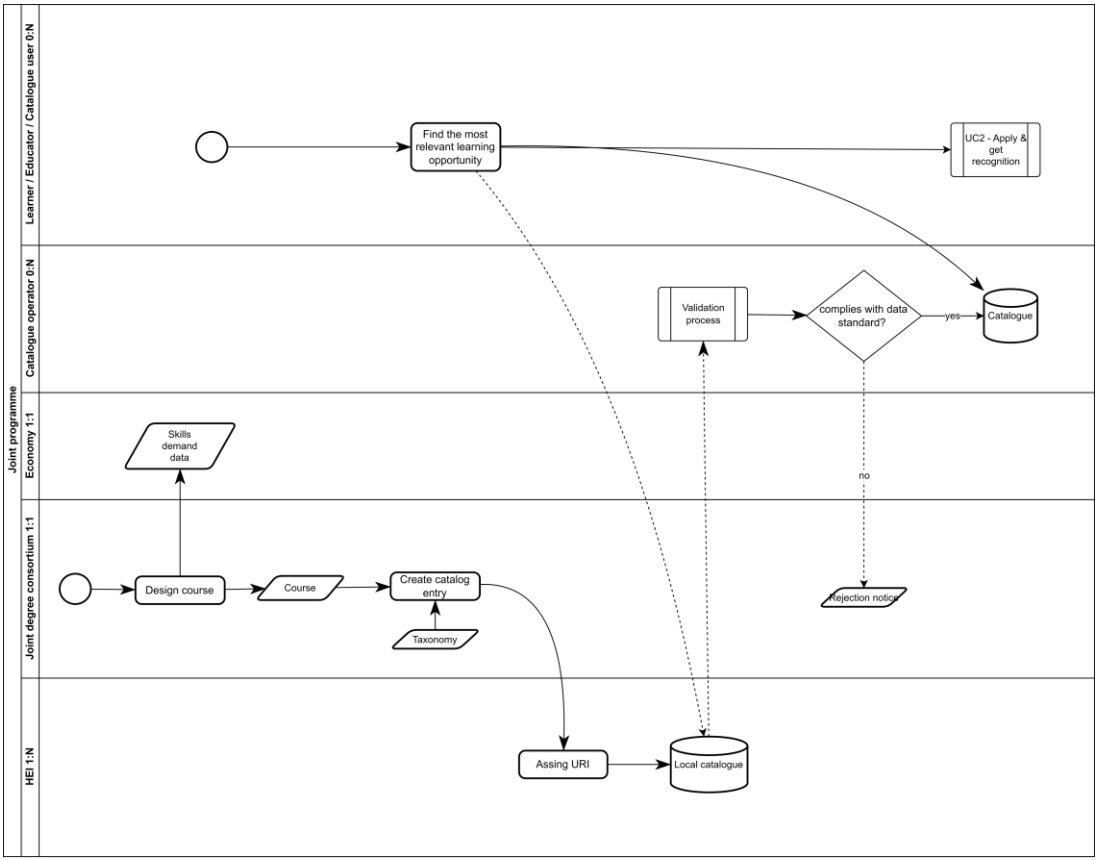

Figure 2: Steps required for the discovery of learning opportunities, joint programme scenario.

The second use case, which will be described illustratively, is on managing educational resources. User stories include, for instance, learners who seek to discover content relevant for their enrolled learning opportunities. Opportunity search should go beyond content published within their own institution and be inclusive of such content from collaborating institutions. Educators want to be able to publish their learning materials, including associated licenses. Finally, administrative staff have an interest in information and metadata about the contents of learning materials.

Based on these and further user stories, the steps required for the search, creation and management of learning materials can be outlined. Educators or learners looking to create content will start with a search for an appropriate tool[3]. Once the access to the tool has been provisioned, the creation phase begins. Finally, content, and associated metadata are stored in the local catalogue. Sharing of such content can be realised following different established strategies depending on the legal requirements of the institutions involved. From the mapping sessions with alliances, the creation of a central catalogue emerged as the most adopted strategy by alliances. The high-level flow showcasing the steps involved is depicted below.

[3] The search for a tool to create content is laid out in another use case and thus not included in the diagram depicted here.

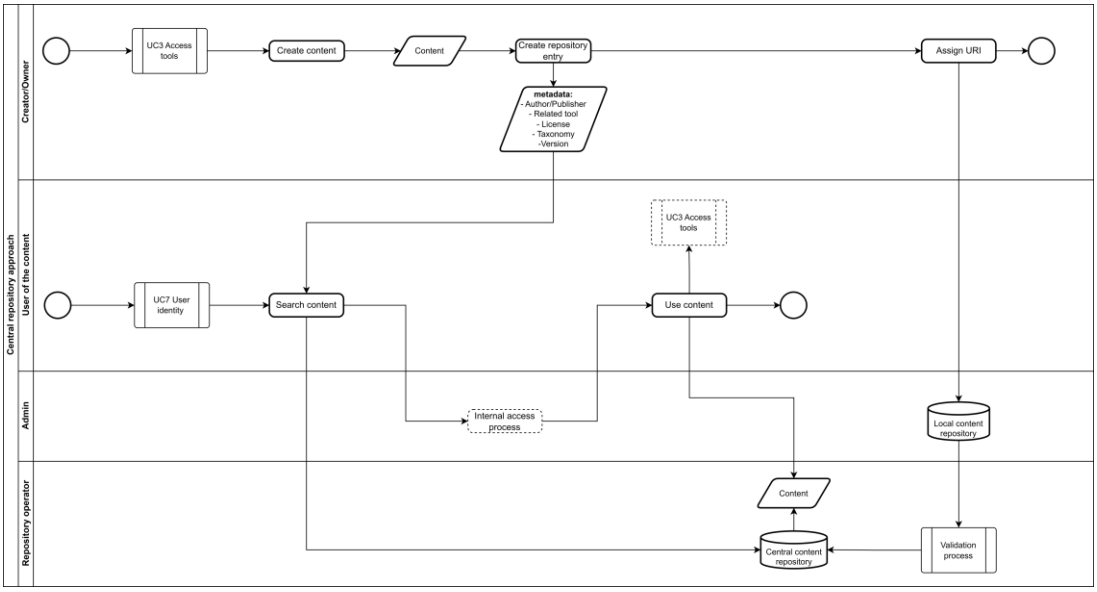

Figure 3: Steps required to share and discover educational resources

Institutions sharing educational resources will share a copy of the original content alongside the metadata of the resources. Whereas content can be shared without any further action, metadata must be translated from the local model to the data standard followed by the central catalogue. Controlled vocabularies play a key role as they ensure discoverability of the resources based on an agreed terminology.

As technology evolves, new systems, standards, and communication protocols emerge. High-level flows are meant to be future proof; therefore, current technology solutions or standards are not represented. This approach allows for mapping of existing solutions, their suitability for the involved tasks, and the set of attributes required. Some tasks might require collaboration between different solutions, thus exposing interoperability problems. Others may not have a candidate solution, thus exposing a missing block required to make systems interoperable. Such gaps are being addressed by the project through a gap analysis, based on which specifications, data models, and interfaces to overcome such gaps shall be proposed.

1.3 Expected outcomes

The targeted outcomes cover three levels: 1) Based on the consolidation of experiences and learnings from EU-A with regards to interoperability solutions for HEIs' digital infrastructure, 2) a co-created interoperability framework for EU-wide virtual campus and learning will be created, the operationalisation of which will be supported by 3) policy recommendations on coordination on the political level to support EU-wide cooperation and exchange between HEIs.

Knowledge about the tools in use is crucial for proposing a reference architecture that can be easily implemented and that takes into account the existing ecosystem. The inventory of tools, challenges, and interoperability problems detected allows to compile a list of available communication mechanisms. Derived solutions include common data models with the minimal set of attributes needed to enable communication based on common protocols and data standards.

Splitting the reference architecture by use case, allows for the creation of Solution Architecture Templates (SAT). Each individual template proposes a set of self-contained solutions that can be implemented independently. Alongside the inventory of existing solutions, self-contained solutions minimise the effort needed to expose interoperable services by letting HEIs choose the solution that works best within their existing systems. The purpose is offering alternatives to solve interoperability issues between the tools and systems in place. The here proposed approach enables HEIs to implement and expose systems in small steps and based on their priorities.

Making systems interoperable solves part of the problem. Publishing interoperability information is crucial to let partners know which services are available and how to communicate with them. This information includes communication mechanisms, authentication, authorisation requirements and organisational information. Institutions should publish such information in an interoperable and standardised way to foster the discoverability of interoperable services. The reference architecture will include a proposal to publish interoperability information. Implementation guidelines will include recommendations to implement the publication of such information. Furthermore, advice on interoperability good practices and implementation of the solutions proposed in the reference architecture will be outlined in the implementation guidelines.

Upon delivering the reference architecture, specific use cases will be proposed for implementing small pilots in selected alliances. This proof of concept will feedback on lessons learned to be incorporated as part of the good practices included in implementation guidelines.

4 Lessons Learned

Many of the lessons learned of the endeavour centre around the community-based approach and the complexity of the undertaking.

The stakeholder- and community-driven approach is invaluable for project success. By anchoring the framework development in the community of stakeholders and practitioners, it will be based upon evidence and in its development is continuously challenged and validated by peers. Yet, at the same time, the community-focus is demanding as it requires constant high levels of community-involvement, input and feedback. For instance, this is crucial for the gathering of good practices, experiences and knowledge. Furthermore, bringing together experts in the very distinct fields of interoperability at the one hand and, on the other hand, experts with an in-depth knowledge of EU-A's structures, processes and activities to bring virtual campuses to life, is a challenge and requires wide reach-out.

It does not come as a surprise that the HE landscape, associated regulations, processes and ways of doing differ across countries and sometimes even within countries, for instance with regards to a virtual student status, standardised "mobility windows", a common and joint academic calendar, to mention just a few. In working with the expert community, it is key to value differences and diversity, while establishing common ground for a way forward. This includes a well-balanced approach to giving room to experts to share their experiences, perspectives and input, while driving the discussion forward and avoiding lengthy discussions on non-essential details. To this end, scoping proved an important element as part of use case development, drawing and communicating clear boundaries that describe the in-scope and out-of-scope elements of use cases.

On a similar note, experiences from the joint development work and sessions with the expert community have underlined the importance of linguistics: One and the same term can reference different concepts,

depending on context. At the same time, the opposite was found to be true as well: Similar concepts might be defined using different terms. To this end, the project leverages a glossary to enable a shared understanding. Moreover, visualisations have proven helpful in establishing a common ground and reducing complexity, for instance in the presentation of relations, processes, phases, and actors in a meaningful and simplified, yet not too simplistic structure.

While many projects have focused on interoperability solutions between individual HEIs or certain EU-As, the here proposed approach takes a holistic view: Building on existing technology, the developed solution interconnects what is already in place across EU-As. Implementation guidelines will advance uptake of the interoperability solutions. In this sense, open standards and APIs are key to create the technical environment and thus support the development of an (open) European ecosystem.

At the time of writing, more than 40 alliances have contributed to the mapping of tools and technical solutions in place at EU-As. Upon finalization, the mapping will be available publicly. Preliminary insights indicate that most alliances have developed their own internal solutions, mostly based on open-source projects, to gather and translate information extracted from the different information systems in place in their member institutions. This presumes the absence of standardized communication protocols, data models and key components that shall be taken into account in the reference architecture. Another key challenge that has already become visible is the complexity of aligning existing business processes due to differences between legal frameworks and traditional organisational structures. In response to this, a set of recommendations shall be incorporated into the implementation guidelines to help alliances overcome organisational challenges.

Beyond such technical insights, the virtual mapping sessions offered have proven invaluable for alliances to share knowledge and lessons learned in the creation of virtual campuses and collaboration settings.

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