Spatiotemporal assessment of snowstorm resilience: a case study in Northeast China

unite! University Network for Innovation, Technology and Engineering

Aligning IT infrastructures for digital learning amongst the European university alliance Unite!

The Unite! digital campus framework and requirements

(Cm.2 Digital Campus Report)

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Lead Authors	TU Graz (Martin Ebner)
	Martin Ebner, Sandra Schön, Jesus Alcober, Roberto Bertonasco, Fabrizio Bonani, Luís Cruz, Carles Espadas, Veruscka Filgueira Xavier, Massimo Franco, Katharina Gasplmayr, Joan Giralt, Christian Hoppe, Markus Koschutnig-Ebner, Etienne Langevin, Romain Laurent, Philipp Leitner, Juha Martikainen, Jorge Matias, Melanie Muchitsch, Mercè Oller, Ana Bela Pereira, Joakim Petersson, Giorgio Santiano, Annelore Schmidt, Fernando M. da Silva, Klaus Steitz, Behnam Taraghi, Marco Torchiano, Sisco Villas, Astrid Würz
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Abstract

The European university alliance "Unite!" has embarked on a mission to bring together their higher education landscape. As part of this ambitious endeavour, the Erasmus+ Work Package 2, called “Community 2 Digital Campus” or "Cm.2" for short, was established to shape and implement a cutting-edge digital campus framework within the alliance. The purpose of the present requirement analysis is to collect and list all the key technological, organizational, and legal needs and requirements for an up-to-date European digital campus. This analysis is built upon desk research, utilizing additional methods such as an online survey and stakeholder discussions within the entire Unite! alliance. The requirements analysis results are provided against the background of a short introduction (chapter 1), an overview of platforms for learning management in European university alliances (chapter 2), and a description of the analysis’ procedures, which are the development of descriptions of digital learning and teaching infrastructures of all partners, a survey of the status quo concerning European Student Card Initiative, a survey amongst e-learning support teams, an interactive event for stakeholders and literature and projects desk research (chapter 3). Chapter 4 introduces the federated infrastructures of the Unite! alliance, especially the Metacampus as a federated learning management system based on Moodle. Chapter 5 provides detailed descriptions (including visualizations) of all partners’ digital infrastructures for learning and teaching. Chapter 6 then shares the status quo of the European Student Card Initiative implementation by all partners. Chapter 7 presents five core requirements identified through the analysis, which are the requirements of (a) interoperability between the digital infrastructures of partners and with European standards, (b) the implementation of decision-making concerning IT infrastructure for the digital campus: the Technical Commission, (c) the strategic support for the effective utilization of existing IT systems, especially the Metacampus, (d) clarifying future (learning) scenarios, mobility, and other issues relating to development of the IT infrastructure, and (e) budgetary considerations for the development and maintenance of federated systems. Finally, chapter 8 sketches the next steps and the future of Community 2 Digital Campus and its tasks, and presents (a) the work plan and organisational structure for Community 2 Digital Campus, (b) further development of Metacampus support and resources (T2.3), (c) update of Metacampus and organisational development of support requests, (d) ESCI: improvement of service, (e) eduGAIN maintenance and further development (T2.6), (f) piloting of LTI and integration of MOOCs (T2.6), (g) implementation of meta-data standards for course description (T2.5, T2.6), and (h) support of openness and innovation (T2.1).

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List of Abbreviations

Aalto – Aalto University (Aalto)

Cm – Community (organizational unit in Unite!, directly connected to “work packages”), e.g. Cm2 stands for “Community 2 Digital Campus” (or “work package 2”).

EEA – European Education Area

EWP – Erasmus Without Paper

ESC – European Student Card

ESCI – European Student Card Initiative

Grenoble INP-UGA – Grenoble INP graduate school of engineering and management, University Grenoble Alpes

GDRP – General Data Protection Regulation

HEI – higher education institutions

IT – Information Technology

KTH – KTH Royal Institute of Technology

LMS – Learning Management System

LTI – Learning Tools Interoperability

API – Application Programming Interface

MMS – Mobility Management System

MOOC – Massive Open Online Course

TU Graz – Graz University of Technology

PoliTO – Politecnico di Torino

ULisboa – Universidade de Lisboa

UPC – Universitat Politècnica de Catalunya/BarcelonaTech

TUDa – Technical University of Darmstadt

Wroclaw Tech – Wroclaw University of Science and Technology

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Overview

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1. Introduction

Martin Ebner, Fernando M. da Silva, Romain Laurent, Sandra Schön

In today's rapidly evolving world, education and collaboration are increasingly reliant on digital technologies. Several European universities collaborate in the form of "**European Universities**", which are transnational alliances that will lead the way towards the universities of the future, promoting European values and identity, and revolutionizing the quality and competitiveness of European higher education (see European Commission, 2023). Collaboration in "European Universities" is a significant challenge. Concerning the current description (European Commission, 2023) the European university alliances "(a) include partners from all types of higher education institution and cover a broad geographic scope across Europe, (b) are based upon a co-envisioned long-term strategy focused on sustainability, excellence and European values, (c) offer student-centred curricula jointly delivered across inter-university campuses, where diverse student bodies can build their own programmes and experience mobility at all levels of study and (d) adopt a challenge-based approach according to which students, academics and external partners can cooperate in inter-disciplinary teams to tackle the biggest issues facing Europe today" [originally a list, a-d was added]. Unite! University Network for Innovation, Technology and Engineering was one of the first 17 European University co-funded by the European Commission, with now 9 instead of previously 7 partners.

The **European university alliance "Unite!**" has as well embarked on a mission to bring together their higher education landscape. As part of this ambitious endeavour, the Erasmus+ work package 2, which is called "Community Digital Campus" or in short as well as "Cm.2" has been established to shape and implement a cutting-edge digital campus framework within the alliance.

The **purpose of the requirement analysis** is to collect and list all the main **technological, organizational, and legal needs and requirements for an up-to-date European digital campus**. This analysis will build upon desk research, utilizing additional methods such as an online survey and stakeholder discussions within the entire Unite! alliance. By conducting this thorough assessment, the aim is to identify and document the essential elements that will shape the development and implementation of the digital campus, ensuring it aligns with the diverse utility, expectations, and goals of stakeholders across the alliance. The requirement analysis will serve as a comprehensive guide, providing a solid foundation for the subsequent planning, design, and implementation phases of the digital campus project.

During the initial weeks and months of the project with the new two partners, **several challenges and requirements emerged**. The Unite! partners exhibited diverse infrastructures, processes, cultures, organizations, and needs. Additionally, varying perspectives on the digital campus, encompassing research, lectures, studying, and administration, often led to misunderstandings, such as the distinction between "Metacampus" – which is our federated learning management platform – and "digital campus". Uncertainty prevailed regarding decision-making for crucial next steps, including external needs from other work packages or the desires of rectors. Furthermore, there was limited knowledge about existing standards, advancements, and the state-of-the-art beyond the Unite! alliance. A slide from a work package meeting collects such issues (see Figure 1).

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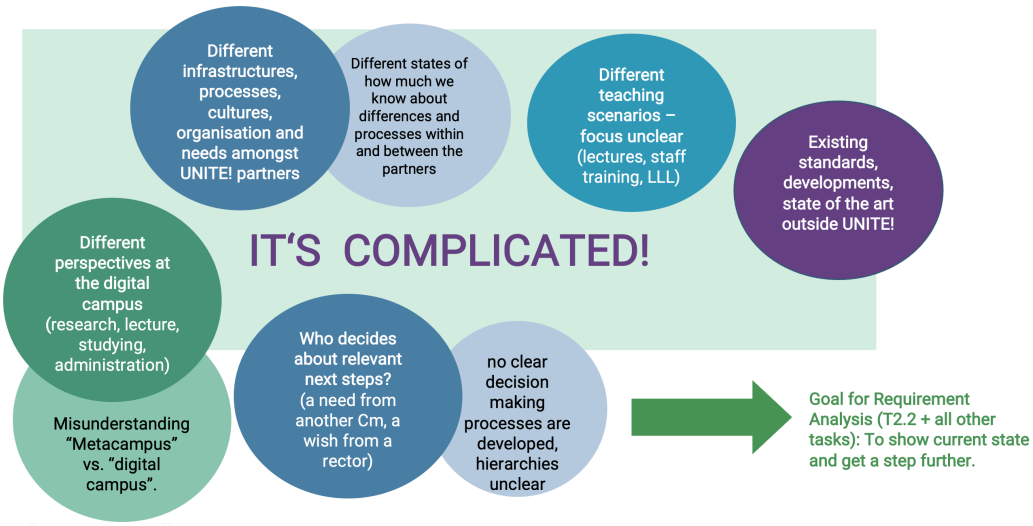

Figure 1: Overview of the challenges we have seen within the first month after the Erasmus+ start. Modified slide from our regular Cm.2 meetings (03/23). Note: LLL stands for "life-long learning" offers.

The requirement analysis will thus **help to shape the "Unite! trans-European campus"**. According to the proposal, the contribution of Cm.2 will "develop the Unite! Metacampus, integrating IT services of the member universities to provide digital Erasmus compliant service processes and progressively providing new learning management system functionalities as required by our innovative pedagogies and our communities (WP2)" (citation from the Unite! Erasmus+ project description, internal document).

The Unite! Mission Statement 2030 (Unite!, 2022) name the following two **Unite! missions** that are (partly) relevant for Cm.2: According to this document, Unite! has the missions

- "Unite! creates the hybrid (virtual, physical and blended) and multilingual Unite! trans-European Campus with easily accessible joint educational offerings, shared and pooled resources, efficient services and green mobility
- [Unite! creates] state-of-the-art learning opportunities with innovative pedagogies for challenge-based approaches, student-centred learning, and high-quality interaction in digital, hybrid and face-to-face learning environments" (paragraph 3)

Cm.2 should aim to establish a digital infrastructure that enable Unite! students to have a seamless journey through digital learning and teaching offers of the alliance and its partners.

The report starts by providing an introductory overview of the concept of a "digital campus" and its implementation within European alliances. Additionally, we offer insights into various European and national initiatives aimed at fostering interoperability among universities. Then we will describe the different strands and its approaches as well as results of this report as presented in Figure 2.

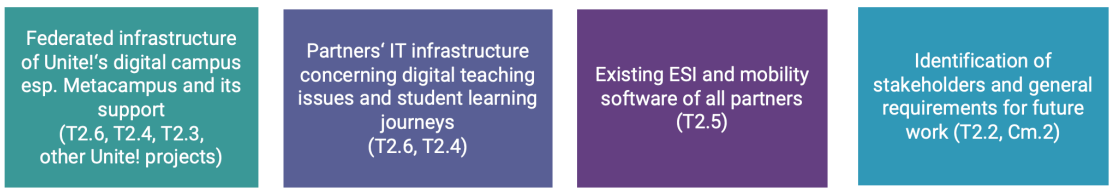

Figure 2: Overview of the different topics of the requirement analysis and the related tasks within the Erasmus+ "Digital Campus" work package 2 (called "Community 2 Digital Campus").

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In general, we used various approaches, including stakeholder engagement, comprehensive analysis of technological, organizational, and legal needs, and the integration of European standards and frameworks to ensure interoperability and seamless collaboration within our university alliance.

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2. Digital Campus development in the European Union

Martin Ebner, Fernando M. da Silva, Romain Laurent, Sandra Schön, Melanie Muchitsch

This chapter introduces to the meaning of digital campus in the case of European university alliances and presents insights into the infrastructure of such alliances concerning their used learning management systems. The chapter additionally introduces overview and example of several relevant interoperability standards that concern digital campuses.

2.1 Definitions and descriptions of “digital campus” in the context of European Universities

The **term “digital campus”** was introduced as a term as well to highlight that learning management systems are not enough for a “sustainable implementation of a digital infrastructure for tomorrow’s campus” (Kerres, 2004, p. 1). In contemporary usage, the term “digital campus” extends beyond universities and encompasses the digital working environment of companies and organizations as well (Unity.de, 2023). For us, the term “campus” can be seen as the concept that designs the overall system for providing services to students, teachers, and staff, and that the challenge of the “digital campus” is therefore to digitalize it.

When describing the digital campus of higher education institutions and universities, this can be done from **different perspectives**. For example, Moşteanu (2021) contrasts the students' perspective with the administration's perspective (see Figure 3).

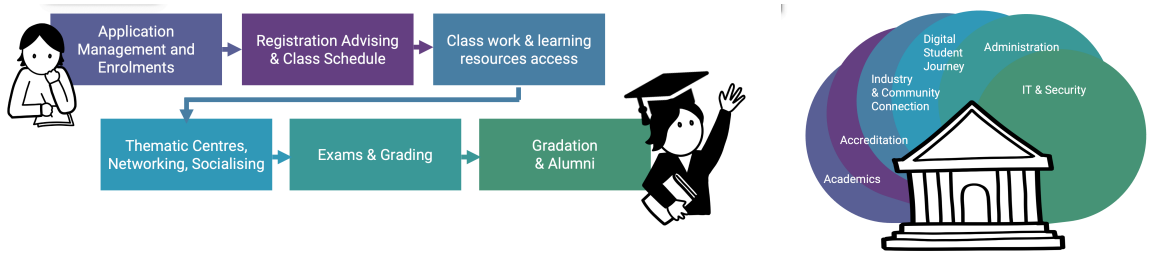

Figure 3: Different ways to sketch the digital campus: From student’s perspective (left) or administrative perspective (right). Source: Own illustrations based on figures by Moşteanu (2021), Fig. 1 (left) and Fig. 2 (right)

Within this analysis, the term “digital campus” is employed to specifically denote the digital infrastructure of a European university alliance which aims to provide a comprehensive system of services for members of the university community digitally. It encompasses the shared infrastructure that enables collaboration and connectivity among universities that are part of a transnational network.

A standardized description and sketches of digital infrastructures in European universities is currently lacking, with only a few examples of published description already. Key sub-areas that deserve attention include **learning, teaching, research, administration, and management.** In the subsequent sections, we will provide a concise overview of some of these sub-areas.

As a first example, the **European university alliance CIVIS** published a report about its digital campus (see Figure 4; Touzot & Martin, without year). Different platforms and tools are part of this description, namely “CIVIS learning platform”, “administrative tools”, “community platform”, “communication”, “European student card initiative” and “Mobility tool” (which includes the CIVIS passport digital credentials).

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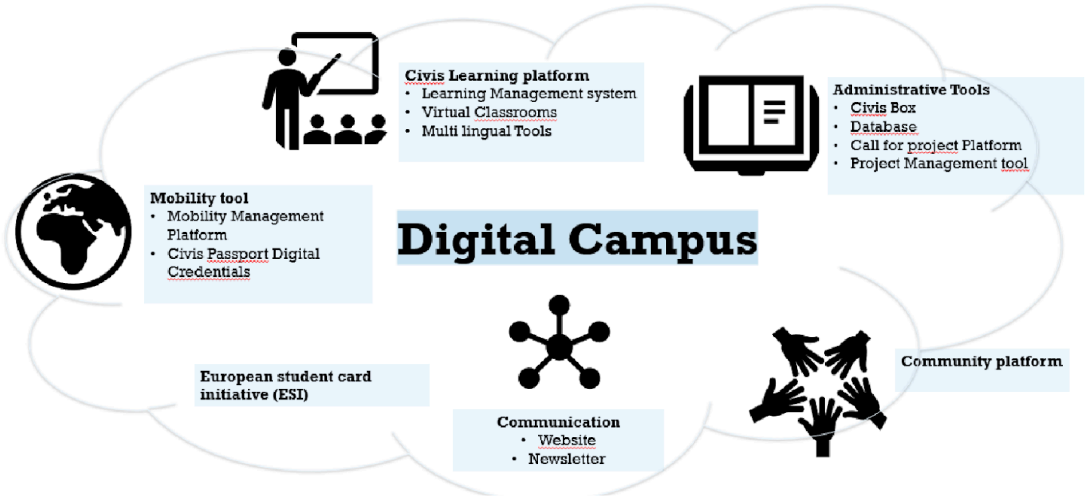

Figure 4: Overview of the CIVIS Digital Campus. Source: Touzot & Martin, without year, p. 7. Please note: Not available under open license.

Another description of a digital campus of a European university alliance is available from the **European university alliance EURECA-PRO** (Lagoudakis et al., 2022). The digital campus of EURECA-PRO "has been designed as a collection of platforms providing different functions to serve the needs of the EURECA-PRO community" (p. 491). An overview is presented in the following Figure 5. However, the abbreviations and references used make it somewhat difficult to understand it.

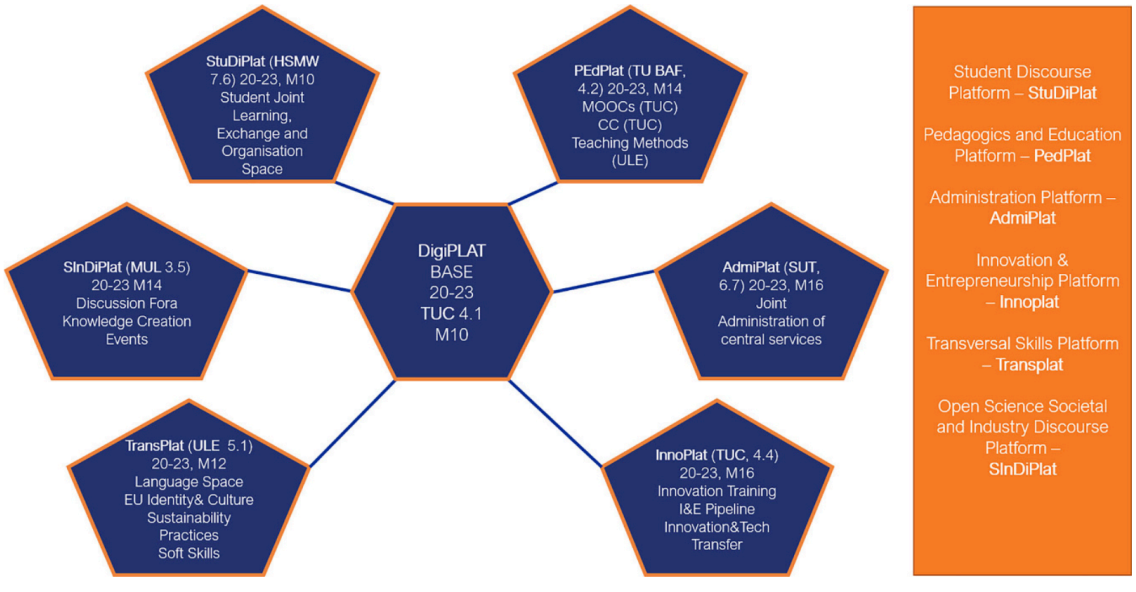

Fig. 1: Overview of the EURECA-PRO Digital Campus infrastructure

Figure 5: Overview of the EURECA-PRO Digital Campus Infrastructure. Source: Lagoudakis et al., 2022, Figure 1, p. 490. Please note: Not available under open license.

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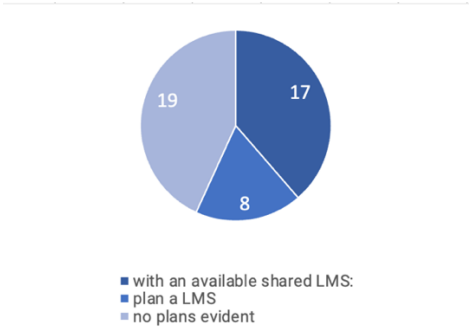
2.2 Platforms for learning management in European university alliances

As already mentioned above, a key objective of the European university alliances is to "jointly delivered across inter-university campuses" (European Commission, 2023). The development of joint learning management platforms by multiple alliances (see Berger et al., 2023) can be attributed to the challenges associated with granting access to individuals from outside the university, particularly those affiliated with other alliance members. This difficulty often necessitates the creation of dedicated platforms to ensure seamless and secure access for all relevant stakeholders. When choosing a platform, it is usually asked in advance which learning management systems are already in use. This overview was also published for the European university alliance EURECA-PRO (see Table 1).

Table 1: Summary of the results of the questionnaire on LMSs used in partner institutions of the European university alliance EURECA-PRO (Lagoudakis et al., 2022, Table 1, p. 493). Please note: Not available under open license.

Data/Partner	MUL	TU BAF	UP	TUC	SUT	ULE	HSMW
Main LMS	Moodle	OPAL	Academia	Open eClass	Moodle	Moodle	OPAL
Self-hosted or cloud-based	Self	Cloud	Self	Self	Self	Self	Cloud
Open source	Yes	No	No	Yes	Yes	Yes	No
Fee (€/year)	No fee	>20000	1000-5000	No fee	No fee	No fee	>20000
Licensed users	250	250	200	200	1800	1192	7600
Students	4000	4000	3700	5000	20000	11550	7000
Secondary LMS platform	-	-	-	Moodle, Web-Courses	MS Teams	-	Moodle

At TU Graz a student was tasked with examining the extent to which the existing 44 European alliances funded by the European Commission under Erasmus+ have either implemented or planned a centralized learning management platform (Muchitsch, 2023). It should be noted that the results obtained through a bachelor's thesis, while informative, are limited in depth as no surveys or questionnaires were utilized. Nonetheless, these findings provide a valuable overview of the potential status of learning management platforms within European university alliances in February 2023. It is important to acknowledge that there may be discrepancies and uncertainties due to variations in self-descriptions and implementations.



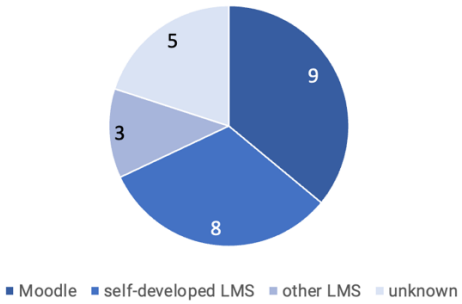


Figure 6 (left): LMS implemented by European university alliances according to their self-descriptions (Website) in February 2023 (left, N=44); Source: Muchitsch (2023).

Figure 7 (right): LMS in use by European university alliances according to their self-descriptions (Website) in February 2023 (n=25), Source: Muchitsch (2023).

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The analysis reveals the self-described status of 44 European University alliances as follows: 17 alliances already possess a shared Learning Management System (LMS), 8 have plans to implement one, and 19 have no plans for an LMS. Focusing specifically on the 25 alliances with an LMS, the breakdown is as follows: 9 utilize Moodle, 8 have developed their own LMS, and 3 use other platforms (Agora, Ilias, and Gala), for 5 the LMS is unknown (see Figure 6f).

2.3 Developments of interoperability standards for digital campuses of European Universities

To enable effective collaboration within European university alliances, several European standards and developments play crucial roles. They facilitate seamless interoperability and data exchange between different systems and platforms.

The **European Interoperability Framework (EIF)** is the strategic framework that provides guidelines and standards for achieving interoperability in the European Union (EC, 2017; Joinup, 2023). It aims to facilitate seamless and efficient communication, collaboration, and exchange of data and services between public administrations, businesses, and citizens across EU member states. The EIF outlines a set of common principles, standards, and best practices that promote interoperability at various levels, including technical, semantic, and organizational aspects. It emphasizes the use of open standards, open specifications, and open-source solutions to ensure compatibility, re-usability, and accessibility of digital systems and services.

Here is an overview of European standards that are essential for successful digital campus development of European universities.

Organizational Interoperability:

- **Erasmus+**: Supports mobility and cooperation in higher education across Europe, promoting harmonized administrative processes and credit recognition (European Commission Erasmus+, 2014)
- **ISCED (International Standard Classification of Education)**: Provides a common framework for classifying and comparing educational programs and qualifications (UNESCO, 2012)

Technical Interoperability:

- **EDU-API:** Defines a set of APIs and standards for interoperability between educational systems, facilitating seamless integration and data exchange. (IMS Global Learning Consortium, 2018).
- **EduGain:** Provides a secure and scalable infrastructure for identity federation and single sign-on across European research and education communities. (Geant, 2014)
- **EMREX (Electronic Management of Student Exchanges):** Enables efficient exchange of student academic records and transcripts across European higher education institutions. (Emrex User Group, 2021)
- **eSEID (European Student eID)**: Aims to establish a European standard for electronic identification and authentication of students across European HEIs. (Nealon et al., 2022)
- **LTI (Learning Tools Interoperability):** Enables integration and interoperability between learning management systems and other educational tools, fostering a unified learning experience, (IMS Global Learning Consortium, 2023)
- **MyAcademicID:** Aims to establish a European-wide solution for digital student identity and credential verification, facilitating secure and trusted access to academic services and resources. The Attribute is released as part of the eduGAIN attributes. (MyAcademicID consortium, 2020)

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- **MOOChub schema:** Aims to enhance interoperability between different MOOC platforms, allowing for seamless integration, data exchange, and collaboration among various platforms within the consortium. (Ebner et al., 2023)

Semantic Interoperability:

- **ECTS (European Credit Transfer and Accumulation System)**: Provides a common framework for recognizing and transferring credits among European universities. (European Commission, 2023a)
- **ELMv3 (European Learner Mobility Vocabulary version 3)**: Defines a standardized vocabulary and data model for describing learner mobility information, facilitating consistent understanding and exchange of data. (European Union europass, 2023)
- **LOM (Learning Object Metadata):** Plays a significant role in addressing interoperability challenges in the context of educational resources and learning objects (IEEE, 2020)

Legal Interoperability and constraints:

- **ePrivacy:** Addresses the privacy and confidentiality of electronic communications, including the use of personal data in digital contexts. (European Commission, 2023b)
- **eIDAS (electronic Identification, Authentication and Trust Services):** Ensures legal recognition and acceptance of electronic identification and authentication methods across EU member states. (European Commission, 2023c)
- **Europass**: Facilitates the storage and exchange of skills and experiences. European Union Europass, 2023)
- **GDPR (General Data Protection Regulation)**: Ensures the protection and privacy of personal data within European university alliances, governing its collection, storage, and use.

Getting a step further, the study "Making Interoperability Work" (Berger, Galati & Witteler, 2023) offers an in-depth examination of challenges of European University alliances by analysing barriers and potential solutions across four use cases—**joint course catalogues, digital enrolment processes, learning platforms, and micro-credentials**—highlighting that interoperability is crucial for fostering efficient international cooperation, modernizing teaching, and utilizing resources effectively in higher education.

Interoperability is a crucial concern for **mobile students**, and to address this, the "**European Student Card Initiative"** or "**Erasmus+ Digital"** (Erasmus+, 2023) was introduced as an ongoing European initiative since 2015. Its primary objectives are to reduce the workload of International Relation Officers and facilitate student mobility, both physically and digitally. The project involves digitizing key steps of the Erasmus mobility process, with the aim of full implementation by 2027. It is expected to become mandatory for all Higher Education Institutions (HEIs) that sign the Erasmus chart. The project consists of three main components: Erasmus Without Paper (EWP), Erasmus+ App, and the European Student Card (ESC).

At present, there are **no established interoperability standards for micro credentials**. Efforts are underway to develop common European frameworks in this area, but these initiatives are still in progress and evolving (European Commission, 2021).

Besides these European developments, there are several initiatives on country level to ensure interoperability of (higher) education issues. Table 2 gives examples for such developments for all Unite! countries.

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Table 2: Examples for national developments to enable or enhance interoperability in higher education in Unite! countries.

Countries	Examples for interoperability developments in higher education
Germany	• **Higher Education Compass (Hochschulkompass)**: A comprehensive online portal providing information about higher education institutions, programs, and admission requirements in Germany. • **National Research Data Infrastructure (NFDI):** A network of research data centres and services that promote data sharing, management, and interoperability across disciplines.
Finland	• **Finnish National Agency for Education (EDUFI)**: Responsible for the development of the national education system, including initiatives to enhance interoperability and data exchange among Finnish universities. • **Studyinfo.fi**: A national online service that provides information about higher education programs, admissions, and study options in Finland.
France	• **National Unique Student Identifier (INE)**: Assigns a unique identifier to each student enrolled in a French higher education institution, facilitating data exchange and management across the education system.
Portugal	• **National Repository of Open Access Scientific Publications (RCAAP):** Promotes open access to research publications by providing a centralized platform for storing and accessing scientific content from Portuguese universities.
Spain	• **Spanish University Information System (SIIU)**: A national platform that supports data exchange and integration among Spanish universities, enabling efficient management of student information and administrative processes. • **Spanish National Research Council (CSIC)**: Facilitates research collaboration and data sharing among Spanish universities and research institutions.
Austria	• **Austrian Academic Information System (AAIS)**: Enables data exchange and management among Austrian universities, supporting administrative processes, student information, and study programs. • **Austrian Science Fund (FWF)**: Promotes research collaboration and interoperability by providing funding and support for scientific projects across Austrian universities and research institutions.
Sweden	• **Swedish Higher Education Authority (UKÄ)**: Responsible for quality assurance and data collection in the Swedish higher education system, facilitating data exchange and interoperability among universities. • **Swedish National Data Service (SND)**: A national infrastructure for managing and sharing research data, promoting data interoperability and accessibility.
Italy	• **National Registry of Students and Graduates (ANS)** is a ministerial database established with the aim of cataloguing all university students enrolled in study programs, facilitating data exchange and management across universities. • **Agency for the Evaluation of the University and Research System (ANVUR)** oversees the national public system for assessing the quality of universities and research entities. It manages the external evaluation of the quality of activities conducted by universities and research entities receiving public funding and guides the activities of evaluation units.

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These examples illustrate the efforts made in various countries to establish national systems, platforms, and standards that enhance the exchange and interoperability of university systems, promoting efficient data management, collaboration, and service integration.

To get an overview of the international developments, there are also not only several individual inventories, but the project “EduXS.eu: Tracing the Path of Digital Education". This project was initiated by SURF in Autumn 2022 and aims to elucidate Europe's multifaceted digital education landscape: It will systematically map out stakeholders, projects, and standardizations to ensure interoperability within the digital educational landscape (see EduXS.eu, 2023).

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3. Procedures for requirement analysis

Sandra Schön, Martin Ebner, Roberto Bertonasco, Katharina Gasplmayr, Markus Koschutnig-Ebner, Romain Laurent, Philipp Leitner, Fernando M. da Silva, Behnam Taraghi

In this chapter the procedure of the requirement analysis of the Erasmus+ work package 2, which is called “Community 2 Digital Campus” or in short "Cm.2" is described, i.e., the sources, stakeholders, topics, and methods. In addition, an event is presented which aim was to get in touch with as many and as versatile Unite! members and to get contributions for the requirement analysis. The developed procedure is complex and versatile and is based on the forms of requirement analysis from the field of system development, which are used for complex challenges and address different stakeholders/users (e.g., Maguire & Bevan, 2002; Demirel & Das, 2018).

3.1 Sources and stakeholders

Concerning relevant sources, we used all existing sources about digital campus issues within Unite:

- public descriptions and published papers about the alliance and its infrastructure,
- internal project reports,
- and the project description of the current Erasmus+ alliance funding.

Besides this, we have seen stakeholders as a relevant source for the requirement analysis (see Gupta, 1995).

Beyond the typical stakeholders at a single university – from the rectorate to teachers to the IT department to students and companies, European university alliances have several other stakeholders. For the identification we used the analysis of the Erasmus+ project description and the existing organizational structures of Unite! In the case of Unite!'s digital campus development and the context of the Erasmus+ project, these include:

- **Alliance Leadership and project management**: The rectors/presidents (forming the governing platform), key liaison officers (main coordinator of Unite! alliance in each partner institution) and Unite! secretariat provide, systemic, structural and strategic decision making and implementation support in the development of the digital campus.
- **University IT Administrators and/or IT departments**: Administrators and/or IT professionals from participating universities who can oversee the implementation and management of the digital campus within their institutions. In our case these people are typically engaged in Cm.2.
- **Faculty and Instructors:** Academic staff members who contribute to the design and delivery of digital learning resources and online courses on the digital campus. In the case of Unite! Erasmus+ project they are primarily organised in Cm.4 (“Innovative Teaching and Learning”).
- **Administrative staff** members are – at least in the case of the Unite! alliance a relevant stakeholder – as potential trainer, learner as well as responsible for support and maintenance tasks – at the digital campus, as the Erasmus+ project plans staff development and trainings (in Cm.4 “Innovative Teaching and Learning” and Cm. 6 “Professional development & Training”).
- **Students** as potential learner at the digital campus can provide valuable input and feedback on the user experience, functionality, and features of the platform (in Erasmus+ they are organized within the Unite! Student Representation “SURE!”)
- **International Relations Officers**: Professionals responsible for managing international partnerships and student mobility programs are relevant to ensure seamless integration of mobility processes.

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Of course, other groups could be listed here, such as quality management or providers of university platforms. In the sense of a focused approach, however, the listed stakeholders are addressed first and foremost.

3.2 Overview of topics, method, and results

Figure 8 provides an overview of the topics addressed in this requirement analysis, the method we chose, the stakeholders involved in each case, and where in the report the respective results are presented.

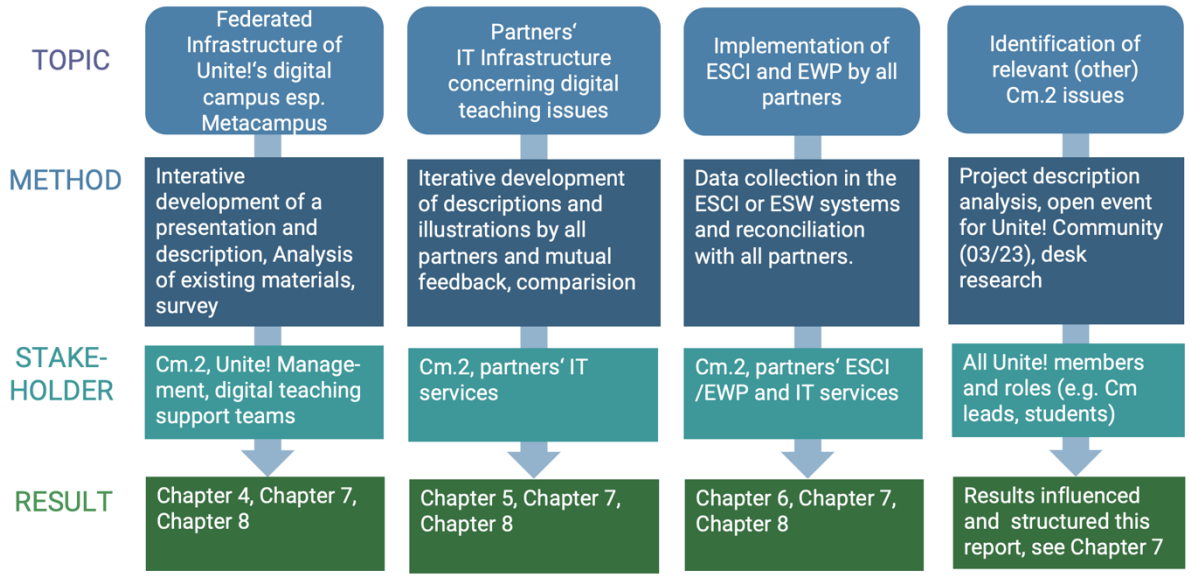

Figure 8: Topics, methods, stakeholders and results of the requirement analysis at digital campus focusing digital teaching and learning issues

In the following we would like to briefly describe the chosen methods.

3.3 Methods for requirement analysis

In the following the different methods for the requirement analysis is described.

3.3.1 Developing a common overview of the Digital Campus Infrastructure

Community 2 Digital Campus tasks have been described as in the Grant agreement as primarily concerned with digital infrastructures related to learning and teaching. But in the reality of alliances the communities are addressed with wider issues that cover in case of Community 2 Digital all IT-related project requirements.

3.3.2 Describing and visualising partners' digital teaching infrastructures[1]

To harmonize the varied IT backgrounds across the partner institutions, an initiative was launched in November 2022 to capture comprehensive infrastructure representations. This effort aimed to promote a systematic description of each partner landscape, facilitating knowledge sharing and the identification of common building blocks and processes of all partner institutions. Our

[1] Please note that the following paragraphs uses texts and figure that are submitted for a EUNIS conference presentation (2024).

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approach was fundamentally driven by several pivotal questions: What are the ideal formats for these descriptions? What common frameworks exist, and how are our partners utilizing them? Which standards for presentation and organization are most logical?

We looked at how "digital campuses" are represented by European university alliances (see chapter 2 in this report) and how IT information systems in higher education are visualized in general. We could not find a standard for this or examples that seemed particularly suitable. We therefore decided to jointly develop the way of presentation in terms of illustration and description. Figure 9 provides a schematic of our methodology, illustrating how we endeavoured to obtain synchronized, coherent, and insightful depictions of IT infrastructures related to teaching and its academic management across all partner universities. For temporal context, we have also incorporated pertinent dates.

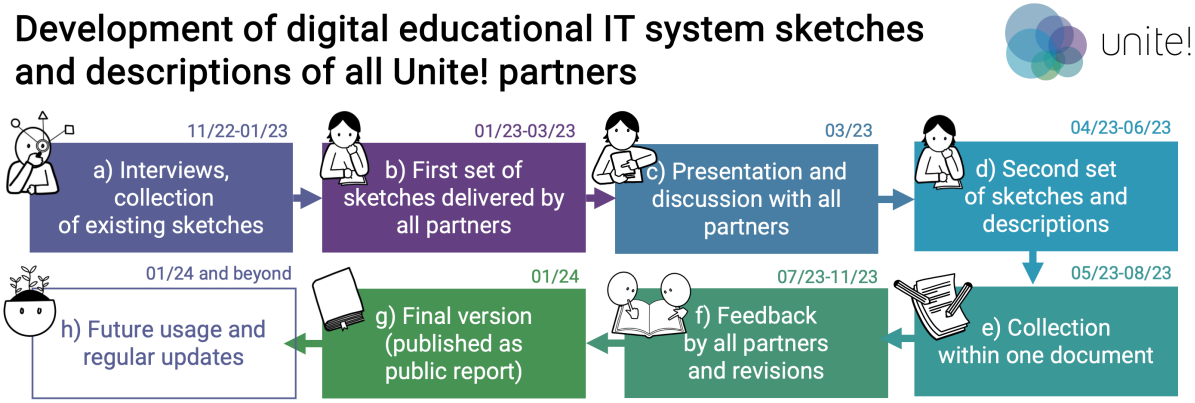

Figure 9: Development of digital educational IT system sketches and descriptions of all Unite! partners

Our progression was methodical and can be summarized as follows:

(a) Initially, we sought meetings with all partners, inviting individuals well-versed in delineating the digital educational infrastructure of their universities. In these meetings, we articulated our goal: to achieve consistent depictions across all partner universities. Several partners already had preliminary system diagrams. We introduced an initial representation of Graz University of Technology's (TU Graz) infrastructure as an example. The ensuing discussions around the contrasts and parallels in our systems were productive and well-received. There was a palpable sense of understanding and dedication to the shared objective. Post this preliminary dialogue, we refined the TU Graz sketches, presenting them as a potential blueprint. Nonetheless, the subsequent directive for (b) was laid out with considerable flexibility:

"Each partner university is asked to contribute with a digital educational system landscape visualization and description as well as with a student journey visualization and description. Please name technology and versions of all digital educational system structures, esp. applications related to educational content within the partner universities. There is not a 'final' idea about the illustration and design consideration. But we are sure to develop step-by-step by sharing and comparing the sketches. Please use the existing sketches and links for inspiration. We will use Draw.io to have the same visual possibility." (from our template)

During our first in-person project meeting, we (c) showcased all the sketches, both in enlarged printouts and digitally, with responsible partners narrating each presentation. Ahead of this, we had formulated a checklist delineating the elements expected in each representation. This checklist served as a discussion point and was subsequently adopted as a foundation for further refinements (see Appendix). Post-meeting, we evaluated the various representation styles to identify the most effective approach, subsequently crafting a template with detailed guidelines.

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This refined template was then presented and debated in an online session before being redistributed to all (d). Subsequently, all refined sketches and descriptions were amalgamated into a collective report, upon which feedback was solicited from all partners. We are currently in the stages of further refinement and finalization (g) to establish a robust foundation for upcoming developments (h).

3.3.3 Survey of the *status quo* regarding European Student Card Initiative and Erasmus without Papers

During the establishment phase of Community 2 Digital Campus, the Task leaders were requested to designate a contact person from each university for both European Student Card Initiative (ESCI) and Erasmus without Papers (EWP) projects. These designated contacts were asked to provide insights into the development status of their internal computer systems concerning interoperability within the ESCI and EWP networks. Specifically, information regarding the status of ESCI and its alignment with the EDUGAIN system was also sought. The data gathered through these inquiries were then merged with the information available on the EWP Registry Service (EWP, 2023).

This combined data set offers a comprehensive view of the progress and alignment of the respective university systems within the ESCI and EWP networks. The goal is to enhance collaboration and promote seamless interoperability among participating universities, facilitating a more efficient and effective exchange of important educational information and resources. This concerted effort aims to optimize the overall experience and outcomes for students and staff involved in international academic initiatives within the ESCI and EWP frameworks.

3.3.4 Survey amongst partner teams responsible for digital teaching support

First, the teams or persons responsible for digital teaching support were identified and then invited to a meeting. During these two online meetings it became clear that there are many similarities but also differences between the universities. It was also unclear in which way the individuals and teams are interested in shaping the support around the federated system Metacampus. It also seemed unclear to what extent stakeholders already have Moodle support experience or what experience faculty at universities have. We designed a written survey to get better insights and comparisons into the similarities, differences, or peculiarities (August 2023). The answers are analysed with simple statistics and some of these results are presented.

3.3.5 Interactive event for stakeholders

At the start of the project in November 2022 and after the analysis of the application and the review of numerous mentions of “Metacampus” or “digital campus” in the Erasmus+ project description, it seemed necessary to promote the exchange with the stakeholders. For the first alliance event, the “Unite! Dialogue Week” at the partner in Grenoble, was seen as a good opportunity to successfully create the appropriate attention and exchange possibilities at an event. Already in the run-up to the event, attention was drawn to the event and an analysis of the proposal about the digital campus were presented in various Unite! committees.

The aim of this event was to get in touch with the community leaders and participants from the whole Unite! community and share the plans and ideas of the several tasks within Cm.2 (T2.2, T2.3, T2.4, T2.5, T2.6) to facilitate future collaboration. The idea behind the interactive session was especially to receive feedback on a set of ideas from stakeholders, not only as part of the requirement analysis (D2.1), but also to become aware of future requirements and plans that concern the digital campus.

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We have planned a two-hour event, where we have invited all "Unite! Dialogue Week" participants. On February 28, 2023, the event took place, which we would like to describe below. The interactive Cm.2 event had several different booths and opportunities to interact, which people could visit according to their interest and needs:

- "Booth A: Information for Visitors" was intended as an informational stand where participants could get general information on the event and on Cm.2, for example how the community is structured and what it focuses on.
- "Booth B" was divided into three different booths related to the Metacampus. The aim in "Booth B-1: Metacampus – Opportunities" was to present the Metacampus to participants, share its opportunities and already existing good practices. At "Booth B-2: Metacampus – Your Plans (T2.3, T2.4)", we provided forms and collected participants' plans and wishes concerning Metacampus. "Booth B-3: Metacampus – Future Tours" finally presented four teaching scenarios based on the project proposal (e.g., joint lectures or staff trainings) and collected feedback on whether participants found these scenarios relevant and what potential challenges could be.
- "Booth C: Tools to support students' mobility" presented the ESCI, its context and the objective of the task. Additionally, participants were asked to write down their expectations of the tasks and what potentials difficulties could be in this field.
- The booth designated as "Booth D: Infrastructure" was intended for individuals interested in technological infrastructures. At the booth, we showcased e-learning sketches from our partner universities and invited attendees to provide feedback.
- "Booth E: Digital Campus – Your Ideas" collected ideas on digital campus issues and integrations, both from a student and university perspective.
- The last booth, "Booth F: Let it fly!" highlighted the need to share our Cm.2 offers with others. For this, we asked people to fold Cm.2 flyer into a paper plane and shoot at a target with the planes. At the end of the dialogue, people received folded paper planes to share them at their university.

Some materials used at the booth and photographs of the event are provided in Figure 10.

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Figure 10: Snapshots from the several booths at Unite! Dialogue in Grenoble 03/2023. Note: Photos are not available under open license.

The collected ideas, comments, plans of the event were documented after the event. The event provided many impulses for the content and structure of this requirement analysis, especially regarding topics and aspects that need to be considered more closely in the future, as these also involve further developments or strategic decisions.

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3.3.6 Literature and project desk research, tools

In addition to the specific methods, overviews of interoperability activities (chapter 2) and challenges for the (virtual) mobility of students (paragraph 4.6) were also described for the deliverable (esp. chapter 2). In these cases, current tools were used for research and presentation (ChatGPT 4.0) and literature databases (ERIC, Google Scholar). Of course, tools to support (better) translations (DeepL version 23.9.1591123) or spelling checker are used as well. All results and texts were reviewed by the authors of the deliverable and adapted where necessary.

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4. Overview of federated infrastructures of the Unite! alliance and its learning management system Metacampus

Martin Ebner, Jesus Alcober, Sandra Schön, Fernando M. da Silva, Katharina Gasplmayr, Romain Laurent, Christian Hoppe, Veruscka Xavier Filgueira

The subsequent sections provide a comprehensive exploration of the Unite! alliance's digital infrastructure, emphasizing its learning management system, Metacampus. This analysis covers an overview of the federated platforms of Unite!, the evolution and current usage of Metacampus, the learner's experience within the Unite! digital campus, and the general challenges tied to virtual mobility and the integration of a federated LMS within a European university alliance according to literature.

4.1 Overview of federated platforms of Unite!

Starting from 2020, Unite! has achieved significant milestones, including the establishment of the Unite! Metacampus platform. This platform serves as a collaborative digital space for staff and students, offering joint courses, programs, and training opportunities. Additionally, Unite! has adapted the uShare platform, a shared data management and communication platform, facilitating efficient collaboration among workgroups and supporting the overall management of the alliance.

In September 2023, four platforms are assigned as key platforms of the Unite! alliance: namely the Unite! Website, Unite! uShare, the LMS Metacampus, and Agora (a business management software (see Figure 11). These platforms serve as essential tools for facilitating communication, collaboration, resource sharing, and learning management within the alliance, enabling a cohesive and efficient ecosystem for the member universities.

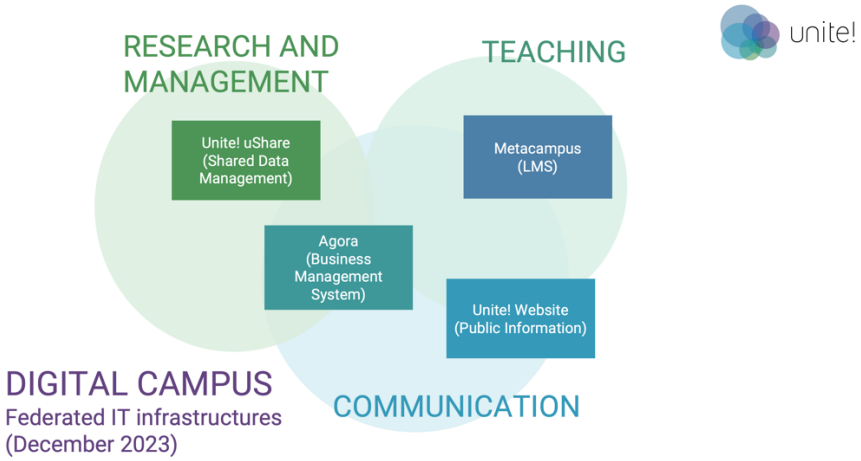

Figure 11: Overview of the Unite! Digital Campus Infrastructure Key Platforms and their key applications

Three key platforms were already implemented at the Erasmus+ project start and are already in use with the aim of seamless collaboration and resource sharing.

- The Unite! Website is based on a content management system (CMS), providing a centralized hub for information dissemination and communication for the public.
- Unite! uShare serves as a shared data platform, enabling efficient data management among alliance members.
- Metacampus, based on Moodle, functions as the learning management system (LMS), facilitating online courses, interactive learning materials, and assessments for students and educators within the alliance. Moreover, Metacampus supports LMS interoperability

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standards, and intends, as a more far-reaching goal, to contribute to development of a central hub of all partner LMSs, facilitating the reuse of shared learning resources and contributing to the seamless integration of courses offered and shared at the alliance level, with local courses available in each partner LMS.

These platforms collectively support the digital infrastructure of the Unite! alliance, promoting effective communication, data sharing, and collaborative learning experiences. In January 2023, with the start of a new project aUPaEU by two Unite! alliance partners and another University alliance called EPICUR, another platform was installed and is under deployment, "Agora", based on the business management platform odoo (aUPaEU, 2023; Odoo.com, 2023).

Table 3 provides brief descriptions to the key platforms utilized within the Unite! university alliance.

Table 3: Overview of IT platform of Unite! and their purposes, technologies, and funding.

	Unite! Website	Unite! uShare	Metacampus	Agora
Purpose	Public information	Unite! Intranet	Interaction among users in Unite! (teachers, students, staff)	Interaction between any user and Unite!
Technology	CMS (content management system)	CMS owned by UPCnet	LMS (learning management system)	BMS (business management software)
Platform	Plone/Zope	Base: Plone/Zope and uShare development	Moodle	Odoo
License	Open-source	Base: open-source development; uShare: Owned by UPCnet	Open-source	Open-source
Developer/ Maintainer	UPCnet	UPCnet	UPCnet	UPC
Responsibility	Unite! Communication Coordination (UPC)	Unite! Secretariat	E+ (Cm.2)	aUPaEU
Examples	News, activities, information	Alliance repository (for all projects within Unite!)	Educational activities (courses), non-educational activities (video contest, student festival, student fair, language tandems)	Shared infrastructures, matching capacities, Metacampus enquiries, Unite! enquiries, events, surveys, etc.
Authenti-cation	User account for editors	User account	eduGAIN	User account, eduGAIN
Status	In use	In use	Pilots in use	Pilots in use
Languages	English	English	English + 9 partners' languages	English

Besides these key platforms, other tools are part of the digital infrastructure and in use:

- Identity and access management: eduGAIN
- Recognition and credentialing: Open Badges
- Communication: Mailing Lists

Additionally, in certain cases, partner infrastructures are also adapted and utilized for the development and management within Unite! One example is the usage of TU Graz cloud system to work within Community 2 Digital Campus.

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According to the Erasmus+ project description, Unite! Community 2 Digital Campus is primarily responsible for IT services related to learning and teaching in the alliance – as is also described in the table under Responsibility. The following description is therefore limited to the learning management system Metacampus, which is supported by Community 2 Digital Campus.

4.2 The federated learning management system Metacampus and its development

Metacampus, Unite!'s central learning management system, was implemented as a virtual hub based on the open-source system Moodle. Metacampus is already in use since 2021 and is essential for the IT-related support of joint learning and teaching in the alliance. (see Alcober & Mohammadali, 2023; Alcober Segura et al., 2021). A cross-functional team from the Universitat Politècnica de Catalunya (UPC) has spearheaded the creation of the Metacampus. This team, directed by the Institute of Education Sciences (ICE), and in partnership with the ICT Services Area and UPCnet (a company offering IT services to UPC), boasts significant proficiency. Their expertise stems from extensive experience with UPC's institutional virtual campus, Atenea, which utilizes the Moodle learning management system. The team's familiarity with Campus Digital, an earlier Lotus Notes-based version of the platform used until 2007, further reinforces their competence in this area (Alcober & Rincón, 2000; Alcober & Mohammadali, 2023).

Developments to date are described in a paper by Alcober and Mohammadali (2023) and relate to EduGAIN, an integrated search engine, the LTI integration, the course catalogue, and several Moodle functions such as GDPR issues, multilingualism, and open badges.

4.2.1 eduGAIN

A vital feature identified is the capacity to avoid the necessity for Unite! ecosystem users to re-register within the Metacampus – because of several reason, just as comfort, traceability, clean data exchange. The optimal solution, *prima facie*, involves the use of eduGAIN (Michael & Anna, 2019). Previously, an interim measure was adopted, whereby users with institutional email addresses from any of the nine universities could temporarily register. This solution permits Unite! community members to access the Metacampus using their native credentials, an aspect that has been greatly appreciated. The platform can recognize the user's role within their home university, and consequently tailor the user experience appropriately, such as restricting visibility of content that is not relevant to the user (Alcober & Mohammadali, 2023). This aspect should be refined because a unified method of informing the roles of the various partners is required.

4.2.2 LTI integration

The incorporation of Learning Tools Interoperability (LTI) is a pivotal attribute, one with which the team is well acquainted (Alier et al., 2021). This technology will potentially permit students to engage with courses *via* the Metacampus in the future, even when the courses are hosted on the original virtual campuses of their respective professors. Consequently, educators can fulfil their responsibilities within their original virtual environments without necessitating the replication of their materials onto an alternative platform. This is made possible through the utilization of an advanced Moodle version (v.3.8 or higher), the creation of a plugin by UPCnet, available in Moodle plugins directory, and the supportive collaboration with the University of Grenoble INP-UGA. Notwithstanding, user management and security present certain challenges that have been identified, necessitating further exploration prior to their application within the operational systems. (Alcober & Mohammadali, 2023)

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4.2.3 GDPR and accessibility of Metacampus

The Metacampus allows compliance with the General Data Protection Regulation (GDPR) (Amo et al., 2019) and aligns with the Web Content Accessibility Guidelines (WCAG) 2.1 at an AA level (White, 2019). (Alcober & Mohammadali, 2023)

4.2.4 Multilanguage plug-ins

Beyond English serving as the principal language of instruction, but not the native language of any of the members of the alliance, the Metacampus also incorporates the native languages and cultures of partner institutions due to its multilingualism. English is adopted for all interuniversity courses despite being the primary language at any of the nine Unite! universities, owing to its acceptance as a common language across all institutions. As Moodle has demonstrated effectiveness for multilingual teaching (Qin et al., 2022), the Metacampus team has integrated the nine different languages utilizing the corresponding language packs. The combination of the Atto Multilanguage plugin with the MultiLanguage Content filter plugin enables users to upload content in any of the nine languages (Mangiatordi et al., 2019). So, users are required to upload content that is both accessible and available in multiple languages to meet accessibility and multilingualism standards. This outcome relies heavily on the active participation of users, as a crucial component for achieving the platform's objectives. (Alcober & Mohammadali, 2023)

4.2.5 Open Badges

Additionally, Open Badges by Mozilla are implemented. This digital credentialing system allows individuals to earn and showcase recognized achievements, skills, and knowledge in a portable and verifiable format. So, the functionality of OpenBadge credentialed courses (Myllymäki & Hakala, 2014) has been employed to deliver courses in a standardized manner to students, faculty, and administrative staff. (Alcober & Mohammadali, 2023). Currently, the option to transfer it to the Open Badges offered by the Moodle platform is being considered.

4.2.6 Additional functionalities

Finally, additionally functionalities of the Metacampus not mentioned before are the following (Alcober & Mohammadali, 2023):

- Communities have been established leveraging the Moodle overflow plugin, which, in addition to the above-mentioned characteristics, offer public forum, so enables functionality reminiscent of StackOverflow (Vasilescu et al., 2013).
- Collaborative spaces for asynchronous interactions, for instance during project events (Boot Camp and Dialogue), or student co-creation initiatives, have been effectively utilized.
- The provision of master thesis proposals, facilitated for a students' summer school through the Moodle database activity, exemplifies the potential of Moodle functionality to accommodate seemingly remote necessities.

4.3 A learner's journey at the Unite! digital campus and with the current set-up

This following Figure 12 gives a comprehensive overview of the learners' journey at the Unite! Digital Campus. Learners can be students, but as well staff members who wants to join Unite! Staff development trainings.

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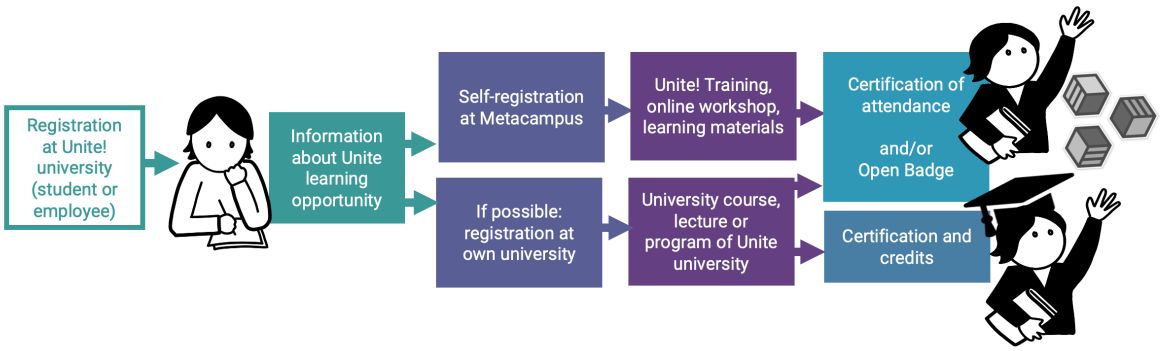

Figure 12: Overview of current learner's journey within Unite! digital campus.

In the following, we would like to describe for whom and for which learning and teaching settings the Metacampus in its current version is suitable and its use should be considered:

- **Objectives**: Metacampus is designed to support **Unite!-wide educational opportunities** and facilitate joint training programs within the alliance, so learning and teaching activities that should be available for at least two partner universities in the alliance – or all. It is particularly useful when a federated learning management system is needed for tasks such as material dissemination, assignment submission, and discussion forums, or a LTI link between partner learning management systems through a central campus.
- **Target group**: Metacampus is intended for the participation of members exclusively from Unite! universities, promoting collaboration among individuals from multiple universities rather than being limited to a single institution. Only members of Unite! universities can serve as providers (teachers) on the platform.
- **Content:** Metacampus serves as a platform for hosting and sharing educational content. The transfer of content through Learning Tools Interoperability (LTI) is a possibility.
- **Registration and Certification:** Users can register themselves on Metacampus by using their own university accounts. Confirmation of participation can be granted through manual issuance of Unite! Certificates or the use of Open Badges. However, there is no direct transfer of registration data to local campus management systems. Due to legal/organisational issues, certification is only possible for students registered at a specific partner university.

In summary, Metacampus is suitable for conducting Unite!-wide educational opportunities and facilitating joint training programs within the alliance. Its functionality as a learning management system supports the dissemination of materials, submission of assignments, and facilitates interactive discussions. The platform is exclusively open to members of Unite! universities, promoting collaboration across institutions.

Case Studies: Metacampus can be effectively utilized for various case studies, including staff development programs, extra-curricular trainings for students, and language tandem initiatives.

4.4 Current usage of the Metacampus

Alcober and Mohammadali (2023) describes the use of the Metacampus in 2022: In 2022, the Metacampus developed 55 distinct spaces, with three accommodating more than 150 participants, five hosting over 50, and a further 23 entertaining more than 20 participants. These spaces encompassed various initiatives such as the Multicultural and Multilingual Training Center, the Teaching and Learning Academy, the Hackathon (H@ckyour-COVID), and Student Co-Creation Unite! Future and Joint Initiatives. As of April 2023, the Metacampus boasted 5,450 registered

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users across the nine Unite! member universities. It is noteworthy to observe that both the mean session duration and user count indicate an engagement of 5,200 users, each averaging a session time of 3 minutes and 28 seconds (see Figure 13). Furthermore, it was discerned that 21% of users accessed the platform via mobile devices compared to 78% who opted for desktop computers, potentially attributable to the absence of a dedicated mobile application for Metacampus access.

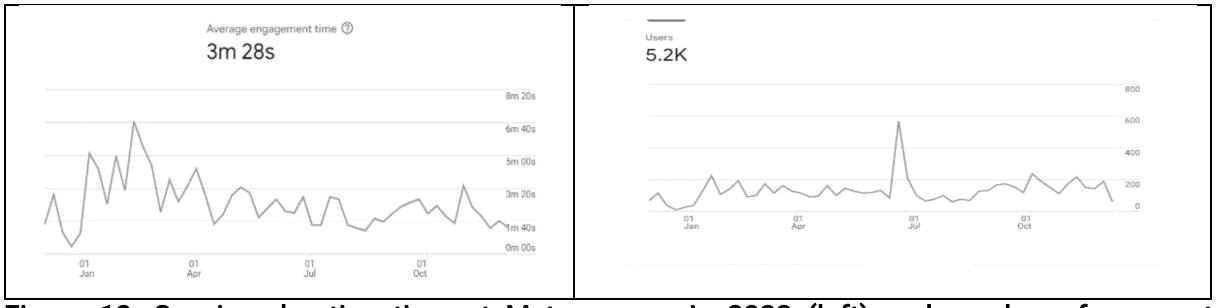

Figure 13: Session duration time at Metacampus in 2022 (left) and number of users at Metacampus (right). Source: Alcober and Mohammadali (2023), Fig. 2 and Fig. 3, Screenshots of Metacampus Google Analytics (2022)

4.5 Metacampus teaching support

In the following, we provide an overview of the current state of the support system for Metacampus as of October 2023. In the subsequent sections, we will explain how user enquiries and issues are efficiently addressed, detailing the underlying structures and processes in place.

While during the introduction of Metacampus, UPC and UPCnet took care of all support requests from users, support was set up differently with the new project (11/22): Now TU Graz is responsible for handling support requests and building a good support strategy in the medium term with the involvement of partners.

First, an e-mail address (metacampus@unite-university.eu) was introduced, which is also used for external communication (e.g., at the Dialogue events of Unite!). Furthermore, with the help of Agora (based on the software Odoo) in cooperation with the aUPaEU project (see Table 3, 26, a documentation and coordination system is being used that allows partners from several universities to view the progress of such requests and, if necessary, to take them over.

It makes sense for some reasons to have a central point of contact for people who provide Metacampus support, as there are some specifics that may be solved differently in your own learning management systems. These are, for example,

- logins are made with the help of eduGAIN to access to the platform using eduGAIN federated credentials,
- multilingual work is possible,
- the Metacampus is based on Moodle and uses special/other plug-ins as local LMS,
- the processes for creating a new course room ("space") are a central service.

The support of the own support service and structures might nevertheless be required or helpful, e.g.

- if the usage of additional tools (e.g., video conference systems) is needed,
- for support in the native language, especially concerning teaching issues and possibilities,
- or concerning copyright issues or other legal issues, e.g. GDPR.

During the initial months of the project, we not only identified and approached key stakeholders but also conducted preliminary meetings and a survey. In the written questionnaire, we aimed to gather data on various parameters, such as the usage of Moodle within the respective institutions, the

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size of the support team, and their organizational and communication structures. Furthermore, we sought to understand the expectations and interests of the partner teams regarding collaboration centred around Metacampus.

At the beginning of August, responses from five partner institutions were available. On the one hand, they show that there are indeed major differences in the organization and communication methods of the support teams, for example 4 of 5 universities use a generic e-mail address for their support, one does not. 4 of 5 seem to support a lot of support online, 1 has regular and busy office hours on-site.

We also asked the digital teaching support teams to share their wishes for future collaboration in Unite! and on potential future issues. From this, it appears that there is a need to get “more information about Metacampus” and that materials for teachers are desired. We as well see interest in exchange (see Figure 14).

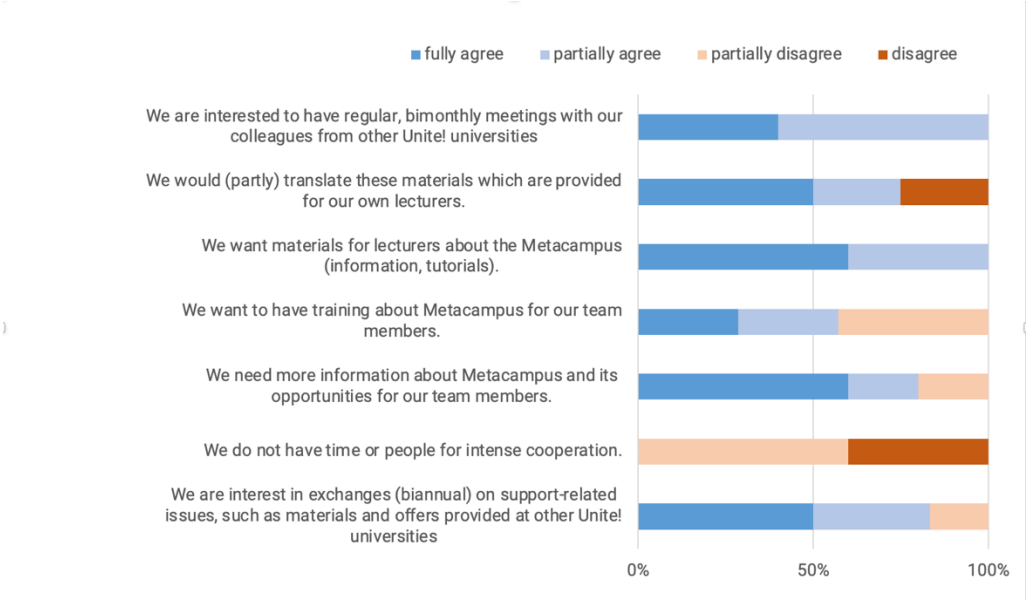

Figure 14: Wishes for future collaboration with other Unite! e-learning support teams and/or T2.3 (N=5 partners, answers from August 2023).

However, the fact that not all partners responded to the survey also shows that the need or the opportunities for future cooperation are also not (yet) seen.

4.6 The challenge of virtual mobility and how to get a federated LMS useful in a European university alliance

Regarding joint learning platforms, the study by Berger et al. (2023) on interoperability challenges in European university alliances presents the Unite! Metacampus as a case study for a successful implementation. In summary, referring to all 4 examples (Unite!, YUFE, Unita, EPICUR), the authors state: "While organisational interoperability is a matter of time and commitment, technical interoperability is yet to be fully solved." (p. 37).

Cm.2 digital campus primarily focuses on the IT infrastructure and technical support for digital teaching and mobility. It is essential to note that it is not directly responsible for the creation and execution of the online courses themselves. But, as part of the requirement analysis we will address as well organisational, legal, and other challenges in the following that need to be addressed to enable more intensive and effective use of the platform in the future. The following will detail these challenges and suggest possible solutions based on authors’ assumptions and

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literature. Although several Unite communities are already addressing some of these identified challenges, we do not go into them in detail in this report.

Firstly, we would like to briefly describe why the question "how an LMS gets to be used in a university" has certainly been raised before. However, practical experience shows that today, LMSs are simply used in all universities to a relevant extend as it supports teaching and learning. For the federated LMS of an alliance, this is not to be expected in the same way as teaching students at other universities is not part of the lecturers' s work description.

Table 4 sheds light on more differences between the usage of a typical university's Learning Management System (LMS) and that of a federated LMS within a European University alliance. The central university LMS is deeply integrated into daily operations, widely recognized, and essential for the academic experience. In contrast, the centralized alliance LMS might have differences in operation and functions, and faces competition from alternative tools offered by individual universities.

Table 4: General differences concerning the usage of a university LMS and the federated LMS of a European University alliance.

Use of the central LMS / systems of the partner universities	Use of federated LMS for an alliance
• Most lecturers and students are familiar with them. • Students expect one (not many different) platform to be used. • LMS functionalities are necessary for many courses (storage of materials accessible only to one user group, submission of assignments).	• Possible differences in operation and functions • There are alternatives (the tools of one's own university). • Support structure and its organisation might be different

There are a series of articles that address why virtual learning in collaborations between European universities is so challenging and difficult, and what solutions are available.

Virtual Mobility expands the range of potential learning situations (Redchuk et al., 2011): For instance, students might opt to attend another university to earn specific credits in-person, whilst simultaneously continuing their studies at their home institution via an online platform. Alternatively, the students could earn credits at the host institution following a period of on-campus study at their home institution. Indeed, the appeal for many students is the opportunity to experience studying at a different university.

In our deliberations and dialogues, we have encountered the complexity inherent in understanding and articulating the precise rules and procedures required when students wish to participate in a course as "virtual" learners, especially concerning accreditation of learning results. It proves difficult, for example, if you want to issue a university certificate to students from other universities. In the case of Graz University of Technology, this is simply not legally possible now. Students who want to receive a certificate must therefore enrol as a regular student – which in Austria, for example, is also legally associated with payment of a tuition fee. This regulation applies regardless of whether only one course or an entire degree program is to be completed.

A relevant finding is also shared by Al Laban et al. (2020) in a survey on virtual mobility from a practical perspective at European universities: "A central finding from the survey is that beyond the decision-making level, the applicable policies are apparently hardly known at HEIs." (Al Laban et al., 2022, p. 155).

Guidelines for online program that facilitates international virtual exchange in higher education are available since more than a decade (Redchuk et al., 2011), but obviously it is still not simple to handle the issue. Giralt et al. (2022) describes scenarios for the integration of virtual exchange in higher education. Their study investigates the integration and accreditation of blended mobility and

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virtual education in academic offerings. Through analysing various case studies, it illuminates practices of accredited virtual education in higher education (Giralt et al., 2022, p. 118). Notably, 'accreditation', signifying official recognition of acquired skills and knowledge typically *via* credits, is distinguished from 'recognition', which might be affirmed through non-credit acknowledgements like certificates or open badges. The European project remote.EDU addresses the issue that virtual mobility makes online assessment a necessity (Rajagopal et al., without year) and as well the need of special virtual learning skills for learner (Rajagopal et al., 2020).

Drawing from the experience of the Unite! alliance, a paper by Kjellgren and Serrano van der Laan (2023) delves into the intricacies and lessons learned from facilitating virtual exchange language and global competence courses within one of the pioneering 17 European university alliances. They highlight organizational issues such as different schedules are influencing virtual exchange courses (Kjellgren, & Serrano Van der Laan, 2023). They as well highlighted the challenge of multilingualism and multiculturalism (Kjellgren & Serrano van der Laan, 2022).

Another challenge might be the differences in copyright rules in European country, in particular the possibilities of using materials with the help of digital technologies in university teaching and/or on a federated system outside the own country and available for students from other countries. Several publications describe the differences of the copyright rules for (higher) education (Congelton & Yang, 2011; Nobre, 2017). This illustrates that it is not simple to identify what is allowed intersection of authorized uses in all European countries. One solution to this is the use of open licenses or the use of Open Educational Resources (OER), which are recommended (UNESCO, 2019) but are still not very widespread. The presentation of authors' assumptions, the literature and the table do not claim to be exhaustive and aim to highlight that there are numerous challenges, some of which can be addressed or alleviated with technical means. In any case, a concerted effort is required to meet these challenges. Within Unite! several communities are addressing some of these identified challenges.

Other European alliances are also facing these challenges and are trying to develop solutions to them. Concepts are being developed for the integration of a potential virtual teaching offering, for example: The CIVIS European university alliance presents the design and implementation of a virtual mobility matrix as a foundational step for creating comprehensive curricular structures like European Degrees (see Zus et al., 2022).

Table 5 delves into the multifaceted challenges and corresponding potential solutions associated with implementing a federated learning management system within European university alliances. The challenges span legal, organizational, and other pedagogical and intercultural domains. For instance, while Europe shares the General Data Protection Regulation (GDPR), its interpretation varies, suggesting a need for uniform benchmarks. Additionally, differing *curricula* require alignment, possibly aided by common academic frameworks like ECTS. Beyond these, motivational and cultural considerations further complicate the landscape, hinting at a broader need for awareness, training, and incentives.

The presentation of authors' assumptions, the literature and the table do not claim to be exhaustive and aim to highlight that there are numerous challenges, some of which can be addressed or alleviated with technical means. In any case, a concerted effort is required to meet these challenges. Within Unite! several communities are addressing some of these identified challenges.

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Table 5: Sketch of challenges and potential technical and other solutions for using a federated learning management system in a European university alliance.

	Challenge	Potential solutions
Legal	Different copyrights in Europe and possibilities to use resources by others	Allowed usage, if openly licensed.
	GDPR issues needs to be fulfilled for federated LMS	The strictest implementation as a benchmark, co-organisation necessary.
	Accreditation of learning results (Giralt et al., 2020) – certificates only for own students	Contracts of the alliance and EC / states
Organizational	Different curricula and lectures need to be aligned.	Standards as ECTS and another curriculum framework might help
	Translation of the materials might be needed (e.g., into English)	Incentives for teaching for external students
	Multilingual user guidance and support.	Staff of partner universities might be integrated in user support
	Simple registration needed	eduGAIN (implemented)
	Online assessment is a necessity (Rajagopal et al., without year)	Tools and assessment supporting e-assessment
	Different schedules (Kjellgren & Serrano Van der Laan, 2023)	good planning and flexibility
	Exchange of resources and course information	LTI (prepared)
	Clarify the possible exchange of user data	Needs a clear description of ALL existing systems and potential interfaces and/or a common campus according to GDPR.
Other challenges	Motivational	Incentives to make the usage attractive for teaching and learning
	Recognition of learning results (Buchem et al., 2018)	Several opportunities, e.g. Open Badges
	Multicultural issues (Kjellgren, Taylor & Serrano van der Laan, 2022)	Awareness and training
	New competencies (e.g. Learner skills) (Rajagopal et al., 2020)	Awareness and training
	Pedagogical differences	Awareness and training

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5. Unite! partners' digital infrastructures for learning and teaching

The following service descriptions vary in the way partner universities have selected the services to include in their descriptions. In advance, it was challenging to establish the level of intrinsic importance of systems we needed to be described. Some partners have only described services that are distinctive and unique to them, while others have also included more general services that they consider important for their infrastructure. The resulting descriptions, in a way, provide deeper insights, as they illustrate what different partner universities prioritize as essential services.

5.1 Overview of the partners and notes on their infrastructure

Juha Martikainen, Martin Ebner, Fernando Mira da Silva, Sandra Schön

First, we would like to give a general overview of the framework data of the Unite! partner universities by presenting their countries of origin and the number of students in Table 6.

Table 6: The Unite! alliance universities in overview.

University	Abbr.	Country	Number of enrolled students	Number of academic staff	Number of admin. staff	Chapter
Aalto University	Aalto	Finland	17,500	2,800	1,200	5.2
Graz University of Technology	TU Graz	Austria	16,500	2,700	1,100	5.3
Grenoble INP graduate school of engineering and management, University Grenoble Alpes	Grenoble INP-UGA	France	8,350	550	730	5.4
KTH Royal Institute of Technology	KTH	Sweden	13,500	2,750	1,250	5.5
Politecnico di Torino	PoliTO	Italy	38,700	1191	986	5.6
Universidade de Lisboa	ULisboa	Portugal	47,800	3,400	2,100	5.7
Universitat Politècnica de Catalunya/BarcelonaTech	UPC	Spain	30,000	3,000	n.a.	5.8
Technical University of Darmstadt	TUDa	Germany	24,406	3,031	1,986	5.9
Wroclaw University of Science and Technology	Wroclaw Tech	Poland	21,176	2,288	1,957	5.10

Sources for students, academic staff and administrative staff (if) as follows:
Aalto (https://en.wikipedia.org/wiki/Aalto_University, 2.10.23),
TU Graz (https://de.wikipedia.org/wiki/Technische_Universit%C3%A4t_Graz, 2.10.23),
INP-UGA (https://www.grenoble-inp.fr/en/about/key-numbers, 14.1.24),
KTH (https://en.wikipedia.org/wiki/KTH_Royal_Institute_of_Technology, 2.10.23),
PoliTO (https://www.polito.it/en/polito/politecnico-at-a-glance, 18.10.2023),
ULisboa (https://en.wikipedia.org/wiki/University_of_Lisbon, 2.10.23),
UPC (https://en.wikipedia.org/wiki/Polytechnic_University_of_Catalonia, 2.10.23),
TUDa (https://en.wikipedia.org/wiki/Technische_Universit%C3%A4t_Darmstadt, 2.10.23),
Wroclaw Tech (https://en.wikipedia.org/wiki/Wroc%C5%82aw_University_of_Science_and_Technology, 2.10.23)

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While developing the descriptions and visualisations of all partners infrastructures, we have acknowledged several special features or settings we would like to introduce to you.

- Grenoble INP-UGA is the product of a recent integration between former UGA university and Grenoble INP (2020) and still operates using dual, overlapping infrastructures.
- University of Lisboa has a partial federated architecture, and there are slight variations at faculty level and university wide level.
- Several partners – KTH (Sweden), Aalto (Finland), UGA-INP (France) – rely on national systems, which is unfamiliar or unparalleled in other countries.
- Some partners seem to focus on open-source and on-premises tools (TU Graz, Austria, Grenoble, France) whereas others more intensively use non-premises tools (Aalto, Finland, KTH, Sweden).

Generally, we would like to highlight, that (some) following presentations does not explicitly name e-mail as service and that hat EduGAIN as implemented, although both are implemented in all universities.

After all partner descriptions, an overview of LMS infrastructure in the alliance is provided.

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5.2 Aalto University (Aalto)

Veruscka Filgueira Xavier, Juha Martikainen (all Aalto)

5.2.1 Overview of digital infrastructures for learning and teaching

Aalto university's digital learning ecosystem is a work in progress, moving towards student centric learning. It is a blend of proprietary, open-source and self-developed software. The main services for teaching and learning (provided by university level) are SISU SIS and MyCourses LMS (Moodle). SISU SIS is developed by a Finnish company (owned by universities). In addition, the department of Computer Sciences host their own, in-house developed open-source LMS (A+). The policy is to integrate learning software into the LMS while moving towards a true ecosystem without central monolith LMS. In addition to degree-based learning services, we host OpenLearning (openlearning.aalto.fi) (Moodle), a service for Open Courses and MOOCs. We are currently planning our next generation MOOC and Life-Wide Learning (LWL) offerings.

Figure 15 gives an overview of Aalto's digital platform and tools.

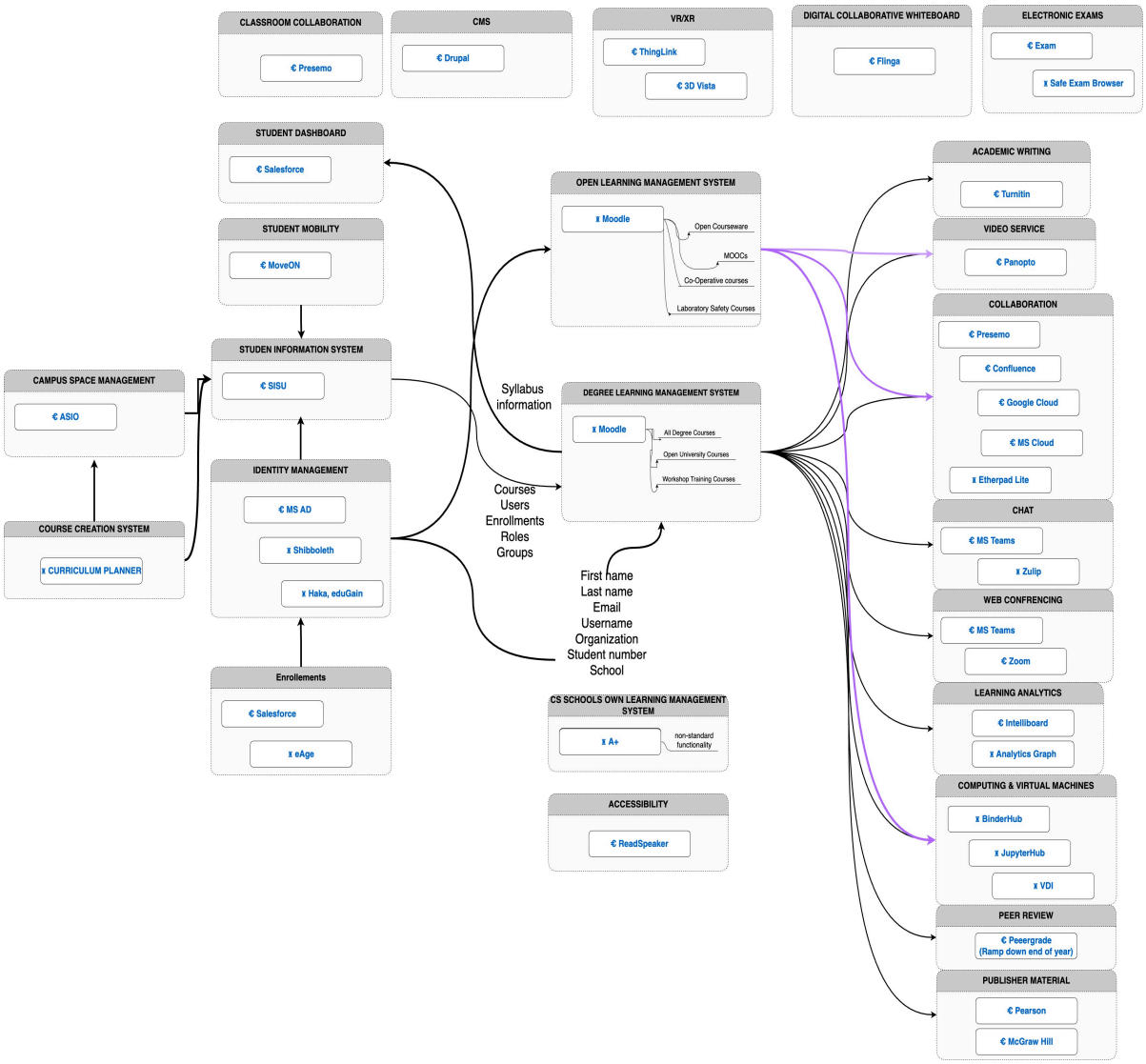

Figure 15: Aalto's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 7 gives an overview about Aalto's key systems in use in students' life cycle perspective.

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Table 7: Aalto's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (version number)
Student registration	• Sisu • National services (Studyinfo, Oili) • Aimo (local) • MoveON • Salesforce (Aalto only)
Getting access data	• Microsoft AD • Sisu
Find curriculum / courses	• Sisu • Aalto.fi (for Open University) • Courses.aalto.fi (Salesforce, degree based) • MyCourses (Moodle, Degree based) • OpenLearning (Open / Mooc)
Course registration	• Sisu • OpenLearning (for Open courses)
Course learning activities	• Moodle 4.1 (Degree based) • Moodle 4.1 (Open Learning) • A+ (in house developed platform, mostly for CS) • Zoom • Zulip • MsTeams • Panopto • Google for Education • Office 365 • Exam (on premises digital exams) • A lot of services / software integrated into Moodle (some accessible otherwise as well)
Course assessment(s)	• Moodle • Sisu • Exam
Ending with graduation (issuing the certificate)	• Sisu • eAge • Aaltodoc
(if) Central authentication platform (SSO, Keycloack, etc.)	• Shibboleth. Azure AD, eduGAIN, One Identity Manager

In the following, all these systems and tools are described in short.

Sisu (Student Information System)

Description	Student Information System developed by a company owned by Finnish universities (Funidata). Master data for courses, enrolments, credits, student information and lifecycle.
Purpose at our university	• Master data for courses, enrolments, credits, student information. • Students use it to search and enrol for courses, see their study information, graduate. Does not contain thesis management or course syllabus. • Teachers use it to grade students and control their courses (groups, accept / deny students enrolments) • Does not contain physical campus management or course creation (These are done on Asio (physical campus management and timetables) and Curriculum Planner service.
Use	• Students (Enrolling to courses, administrating their information, Credits) • Teachers (Course administration, groups)
Additional features	Developed by Finnish universities, used in the developer universities

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Data flow /exchange	Master data for course and student related information. Integrated into Moodle (degree based) for: • Courses (name, dates, responsible teacher, 2-year course content) • Enrolments (roles) • Groups • Users (name, email, study number, organization) MS AD Gets information from • MS AD • Workday (Staff roles)
Authentication	Shibboleth SSO, MS AD, Role based

MyCourses LMS – Moodle (Learning Management System)

Description	Learning Management System using Moodle (4.1.3) as core with some personalizations and core changes done in-house. Extensive integration both into Sisu SIS and Salesforce platforms and several learning services. Hosted in-house (some integrated services hosted in cloud or SAAS).
Purpose at our university	Central place for course related activities and "home" for all course instances. Integrated hub for digital learning services and tools. User interface for course syllabus information. All course instances have a workspace in MyCourses (weather the teacher uses it or not).
Use	Home for all course instances • UI for adding syllabus information about the course. • Basic information about the course is visible to world. Basic Learning activities and assignments Automatically assessed quizzes (Stack for math, Coderunner for coding, Molsimilarity for Chemistry) Chats and discussions (MS Teams (in-house integration) and Zulip) Video and conferencing (Panopto and Zoom) Collaboration (Etherpad, OU Wiki) H5P Virtual computing (JupyterHub) Educational analytics (Intelliboard) Educational materials (Wiley, Pearson) Syllabus input and read (In-house developed) Access creator for lab courses and workshop safety courses (AD groups based on course completion, in-house developed) VDI resource group creation (AD Groups based on course enrolment, in-house developed) Safe exam browser Integrations to CS Dept. services (A+ LMS, Code repository, Course assistant queue)
Additional features	Works as UI for syllabus information input
Data flow /exchange	From SISU • Enrolments • Course instances • Course role (teacher, student, course assistant) • Groups and groupings • Basic course information • Course schedules (start,end, exams) From AD (trough Shibboleth) • Username • Firstname, Lastname • Student number / Learner number • School • Email To Salesforce • Syllabus info (business co-operation information – in development)
Authentication	Shibboleth SSO, Sisu (roles, enrolments), Haka, Guest

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OpenLearning LMS – Moodle (Learning Management System)

Description	Learning Management System using Moodle (4.1.3) as core with some personalizations and core changes done in-house. Hosted in-house (some integrated services hosted in cloud or SAAS).
Purpose at our university	Open Education materials, MOOCs, Open courses, collaboration with other institutions.
Use	Basic Learning activities and assignments Automatically assessed quizzes (Stack for math, Coderunner for coding, Molsimilarity for Chemistry) Collaboration (Etherpad, OU Wiki) H5P Video (Panopto) Virtual computing (JupyterHub) Access creator for lab courses and workshop safety courses (AD groups based on course completion, in-house developed) Safe exam browser
Additional features	
Data flow /exchange	From SISU • Course role (teacher, student, course assistant) From AD (trough Shibboleth) • Username • Firstname, Lastname • Student number / Learner number • School • Email
Authentication	Shibboleth SSO, Sisu (roles, enrolments), eduGain, Local users, Guest

5.2.2 Special features in Aalto/Finland

Opintopolku (Studyinfo) – national service and registry for applying for basic, secondary, and higher education. Is the national master data for education.

Sisu – Student Information System developed in co-operation by a co-operation of Finnish universities, maintained and developed by a share owned company Funidata).

Teachers / professors have a lot of freedom to choose the tools for teaching.

MFA in use for all, but OpenEducation resources / Open information.

5.2.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 16 to illustrate the journey of students within the system.

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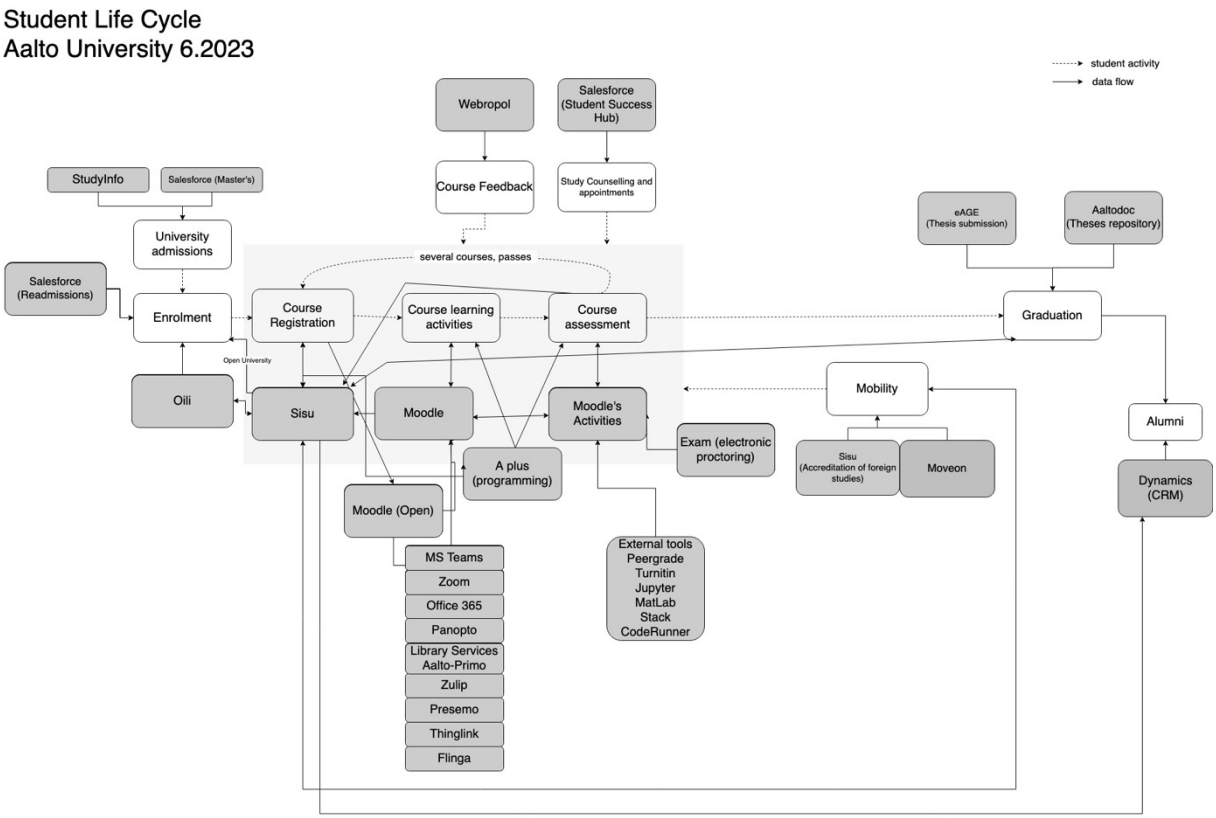

Figure 16: Aalto's student's journey within the digital systems at a glance.

A typical student's cycle starts with applying for university admissions on Study info. Admitted students' info is then transferred to Oili, where the student must register as attending for each study semester. Attending students then enrol for individual courses at Sisu (a system used for many other study administration functions) and their registration info is automatically transferred to the course pages on Moodle. Several teaching tools are used as complement and/or in parallel to Moodle in teaching and in assessment. Course completion and achievements information is transferred from Moodle by the teacher back into Sisu. During their studies, students provide course feedback (Webropol, soon to be replaced with Spark) and have study counselling appointments, managed via Salesforce. The student interested in exchanges apply to mobility via MoveON but their attainments must be inserted on Sisu by study administrators. At the end of their degree, students apply for graduation on Sisu and submit their theses on eAge. Alumni info is managed on Dynamics.

5.2.4 Current and Future Directions

More co-operation with Aalto Executive Education in life-long learning areas. Micro-credentialing and Life Wide Learning offerings being developed. National move towards micro-credentialing and supporting life-long learning mandates, some, integrations in the future. Aalto is pushing for a national blockchain ledger node for credentialing using EU standards.

For Aalto, future is an ecosystem of learning solutions heavily based on integration and common Learning Experience Platform. Headless LMS and Headless CMS and microservices for Learning seem to be (at this point) the way to go. Pushing towards open-source development in-house and good supplier relations with trusted providers.

Aalto University is studying the use cases and benefits of using AI in teaching and learning. We aim to gather the needs of teachers and learners and map them to actual benefits that AI can produce.

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5.3 Graz University of Technology (TU Graz)

Philipp Leitner, Behnam Taraghi, Martin Ebner, Sandra Schön, Markus Koschutnig-Ebner, Katharina Gasplmayr (all TU Graz)

5.3.1 Overview of digital infrastructures for learning and teaching

TU Graz's e-learning architecture is designed to enhance the quality of education by offering an interactive and flexible learning environment. TU Graz employs open-source systems along with its proprietary campus management system, TUGRAZonline. This system is utilized by numerous universities in German-speaking Europe. Additionally, TU Graz hosts iMooX.at, which is based on Moodle and serves as the national MOOC platform.

Figure 17 illustrates the digital platforms and tools at TU Graz.

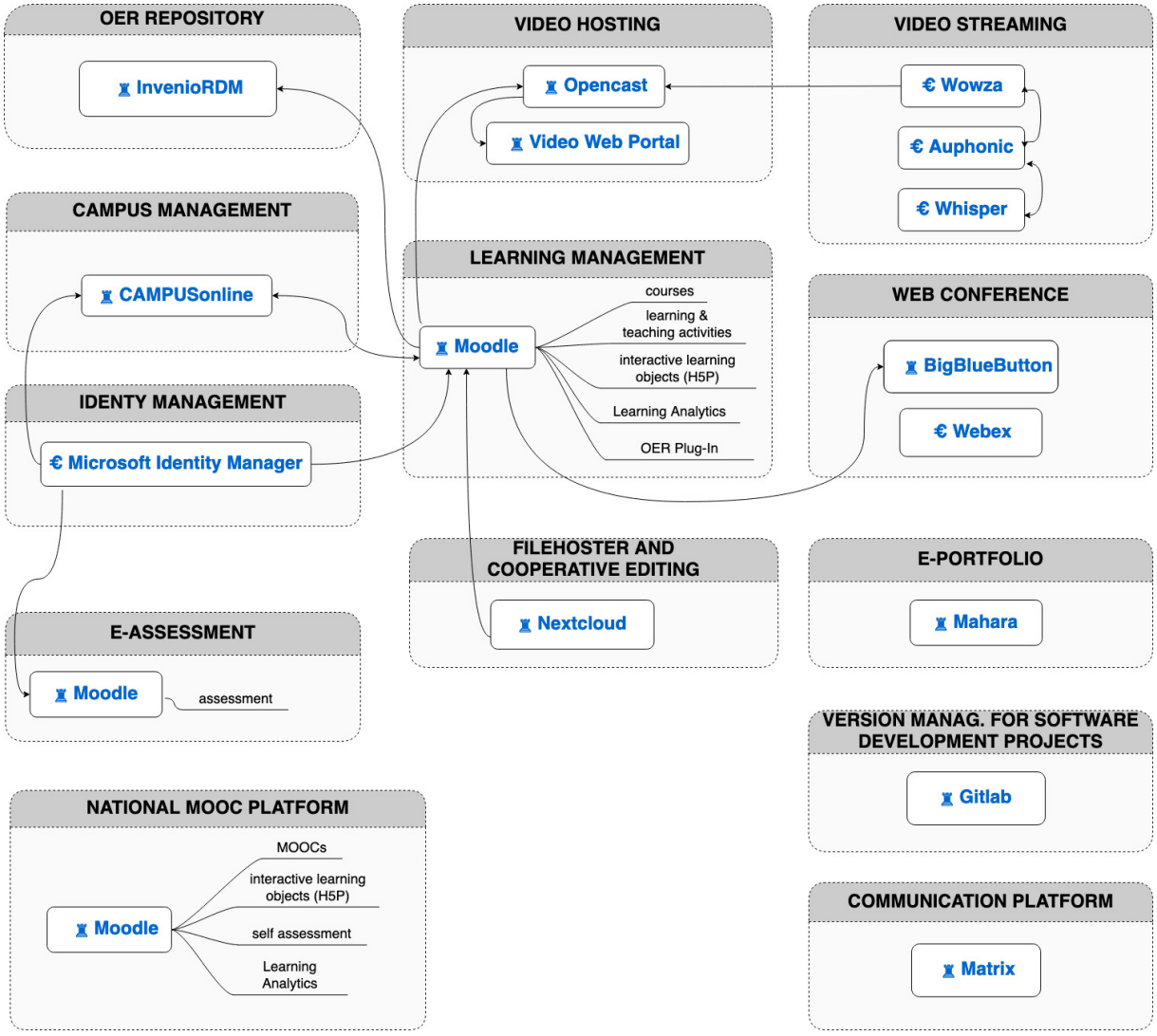

Figure 17: TU Graz's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 8 provides an overview of TU Graz's key systems used from a student's life cycle perspective.

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Table 8: TU Graz's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use inkl. version number, if possible
Student registration	• CAMPUSonline (Campus Management System)
Getting access data	• CAMPUSonline (Campus Management System)
Find curriculum / courses	• CAMPUSonline (Campus Management System)
Course registration	• CAMPUSonline (Campus Management System)
Course learning activities	• Moodle (Learning Management System) v4.1.6 • Moodle (MOOC Platform) v4.1.6 • Opencast (Video Platform) • BigBlueButon (Virtual Classroom) • Webex • Matrix • Gitlab • Nextcloud • LearningLab
Course assessment(s)	• Moodle (Learning Management System) v4.1.6
Ending with graduation (issuing the certificate)	• CAMPUSonline (Campus Management System)
(if) Central authentication platform (SSO, Keycloak, etc.)	• Keycloak, Single Sign-On (SSO)

In the following, all these systems and tools are briefly described.

CAMPUSonline (Campus Management System)

Description	CAMPUSonline serves as the campus management system for Graz University of Technology, as well as 39 other higher education institutions in Austria and Germany. It encompasses the entire student life cycle, from applying for a study program to student and examination management, all the way to graduation. The platform also handles comprehensive university administration tasks. See: https://www.campusonline.tugraz.at/produkt/referenzen/ – last accessed October 17th, 2023
Purpose at our university	CAMPUSonline handles campus management, overseeing everything from application to graduation. It manages the entirety of the university administration process.
Use	• Student life cycle (application and admission at university, access data, curriculum, course registration, exam registration, certificates, graduation) • Teacher life cycle (registration, access data, course offering, exam management, issuing certificates, research documentation, publications, surveys) • University administration (faculties, institutes, administrative staff and their roles and functions, rooms, locations, ...)
Additional features	None
Data flow /exchange	From CAMPUSonline to Moodle: • Courses and course enrollments (students, teachers, tutors, etc.) • Exams and exam participants (examinees, examiners) • Faculties and institutes structured as Moodle course categories • Organization members (e.g., Institute) and their roles From Moodle into CAMPUSonline: • Exam grades
Authentication	Keycloak, Single Sign-On (SSO), oAuth2.0 in CAMPUSonline

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Microsoft Identity Manager (Identity Management)

Description	The unique identity of everyone (teacher, student, administrative staff, and external users) requiring access to one or more university systems is recorded in the Identity Management System. See: https://learn.microsoft.com/en-us/microsoft-identity-manager/ – last accessed October 17th, 2023
Purpose at our university	User identities at Graz University of Technology are managed using this system
Use	The system primarily handles user auto-provisioning in university systems
Additional features	None
Data flow /exchange	Synchronizes users into various university systems: • CampusOnline • Moodle • Nextcloud
Authentication	No user authentication is required.

Moodle (Learning Management System)

Description	Moodle is an open-source learning management system designed to offer educators, administrators, and learners a single integrated system for creating personalized learning environments. See: https://docs.moodle.org/401/en/Features – last accessed October 17th, 2023
Purpose at our university	At TU Graz, multiple Moodle installations are operational. Moodle aids teachers in lecture management, online exams, and assessments. It supports students in daily learning activities like group formation, assignments, self-assessments, and more. Additionally, TU Graz offers lifelong learners and educators a Moodle system for lecturing in areas like iMooX, the national Austrian MOOC platform based on Moodle. Operated by TU GRAZ, iMooX.at allows Austrian universities to present MOOCs, which can be accessed by any student or interested individual.
Use	Course learning activities: • Provision and consumption of course materials • Assignment submissions • Group formation • Scheduling • Integration of BigBlueButton • Integration of Opencast (for video uploads and consumption) • Integration of Nextcloud as a repository • Integration of other learning tools via LTI (e.g., Matlab) • Course assessments • Online exams and assessments • Offline exam question pool management • Learning Analytics
Additional features	Thanks to Moodle's modular design, its functionality can be expanded with plugins to meet specific needs. TU Graz has developed several Moodle plugins, including: • Course and enrolment synchronization from CAMPUSonline • Grade export to CAMPUSonline • Publishing OER course materials to the Austrian OER hub • Learning Analytics
Data flow /exchange	To Moodle • See CAMPUSonline • See Identity Management System • See Nextcloud From Moodle • See CAMPUSonline • See Opencast • See OER repository • See Mahara • See Bigbluebutton • See Opencast • Transferring grades between Moodle instances
authentication	Keycloak, Single Sign-On (SSO)

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Video Web portal

Description	A Video Portal that offers course videos, event videos, and other engaging content.
Purpose at our university	• Serves as the frontend for Opencast. • Offers course videos, event videos, and other intriguing videos from TU Graz.
Use	• Provides recorded lecture videos, event videos, and other captivating content to students. • Offers live streams of courses and events to students. • Acts as a contact point for 1st-level support.
Additional features	The video portal is a self-developed platform.
Data flow /exchange	• Consumes data from Opencast via the Opencast API. • Determines which videos a user has permission to view. • Identifies live channels a user is permitted to watch.
Authentication	Keycloak, Single Sign-On (SSO)

Opencast

Description	Opencast is a scalable open-source system for video capture, management, and distribution tailored for academic institutions. See: https://opencast.org/features/ – last accessed October 17th, 2023
Purpose at our university	At TU Graz, automated lecture recordings and/or live streams from lecture halls are managed and disseminated using this system.
Use	• Management of videos (upload, auto-processing, publishing) • Management of live stream channels • User authorization
Additional features	A video Web platform was developed as the frontend for Opencast.
Data flow /exchange	Synchronizes user authorizations from Moodle, including: • Moodle course enrolments (Instructor/learner permissions) • Upload and management of videos and their metadata from Moodle Provides metadata for the Video portal via the Opencast API, including: • Videos and live channels • User permissions
Authentication	Via the video portal.

Vowza Streaming Engine

Description	Vowza Streaming Engine, formerly known as Wowza Media Server prior to version 4, is a unified streaming media server software developed by Wowza. See: https://www.wowza.com/streaming-engine – last accessed October 17th, 2023
Purpose at our university	The server is utilized for streaming both live and on-demand videos related to lectures and special events at TU Graz.
Use	• Delivery of course live streams and recorded videos to users via the video portal. • Transcoding of live streams (e.g., for adaptive streaming).
Additional features	None
Data flow /exchange	• Video feeds originating from lecture rooms. • Video data delivered to clients via the video portal.
Authentication	No user authentication is required.

Nextcloud

Description	Nextcloud is a renowned open-source software primarily used for storing, sharing, and collaboratively working on documents. See: https://nextcloud.com/ – last accessed October 17th, 2023
Purpose at our university	Nextcloud is predominantly utilized for sharing documents among colleagues and students, as well as synchronizing them across various devices.
Use	• Storing, sharing, and collaboratively working on documents. • Enabling users to store, sync, and share files and folders across devices and platforms.

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	• Calendar sharing. • Survey tool functionality.
Additional features	None
Data flow /exchange	• Transfer of shared documents into Moodle as a client. • LDAP integration for user attributes, user search, user groups, and account clean-up.
Authentication	Keycloak (OIDC), Single Sign-On (SSO)

OER repository

Description	An in-house development built on InvenioRDM (open-source).
Purpose at our university	Members of TU Graz can publish Open Educational Resources (OER) on this platform.
Use	Publishing (and searching for) OER from TU Graz.
Additional features	• With the assistance of a Moodle plugin in the Moodle LMS, qualified lecturers can authorize the publication of their content as OER. • The OER repository supports direct OER publication for those who are certified (OER certification). • The metadata of TU Graz OER is subsequently published at the Austrian OERhub.at. See: https://oerhub.at – last accessed October 17th, 2023
Data flow /exchange	• Transfer of course materials from Moodle and videos from Opencast into the OER repository. • Transfer of predefined metadata about the OERs, such as the author, course-related name, descriptions, etc.
Authentication	No user authentication is required.

Mahara (e-portfolio software)

Description	Mahara is open-source software that can be utilized for various e-portfolio purposes, such as study, professional development, work-integrated learning, assessment, showcase and presentation, and employability. See: https://mahara.org/ – last accessed October 17th, 2023
Purpose at our university	Mahara is primarily used for training purposes at TU Graz.
Use	• e-portfolio platform • Reflection, goal setting, and career planning
Additional features	None
Data flow /exchange	Transfer of user identifier during the login process via Moodle.
authentication	Single Sign-On (SSO)

BigBlueButton

Description	BigBlueButton is an open-source web conferencing system. See: https://bigbluebutton.org/ – last accessed October 17th, 2023
Purpose at our university	The system is used for web conferencing, especially for online presence teaching at TU Graz.
Use	• Web conferencing • Online (virtual) classrooms
Additional features	None
Data flow /exchange	• Transfer of user authorization from Moodle within the course context. • Transfer of user authorization from BigBlueButton within the plugin context.
Authentication	Via Moodle and Nextcloud

Webex

Description	Webex is a commercial web conferencing system. See: https://www.webex.com/ – last accessed October 17th, 2023

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Purpose at our university	Use of web conferencing system especially for online presence teaching.
Use	Online sessions/meetings
Additional features	None
Data flow /exchange	No data exchange
Authentication	Keycloak (OIDC), Single Sign-On (SSO)

Matrix

Description	Matrix is an open-source system designed for secure, decentralized communication. See: https://matrix.org/ – last accessed October 17th, 2023
Purpose at our university	Matrix supports courses (livestream) by facilitating chat communication at TU Graz.
Use	Chatting
Additional features	None
Data flow /exchange	No data exchange
Authentication	Keycloak (OIDC), Single Sign-On (SSO)

Gitlab

Description	Version Control System for Software Development.
Purpose at our university	Gitlab provides a Version Control System for Software Development at TU Graz. See: https://gitlab.tugraz.at/ – last accessed October 17th, 2023
Use	Code submissions in computer science-specific courses.
Additional features	None
Data flow /exchange	No data exchange
Authentication	Keycloak (OIDC), Single Sign-On (SSO)

5.3.2 Special features

Relevant technical special features that distinguish TU Graz from many other universities include:

- Proprietary Campus Management System: TU Graz not only uses but also sells its own campus management system, CAMPUSonline.
- Enhanced Security: TU Graz has implemented a 2-factor authentication for enhanced security on their central login pages. This was rolled out to staff in September 2022 and extended to all students in November 2022.
- Hosting and Management: TU Graz hosts the national MOOC platform iMooX.at, an OER repository, and a video platform.

In terms of relevant national developments:

- Autonomy in IT system selection: There are no national requirements or proposals dictating the use of IT systems at public universities. The choice and utilization of these systems are at the discretion of the individual universities. Regulations, such as the GDPR, are interpreted strictly and taken into consideration.
- Student directory: There is no national directory of students or their degrees, nor are there plans to establish one.
- 2FA: A security measure requiring two forms of verification before granting access. TU Graz's adoption of 2FA emphasizes its dedication to enhanced cybersecurity for its staff and students.

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5.3.3 Students' Journey at a glance

The digital infrastructure of TU Graz is visualized in Figure **18** to represent the journey of students within the system.

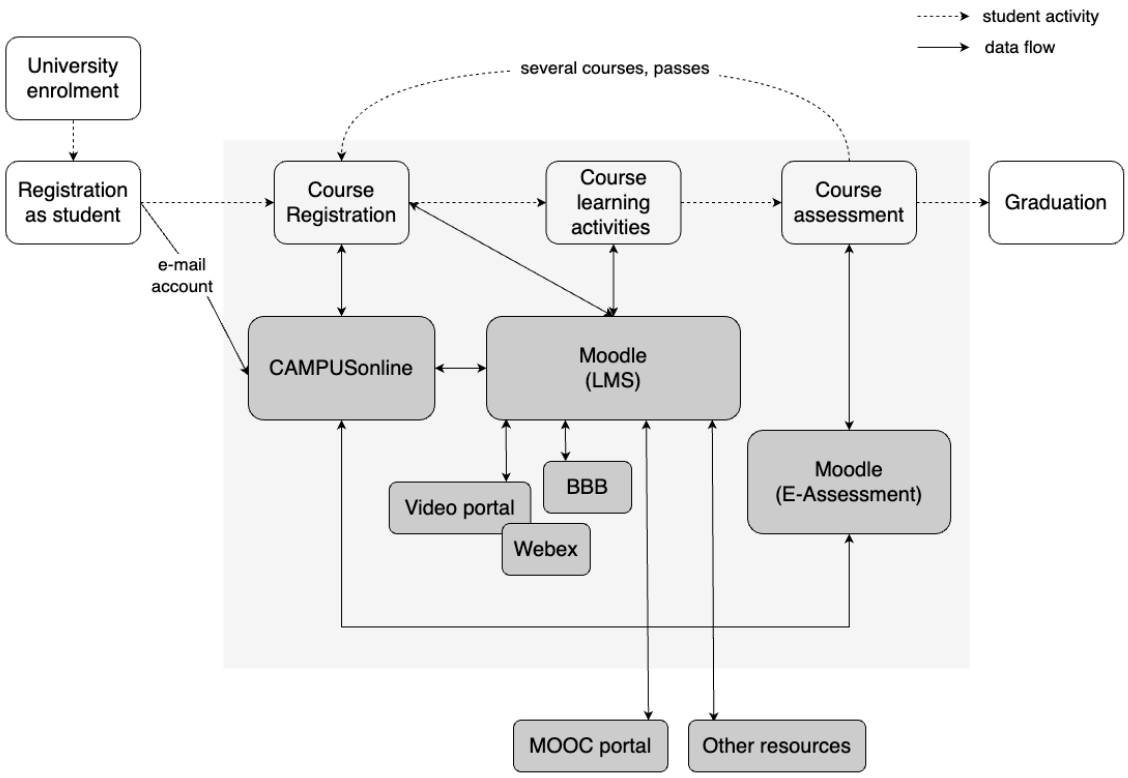

Figure 18: TU Graz's student's journey within the digital systems at a glance.

Upon registration, each student is assigned an account, which includes an email address essential for course registration. Course selection is facilitated through the Campus Management System, TUGRAZonline. If instructors utilize the Learning Management System (LMS) for purposes such as providing materials or receiving assignments, additional tools might be integrated. Examples include a video conferencing system like BigBlueButton (BBB) or videos from the university's dedicated video platform, TUbe. For online course assessments, the Moodle instance "TeachCenter Exam" may be employed. Finally, grades are recorded in CAMPUSonline, either manually, via CSV import, or through a web service.

5.3.4 Current and Future Directions

As of April 2023, the integration of Matrix Chat into productive use has commenced. Looking ahead there are plans to incorporate Whisper for the automatic generation of subtitles for videos, potentially within the TUbe platform, in the upcoming months. Generally, AI applications for learning and teaching will be analysed, tested, and piloted.

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5.4 Grenoble INP graduate school of engineering and management, University Grenoble Alpes (Grenoble INP-UGA)

Romain Laurent (UGA), Etienne Langevin (Grenoble INP-UGA)

5.4.1 Overview of digital infrastructures for learning and teaching

University Grenoble Alpes (UGA) and Grenoble INP-UGA is the result of several institutions integration and mergers taking place over several periods of time, the latest one dating back to 2020. In 2023, Grenoble UGA and Grenoble INP-UGA represents 60 000 students and 10 000 staff. As a result, UGA and Grenoble INP-UGA is composed of a lot of various components such as schools, research laboratories, services units, central departments, etc. However, the university does not have a central authority but rather a distributed hierarchy with several authorities. For example, a lot of research laboratories are associated to the university but are under the authority of the National Centre for Scientific Research (CNRS). Those national authorities often prescribe mandatory management applications can be hosted locally. In conclusion, the complex history and structure along with the important number of users of our university impacted the evolution of our digital learning infrastructure which remains to this day partially heterogeneous and compartmentalized. One of the university current priorities is to bring together and homogenize our digital learning infrastructure.

Figure 19 gives an overview of Grenoble UGA and Grenoble INP-UGA's digital platform and tools.

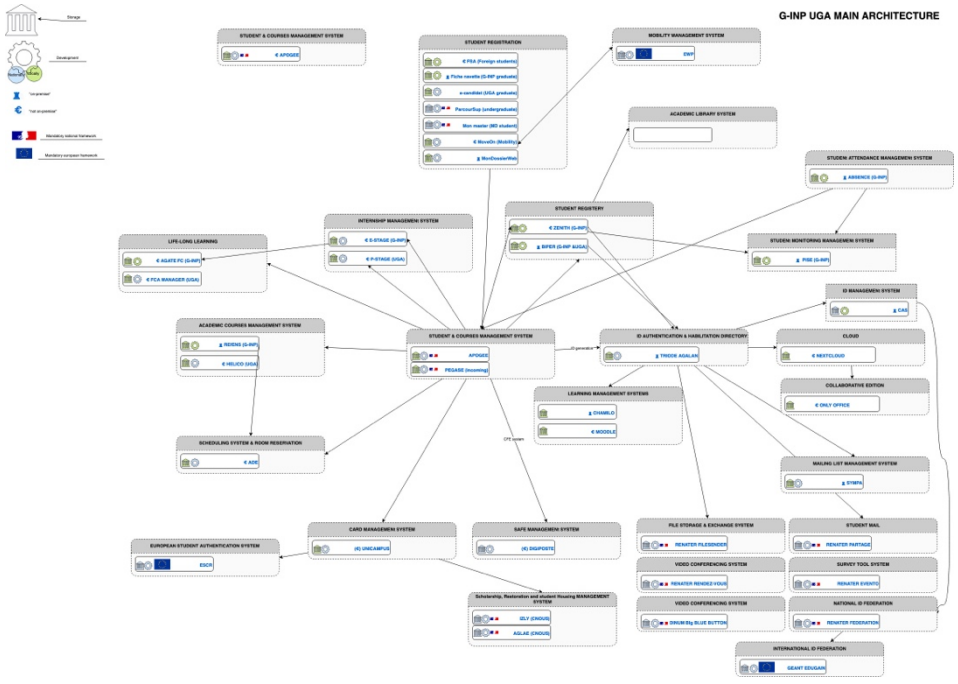

Figure 19: Grenoble UGA and Grenoble INP-UGA's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools. [Online version for details: https://doi.org/10.3217/9rrz9-ywt68]

Table 9 gives an overview about UGA and Grenoble INP-UGA's key systems in use in students' life cycle perspective.

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Table 9: Grenoble UGA and Grenoble INP-UGA's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (version number)
Student registration	• FSA • Fiche navette • E-candidat • ParcourSup • Mon master • MoveOn • MonDossierWeb
Getting access data (authentication)	• Triode Agalan • Biper
Find curriculum / courses	• REfENS • Chamilo • Moodle
Course registration	• Apogee • Triode Agalan + Moodle/Chamilo
Course learning activities	• Chamilo (online) • Moodle (online)
Course assessment(s)	• Mainly offline then results are filled in Apogee
Ending with graduation (issuing the certificate)	• Apogee
(if) Central authentication platform (SSO, Keycloack, etc.)	• Central Authentication Service (CAS)

In the following, all these systems and tools are described in short.

APOGEE

Description	APOGEE is a management system that gather a big part of our *curricula* and students processes such as student registration, grades, certifications, etc.). This solution has been mandatory and nationally developed since 1995 for all french HEIs. HEIs have to implement their own APOGEE instance. APOGEE instances can then communicate between one another in the APOGEE network. APOGEE is planned to be replaced by the also nationally developed PEGASE https://fr.wikipedia.org/wiki/Apog%C3%A9e_(logiciel)
Purpose at our university	Apogee is used for the organization and management of courses and students. It is a nationally mandatory application.
Use	Staff and teachers use it for managing the student journey.
Additional features	It is an all-in-one mandatory system, which purpose is to interact with other mandatory application
Data flow /exchange	Apogee contains every needed student personal data and every *curricula* features
Authentication	Heavily restricted (high stakes data) : CAS + VPN + local authorization to specify perimeter. For example, one staff-person dedicated to 4-6 student groups and only him.her is allowed to access.

BIPER/ TRIODE-AGALAN

Description	BIPER is our inter-university Identity Management System. It contains an identity repository of all the people of the universities of Grenoble and their roles (staff, students, etc.). It manages all the authentication and permission processes. It is by design made for integration into other applications. **TRIODE-AGALAN** is the UID creation system. BIPER is a locally developed and hosted application. LDAP directory with OpenLDAP + AD SSO with CAS
Purpose at our university	BIPER aim at giving every member of the university an UID, a role (or several) and their related permissions.

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Use	As it is our IdMS (everybody uses it).
Additional features	It is a local but widely spread application in the French Alps. BIPER has three very important extra-features: • The prevention of user duplication. It merges users Unique Identifiers in a single framework for all HEIs in the French Alps • The automatic search and management of possible user duplications • The automatic or manual creation and management of groups of people by their role. It is useful to manage users access to all digital services • Our IdMS is integrated into eduoram and beyond eduGAIN
Data flow /exchange	The distribution of users in their role/group is propagated to other applications by BIPER. It is a core application in our digital ecosystem.
Authentication	Accessible to everybody as it is the authentication system but with restricted permission especially for administrators.

5.4.2 Special features

In France, mandatory frameworks prescribed by national authorities are very common and widely spread. All our locally developed solutions **must be inter-operable with those national frameworks,** but they also need to be **validated by the various national authorities** in charge. As a result, the integration of applications in the French HEI ecosystem can be both technically and politically challenging. HEIs are encouraged to collaborate with each other and to form *consortia* in order to define common needs, develop applications that best suits the HEI ecosystem needs and to spread common tools and good practices (e.g. AMUE, RENATER, E-SUP, Cocktail, etc.).

France also have an **intergovernmental open-source software platform** (SILL: https://sill.etalab.gouv.fr/list). French HEI are strongly encouraged (but not obliged) to use the open-source software recommended on this platform. Open source is nationally recommended for financial, sovereignty and GDPR reasons. One example for not always giving way to Open Source is, the widely used operating system in HEI is Microsoft Windows instead of recommended Debian (because users are mostly Microsoft Windows-natives).

A **special feature** of the UGA digital infrastructure is, that it was developed primarily for staff. Students have little access to it, apart from ADE (scheduling), Moodle, and their intranet. We are now working on giving access to collaborative applications to our entire community, in order to provide them with secure, open-source and GDPR compliant digital workplace.

5.4.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 20 to illustrate the journey of students within the system.

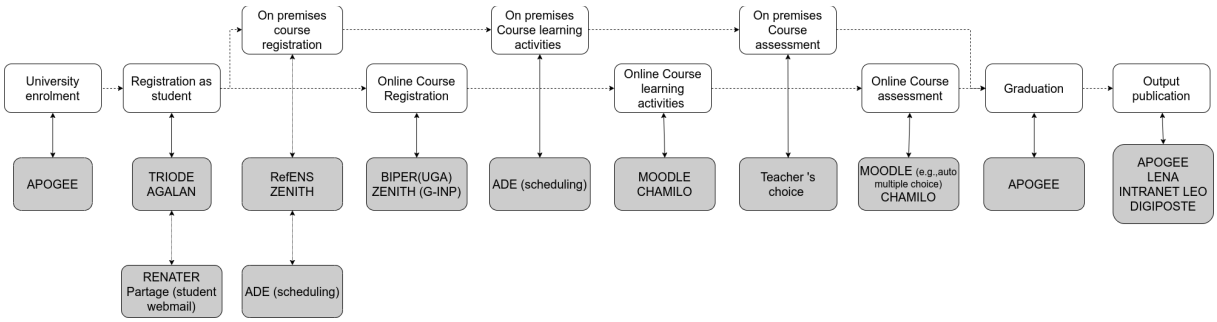

Figure 20: Grenoble UGA and Grenoble INP-UGA's student's journey within the digital systems at a glance.

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At first, students' data and curricula choices are filled into our core student management system, APOGEE, from different entry points (e.g., nationwide Parcoursup). Once students' administrative registrations are approved by the university, students' data are sent from Apogee to our IdMS Triode/agalan which generates students unique IDs.

This ID is associated to roles in BIPER, which are then propagated throughout the whole university ecosystem to give access to digital services by role (e.g., library, intranet, RENATER tools).

BIPER also creates groups of students and allow university to manage digital permissions and accesses by group rather than by individual. Those groups are used for institutional communication (e.g., mailing lists), students' automatic registration to LMS courses and for publication of students' timetables (ADE). For example, students which are part of the "Mathematics L3" BIPER group will have access to the "Mathematics L3" timetable in ADE, to all "Mathematics L3" LMS courses and can all be contacted using to "Mathematics L3" mailing list.

Finally, exams are usually held on premises and on paper. Teachers then fill in students grades into Apogee which will apply curricula rules to know if the student succeeded or failed the graduation. Afterward, student role is updated accordingly.

Grades, courses transcripts, graduation certification, etc. are then available in the student personal workspace and eSafe (Digiposte).

5.4.4 Current and Future Directions

Our national Student Management System, Apogee, although regularly updated through the years, is almost 30 years old and is getting deprecated. A new solution is being developed nationally, PEGASE. PEGASE aims at maintaining Apogee core features while offering a better interconnection specifically to other national-wide solutions through APIs. As Apogee, PEGASE will also be mandatory and its integration into our infrastructure will bring a very consequent workload in the incoming years.

Following the fusion of different HEIs into our current Grenoble UGA and Grenoble INP HEI, we aim at further integrating and homogenize our shared digital infrastructure. In the same approach, future in-house developed solution should also be as suitable as possible for all our HEI components. For example, we are currently trying to homogenize BIPER processes throughout our HEI.

In addition, an important part of our digital infrastructure comes from different national decisions and national authorities. In consequent, future directions can sometimes be quickly and widely changed to best comply with new national decisions.

Lastly, we are looking at providing our students with solutions (e.g., collaborative works) that best suits their needs and help them achieve their prospects while following national and European norms and ensuring our digital sovereignty.

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5.5 KTH Royal Institute of Technology (KTH)

Joakim Petersson (KTH)

5.5.1 Overview of digital infrastructures for learning and teaching

KTH's e-learning architecture is based on two fundamental systems. Canvas from Instructure and Ladok, the national student records system. The goal is to provide teachers and students with an integrated set of best-of-breed digital tools for education, with as much of the administrative tasks automated as possible.

Figure 21gives an overview of KTH's digital platform and tools.

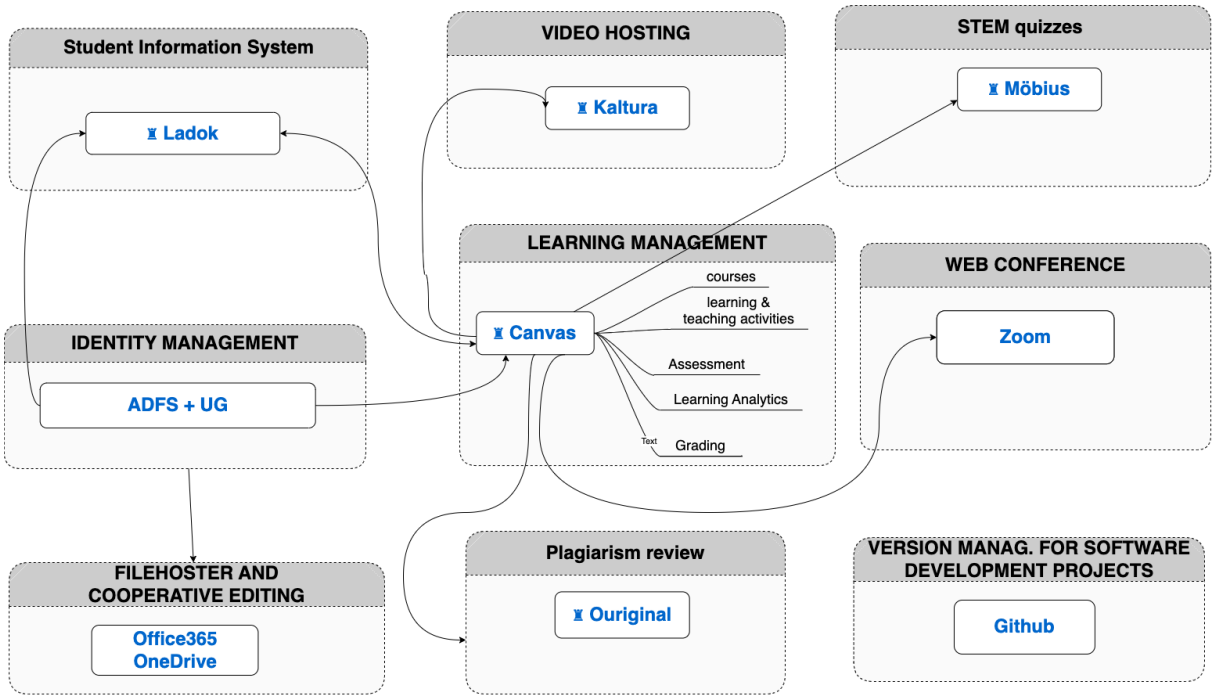

Figure 21: KTH Royal Institute of Technology's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 10 gives an overview about KTH's key systems in use in students' life cycle perspective.

Table 10: KTH Royal Institute of Technology's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (sort of system) and version number
Student registration	• LADOK (National system of student records)
Getting access data	• LADOK (National system of student records)
Find curriculum / courses	• KOPPS (Local course database)
Course registration	• LADOK (National system of student records)
Course learning activities	• Instructure – Canvas (Learning Management System) • Kaltura (Video Platform) • Zoom (Virtual Classroom) • GitHub • Office365/OneDrive
Course assessment(s)	• Instructure – Canvas (Learning Management System) • Möbius

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Ending with graduation (issuing the certificate)	• LADOK (National system of student records)
(if) Central authentication platform (SSO, Keycloak, etc.)	• ADFS / Shibboleth – EduID / eduGAIN

In the following, all these systems and tools are described in short.

LADOK (National system of student records)

Description	Ladok is the student information system for storage and management of academic records in Sweden. It is developed and maintained by the Ladok Consortium, consisting of 40 Swedish higher education institutions. Each HEI is responsible for their own information, stored in a common database
Purpose at our university	Ladok is our study registry system where we handle students' registrations, study results and degrees. It also supports some educational financial management and follow-up requirements.
Use	• Student life cycle (course registration, exam registration, certificates, graduation) • Teacher life cycle (exam management) • University administration (planning, running, reporting)
Additional features	No

Data flow /exchange	• Synchronisation of following data entities into Canvas:
	  ○ Courses, course enrollments (students, teachers, tutors, ...)
	  ○ Exams, exam participants (examinees)
	  ○ Organization (e.g. Institute) members and their roles
	• From Canvas into Ladok:
	  ○ Exam results

Authentication	• ADFS/eduID

UG + ADFS (Identity Management)

Description	UG is an in-house developed identity management system. It maintains unique identifiers for people associated with KTH (employees, students, and external users) by synchronizing user data from Ladok as well as the HR-system. It also creates roles from the database-information.
Purpose at our university	To securely keep track of people associated with KTH and provide authorization.
Use	By integration with ADFS (and some other tools like Shibboleth and BankID) it provides authentication, authorization, and account-provisioning for the university.
Additional features	No
Data flow /exchange	To UG from Ladok • Student information (name, address, program/course admissions, etc) • Course-information for role purposes From UG into Canvas • Accounts
Authentication	N / A

Canvas (Learning Management System)

Description	Canvas is a commercial LMS developed by Instructure with pretty good usability and integration support. It is the main LMS for KTH and 28 other higher-education institutions in Sweden. It is a cloud service and is provided by the Swedish NREN Sunet – as “Sunet LMS”.
Purpose at our university	Canvas is the hub for educational digital tools for teachers and students. Apart from basic course management, it provides some good functionality like Gradebook and Canvas Studio, but it is also easy to integrate external tools with LTI, which makes it excellent as the main LMS for us.

Use	• Course learning activities:
	  ○ Course materials and other useful information
	  ○ Course discussions / messaging

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	○ Quizzes ○ Peer-Review ○ Submission of assignments ○ Supports Digital exams together with SEB ○ Integration with Ouriginal ○ Integration with Möbius ○ Student feedback / assessments • Learning Analytics • Grading exercises and (scanned) paper exams. • Reporting results (export) to Ladok.
Additional features	No
Data flow /exchange	To Canvas • See Ladok • See ADFS From Canvas • See Ladok • See Ouriginal • See Möbius
authentication	ADFS

Kaltura

Description	Kaltura Video Cloud Platform for Education is a single platform purposefully built to power real-time, live and VOD experiences for online programs and virtual learning. https://corp.kaltura.com/education-video-platform/
Purpose at our university	We use another NREN – provided service called Sunet Play (which is based on Kaltura) as a video repository for courses.
Use	Management of videos for courses Automatic video-transcription with Amberscript Non-public videos
Additional features	No
Data flow /exchange	File integration with Canvas when creating content
Authentication	ADFS

Ouriginal

Description	Ouriginal is a tool intended for plagiarism review. It is meant to be used by you as a teacher and examiner when you receive text files from students who have submitted them via Canvas. https://www.ouriginal.com/
Purpose at our university	Guide students away from plagiarism
Use	The review result is compiled in an analysis report that the teacher needs to review.
Additional features	No
Data flow /exchange	Transfer of user authorisation from Moodle within course context Transfer of user authorisation from BugBlueButton within plugin context
Authentication	The report Integrated in Canvas.

Möbius

Description	Möbius is an LTI-tool recommended when you wish to create exercises where numerical calculations are a significant factor. Möbius gives you, among other things, the ability to evaluate answers containing numerical calculations, to dynamically change the task formulation based on the student's previous answers, and greater possibilities to randomize variables and tasks than what Canvas quizzes can offer. https://www.digitaled.com/mobius/
Purpose at our university	For mathematical exercises where Canvas generic quiz tool doesn't work
Use	Quizzes or exams
Additional features	No
Data flow /exchange	Results from exercises in Möbius is transferred to Canvas with LTI.
Authentication	Students through Canvas, Teachers needs a Möbius account.

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5.5.2 Special features

Relevant technical special features of KTH – in comparison to many other universities in the alliance – might be the following: Most Swedish universities also use **Canvas** which has made a Ladok-funded and -supported integration with Canvas possible. The use of cloud solutions for education has been evaluated and considered compliant with Swedish laws on privacy and security. This is of course a continuous exercise and might change in the future.

Concerning relevant national developments, it might be noted that there is a **national Swedish student record system**.

5.5.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 22 to illustrate the journey of students within the system.

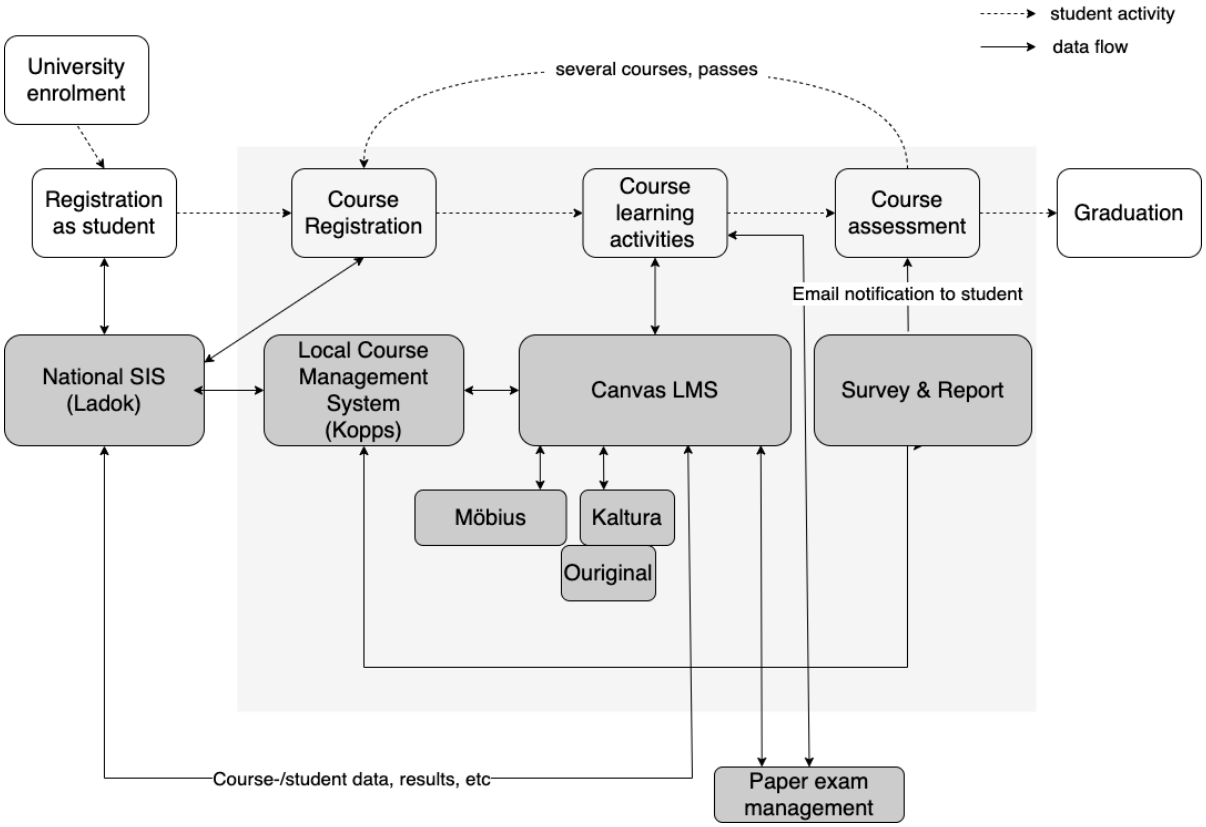

Figure 22: KTH's student's journey within the digital systems at a glance.

A student's journey at KTH begins by applying for a KTH course or program in the national system for admissions https://studera.nu.

Admitted students who accept the education offer are imported into the national student information system (Ladok).

For course enrolment, students register for the course with Ladok. Registered students is automatically given access to the course in the LMS (Canvas).

During the course, digital learning activities are conducted in Canvas, in some cases also in integrated tools through Canvas.

Students get feedback on their Digital learning assignments and in many cases also paper exams through the course page in Canvas.

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After the course, the students get an automatic course assessment form.

The final grades are registered in Ladok, where the student can see all their started or completed courses and education from all Swedish universities.

5.5.4 Current and Future Directions

There is an initiative for a national collaboration on education in “Transformational technology like AI” that considers a platform much like the Unite! virtual campus but with Swedish universities. This accentuates the need for a reasonable integration pattern where students and teachers get a good usability experience despite the different underlying “sourcing” of educational content.

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5.6 Politecnico di Torino (PoliTO)

Marco Torchiano, Fabrizio Bonani, Roberto Bertonasco, Massimo Franco, Giorgio Santiano (PoliTO)

5.6.1 Overview of digital infrastructures for learning and teaching

The computer system at the Politecnico di Torino employs a **combination of open-source and proprietary software**, with a notable emphasis on developing and integrating custom applications to meet the diverse needs of students and faculty. This system serves as the backbone for various functions within the institution. The Politecnico di Torino's computer system leverages open-source technologies to provide a solid foundation for its operations. These systems are known for their flexibility, cost-effectiveness, and extensive community support. Additionally, the institution has developed its own software solutions to address specific requirements. One of the system's standout features is its ability to **develop and integrate custom applications**. This capability allows the Politecnico di Torino to create tailored software solutions that cater to the unique demands of students and faculty members. Whether it is designing applications for project management, data analysis, or collaborative research, the system can adapt to different academic disciplines and enhance the learning and teaching experience. Moreover, the system also incorporates commercial software for certain functions. By leveraging the strengths of both open-source and commercial solutions, the Politecnico di Torino ensures a comprehensive and efficient computing environment.

Overall, the computer system at the Politecnico di Torino **combines open-source software, proprietary solutions, and custom application development** to support a wide range of academic activities. This approach enables the institution to meet the evolving needs of its students and faculty while fostering innovation and collaboration in the academic community.

Figure 23 gives an overview of Politecnico di Torino ’s digital platform and tools.

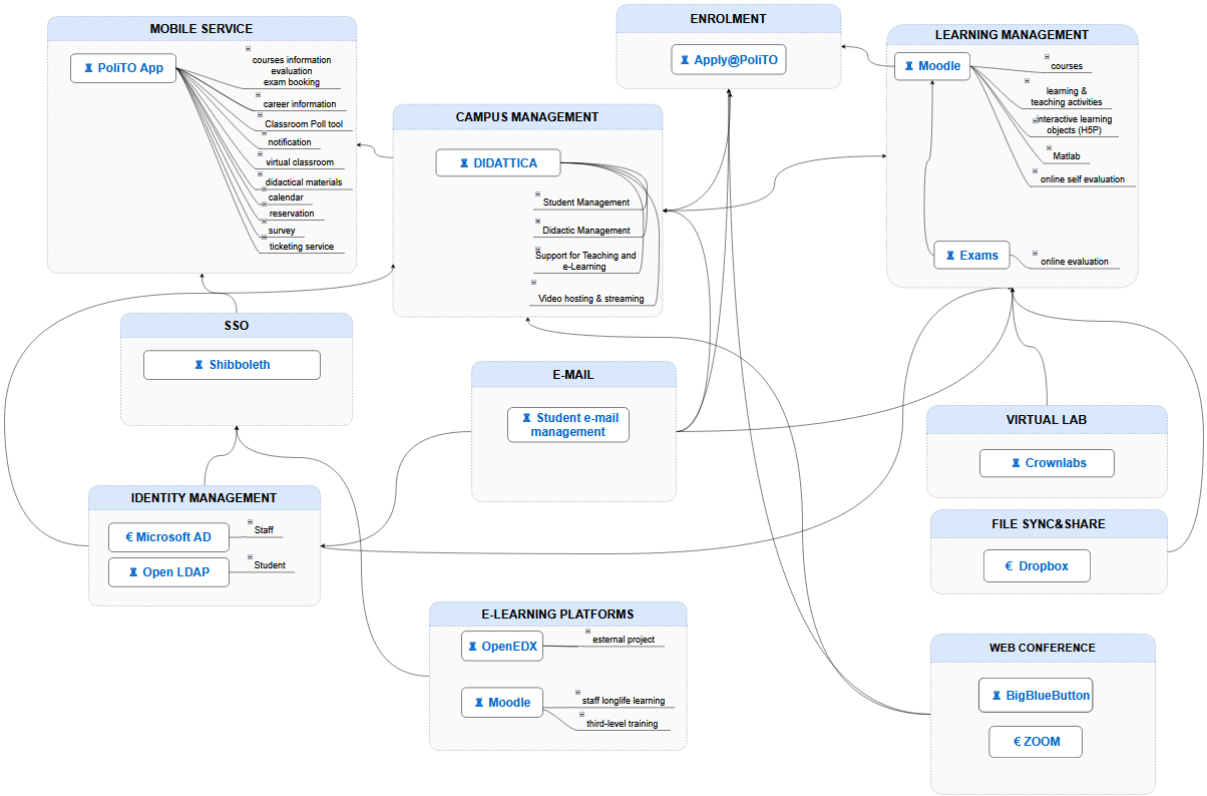

Figure 23: Politecnico di Torino’s digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

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Table 11 gives an overview about TU Graz's key systems in use in students' life cycle perspective.

Table 11: Politecnico di Torino's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (sort of system) and version number
Student registration	Apply@PoliTO
Getting access data	DIDATTICA (Campus Management System)
Find curriculum / courses	DIDATTICA (Campus Management System)
Course registration	DIDATTICA (Campus Management System)
Course learning activities	Moodle (Learning Management System) v4.2 BigBlueButton (Virtual Classroom) 2.5.8 (3150) DIDATTICA Rocky Linux release 8.6 Server version: Apache/2.4.37 Varnishd (varnish-6.0.8) Mod_Owa-2.11.9 Virtual lab
Course assessment(s)	Moodle (Learning Management System) v4.2
Ending with graduation (issuing the certificate)	DIDATTICA (Campus Management System)
(if) Central authentication platform (SSO, Keycloack, etc.)	Shibboleth, SSO

In the following, all these systems and tools are described in short.

DIDATTICA (Campus Management)

Description	The Didactic Computer System, "DIDATTICA" used by the STUDI Directorate and other organizational units of the University involved in teaching, supports key service activities by providing computerized procedures in the following main domains: Student Management Didactic Management Support for Teaching and e-Learning
Purpose at our university	Student Management (enrolment, registrations, transfers, fees, degrees, state exams, educational offerings, study plans, contracts and selections of external teachers, assignments, educational reports and budgets, and more). Didactic Management (educational offerings, study plans, program guides, course coverage, admission tests, lists of enrolled students, interface with institutional email service, and other services). Support for Teaching and e-Learning (sharing educational materials between teachers and students, submission of assignments, forums, delivery of video lessons, tests, and self-assessment exercises). POLITOApp, an app distributed for Android and iOS systems, which provides personalized services for teachers and students using data made available by the DIDATTICA system through REST web services.
Use	• Student life cycle (application and admission at university, access data, curriculum, course registration, exam registration, certificates, graduation, mobility life cycle) • Teacher life cycle (registration, access data, course offering, exam management, issuing certificates, research documentation, publications, surveys) • University administration (course management, statistics, generation of study plans, publication of study plans)
Additional features	• Student page with access to management services and course pages (teaching) • Teacher page with access to management services and course pages (teaching) • Course pages (teaching) • Educational materials with access-list management and monitoring of downloads and textual search within the content

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	• Video lessons and e-learning materials • Submission of ongoing assignments • High school page with services related to orientation and student performance • Company page with services related to internships and job placement • Internship and job placement services to connect companies with students and manage resumes/CVs. • Mobility services
Data flow /exchange	Synchronisation of following data entities into Moodle: • Courses, course enrollments (students, teachers, tutors, ...) • Exams, exam participants (examinees, examiners) From Moodle into DIDATTICA: • Final exam grades
Authentication	Shibboleth, SSO

Identity Management

Description	The unique identity if each person (teacher, student, administrative staff and external users) who requires access to one or more university systems needs to be recorded in the Identity Management System. PoliTO use 2 different system to identify user: • OpenLDAP for student (https://www.openldap.org/) • Microsoft AD for staff (https://it.wikipedia.org/wiki/Active_Directory)
Purpose at our university	The identities of all users accessing university computer systems are managed using one of these two services.
Use	It is mainly responsible for user auto-provisioning in university systems.
Additional features	
Data flow /exchange	Synchronization of users into all university systems: • DIDATTICA • Moodle • Dropbox • …
Authentication	No user authentication

Moodle (Learning Management System)

Description	Moodle is an open-source learning management system designed to provide educators, administrators and learners with a single integrated system to create personalized learning environments, see: https://docs.moodle.org/401/en/Features
Purpose at our university	At the Politecnico di Torino, the Moodle platform is extensively used, with the current configuration consisting of one main installation and several supporting installations. The main installation (moodle.polito.it) is directly connected to the Single Sign-On (SSO) system and contains all the university courses. A secondary installation (Exams) is dedicated to online exams.
Use	Course learning activities: • Providing and consuming course materials • Submission of assignments • Group building • Scheduling • Integration of BigBlueButton • Crownlabs integration • Integration of other learning tools Course exams Online self assessments Learning Analytics
Additional features	The Moodle platform is fully integrated within the DIDATTICA portal, providing a seamless integrated user experience. The working environment is unified, and essentially Moodle tools are utilized within DIDATTICA.
Data flow /exchange	To Moodle • See DIDATTICA • See Apply@PoliTO

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	• See Crownlabs From Moodle • See DIDATTICA • See Apply@PoliTO • Transferring grades between Moodle instances
authentication	Shibboleth

Student e-mail management (e-mail)

Description	Our university student mail service is built on a robust open-source infrastructure using the powerful combination of Dovecot, Postfix, and Roundcube. This service provides a secure and feature-rich email solution tailored specifically to the needs of our students. Dovecot, a widely used open-source IMAP and POP3 server, ensures reliable and efficient access to email messages, allowing students to seamlessly manage their mailbox across various devices and email clients. With its advanced features such as caching, indexing, and filtering, Dovecot guarantees a smooth and responsive user experience. Postfix, a popular open-source mail transfer agent (MTA), forms the backbone of our mail service, handling the secure delivery of incoming and outgoing messages. It boasts a strong reputation for its robustness, scalability, and extensive configuration options, making it a reliable choice for handling the email traffic of our student community. Roundcube, an intuitive and user-friendly webmail client, serves as the front-end interface for our student mail service. Its clean and modern design, coupled with a rich set of features including email composition, folder management, address book, and search capabilities, empowers students to efficiently communicate and organize their email correspondence. Together, these open-source components form a powerful and flexible ecosystem that ensures a seamless and secure email experience for our university students. By leveraging the capabilities of Dovecot, Postfix, and Roundcube, we provide our students with a reliable, feature-rich, and user-friendly mail service that meets their academic and communication needs.
Purpose at our university	This email configuration was chosen primarily for the following reasons: • Desire to utilize an open-source solution. • Need for a highly customizable and integratable system within the IT infrastructure. • Requirement for full control over the user's mailbox to ensure reliability of sent communications.
Use	Official communications to students with guaranteed delivery dates.
Additional features	Automatic management of the mailbox lifecycle
Data flow /exchange	Open LDAP
Authentication	Shibboleth, OpenLDAP

E-Learning Platforms

Description Purpose at our university	At the Politecnico di Torino, different e-learning platforms are utilized for special initiatives and specific areas. The main platforms include: • An instance of Moodle is used to address the long-life learning needs of employees, third-level training for doctoral students, and safety training for all individuals associated with university premises. • An instance of OpenEdx is employed for special projects linked to external funding.
Use	Course creation Publishing e-learning courses.
Additional features	Use SSO
Data flow /exchange	User from identity management
Authentication	SSO

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Apply@PoliTO (Enrolment)

Description	Apply service
Purpose at our university	Unified Portal for Enrolment in all levels of study programs
Use	• management of applications for all levels of study programs • integration with the platform for administering admission tests • production of minutes for evaluation committees • implementation of application evaluation workflows for foreign and EU students
Additional features	
Data flow /exchange	• Moodle exchange test result • DIDATTICA exchange user data for ranking
Authentication	No user authentication

Dropbox (File Sync & Share)

Description	Dropbox is a widely used cloud storage service that allows users to securely store, access, and share their files from anywhere. Users can easily upload files of any type to their Dropbox accounts, which are then synced across all devices connected to the account, including computers, smartphones, and tablets. www.dropbox.com.
Purpose at our university	This cloud-based file hosting service is mostly used for saving, sharing, and collaborating on documents, both by students and teachers. It is also utilized as a file area for deploying assignments
Use	• Saving, sharing, and collaboratively working on documents • Allows users to store, sync, and share files and folders across devices and platforms
Additional features	Enterprise subscription
Data flow /exchange	DIDATTICA: • the student's account is used to perform operations on the Dropbox account (share creation, add account to courses share) • is used as frontend to the data
Authentication	shibboleth, SSO

Crownlab (Virtual Lab)

Description	Kubernetes is an open-source container orchestration platform that automates the deployment, scaling, and management of containerized applications. It provides a robust and flexible framework for efficiently managing containerized workloads across a distributed cluster of nodes. https://kubernetes.io/
Purpose at our university	CrownLabs is a set of services designed to deliver remote computing labs through per-user environments, based either on virtual machines or lightweight containers.
Use	This tool is used for exercises and exams.
Additional features	The project is available on the GitHub platform: https://github.com/netgroup-polito/CrownLabs
Data flow /exchange	Moodle user data and exam result
Authentication	By the way of moodle

Web Conference Systems

Description	Web conference systems are used for online classroom
Purpose at our university	Currently, there are two main systems in use in this context: • BigBlueButton, an open-source system primarily used for online lessons. • Zoom Educational, a paid system also used as a web conferencing solution by staff members. Both systems are integrated within the main Moodle instance. Teachers can freely choose to use either of them, and the recordings produced are automatically transferred to the course page. The teacher has full control over the material and can edit it, as well as decide whether to make it available to students or not.

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Use	• Webconferencing • Online (virtual) classrooms
Additional features	Custom development to integrate into DIDATTICA
Data flow /exchange	Transfer of user authorization from Moodle within course context
Authentication	SSO

PoliTO App (Mobile Service)

Description	Internally developed mobile app for student access to educational services.
Purpose at our university	The ability to provide native access to computer services on mobile devices has always been a challenge for the Politecnico di Torino. The system has been developed using React Native and is available for both Android and iOS platforms, enabling access to numerous functions of the university's internal computer system.
Use	• courses information • evaluation • exam booking • career information • Classroom Poll tool • Notification • virtual classroom • didactical materials • calendar • Room reservation • Survey • ticketing service
Additional features	
Data flow /exchange	DIDATTICA all the student's data IDP authentication data
Authentication	Shibboleth, SSO

Shibboleth (SSO)

Description	Shibboleth is an open-source software solution that provides federated identity and single sign-on capabilities. It allows organizations to securely authenticate and authorize users across multiple systems and applications, eliminating the need for separate usernames and passwords. Shibboleth supports the exchange of user identity information through standard protocols, enabling seamless and secure access to resources within a trusted network of organizations. It is widely used in academic and research institutions, as well as in various other industries, to establish a federated identity infrastructure for efficient and secure user authentication and access management.
Purpose at our university	User identification
Use	IDP
Additional features	The system is deeply integrated with all university systems, utilizing the single sign-on mechanism.
Data flow /exchange	User ID to/from all the system
Authentication	

5.6.2 Special features

Relevant technical special features of PoliTO – in comparison to many other universities – might be the following:

- The university's computer system has been internally developed by Politecnico di Torino.
- The management of access permissions to all systems is centralized.
- The first version of the system dates to the 90s, and since then, it has been continuously evolving.

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Concerning relevant national developments, it might be noted that:

- There are no national requirements or proposals for the use of IT systems at public universities, the choice and use are up to the universities. Regulations as e.g., GDPR are narrowly interpreted and considered.
- In Italy, the matriculation numbers are unique at university level.
- There is no national directory of students or their degrees (or plans for this).

5.6.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 24 to illustrate the journey of students within the system.

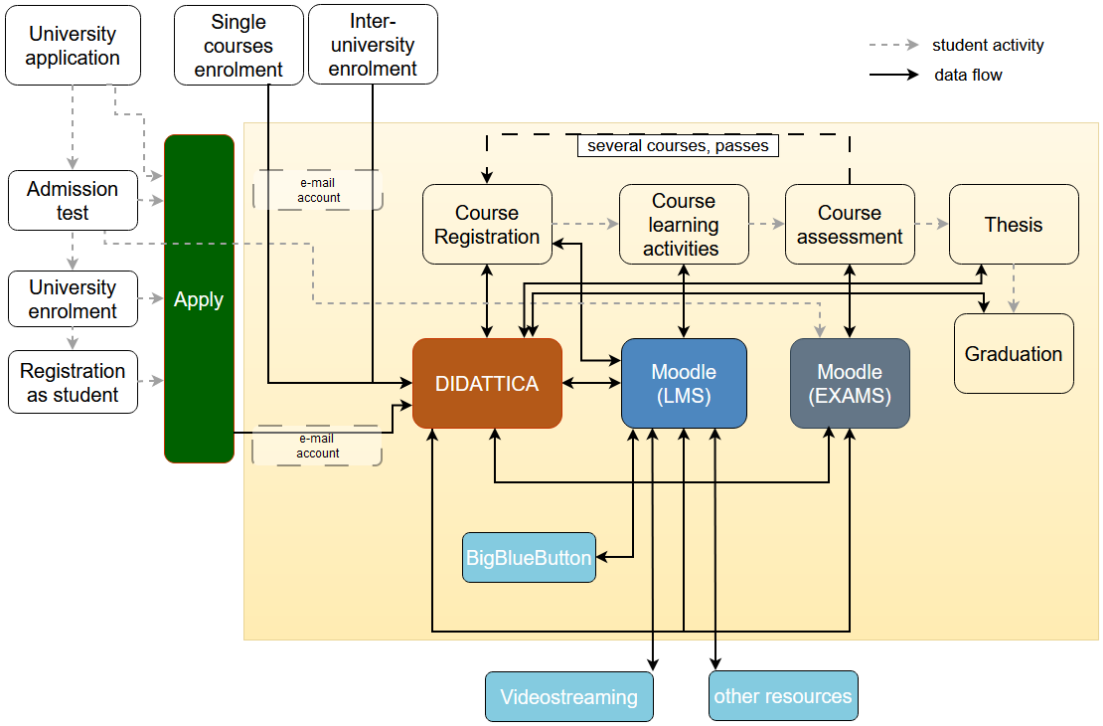

Figure 24: PoliTO's student's journey within the digital systems at a glance.

After registering as a student, an account and an email address are assigned. Students enrol in various levels of study programs using the Apply system. The course selection takes place in the Campus Management System (DIDATTICA), which serves as the central hub for Polito's information systems.

Different types of enrolment are implemented for special cases, such as inter-university courses or specific courses, where data is imported from dedicated files.

If teachers utilize the Learning Management System (LMS) – for instance, to share course materials or collect assignments – additional tools may also be integrated, such as a video conferencing system (BBB). In the case of online courses, course assessments can be conducted with the assistance of the customized Moodle instance called "Exams". Grades are recorded in DIDATTICA, directly through Moodle.

All data is centralized and interconnected.

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5.6.4 Current and Future Directions

PoliTO confirms its decision to continue the evolution of the in-house developed DIDATTICA Portal, the main actions outlined in the roadmap are as follows:

- First release of the new student app, with the code being made available in open mode.
- UX review and development of an app for teachers and staff, following similar methodologies as the student app.
- Further integration and evolution of tools for independent recording, editing, and publishing of audio/video content.
- As teaching aids, integration of Wooclap, Padlet, and other products.
- Development of a two-factor authentication system for both students and staff.

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5.7 Universidade de Lisboa (ULisboa)

Fernando Mira da Silva, Jorge Matias, Luís Cruz, Ana Bela Pereira (ULisboa)

5.7.1 Overview of digital infrastructures for learning and teaching

The new University of Lisbon was created in 2013 and results from the merge of the two main Lisbon Universities: the former Classic University of Lisbon (founded in 1911) and the Technical University of Lisbon (founded in 1930). Given the mostly fragmented and federated nature of the Technical University of Lisbon, which included Técnico Lisboa (the Engineering School, the largest faculty of the new University) and given the very different maturity level of digital services between participating Faculties when the new University was founded, the creation of common transversal digital services was a challenging task, and it is still today an on-going process. While all Faculties of the University use the same Learning Management System (LMS) and Campus Management System (CMS) platform, sharing the same core components, due to this historic background there is still one instance of the platform for each faculty. In Tecnico Lisboa, given its larger size, complexity, and capacity for autonomous software development, as well as specific functional requirements, lead to the development of a slightly different LMS/CMS flavor in Técnico relative to the ones running in other ULIsboa faculties.

In all ULisboa faculties the digital campus is supported in the Fenix platform, an open-source integrated Campus Management System (CMS) platform, which provides and manages all the academic assets and includes a built-in advanced web-based Learning Management System (LMS).

The Fenix platform is an open project originally developed at Tecnico Lisboa, which was later extended in slightly different flavours to all schools of the University of Lisbon and some other Universities by private companies which offer installation services, add-ons and built in customization. The integrated nature of the Fenix CMS/LMS platform offers automatic provisioning of web pages for courses, curricula, and subjects, including support for all essential LMS tasks at the subject level, including automatic student provisioning at the subject level as well as grading support and automated final grading integration in the main academic record database. Moreover, it offers an integrated experience for students during the full student life cycle, from the initial enrolment at the University to the issue of the final diploma at the graduate or post-graduate level. The Fenix platform is complemented by specialized applications for specific purposes whenever convenient or required. Generally, open-source platforms and solutions are preferred and prioritized.

Figure 25 shows an overview of ULisboa faculties digital platform and tools, using the case of Técnico Lisboa as a reference. The overall model is similar in all ULisboa faculties.

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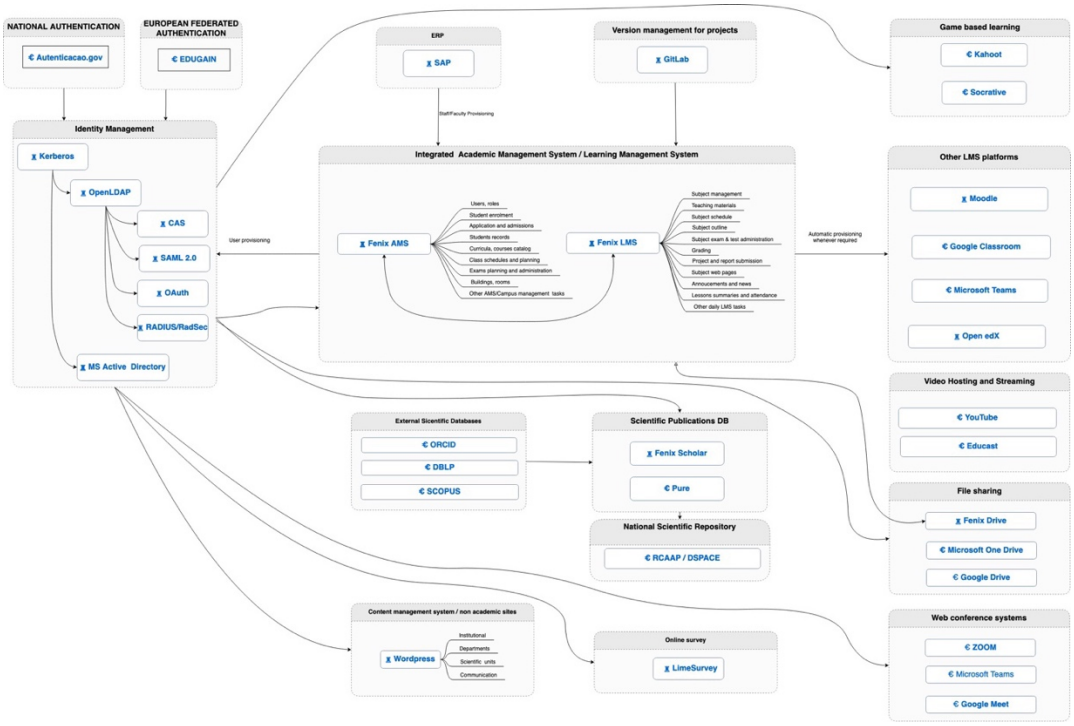

Figure 25: Universidade de Lisboa's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools. [Online version for details: https://doi.org/10.3217/j8ka9-d7s86]

Table 12 gives an overview about Universidade de Lisboa's key systems in use in students' life cycle perspective.

Table 12: Universidade de Lisboa's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (sort of system) and version number
Student registration	Fenix platform (LMS/CMS)
Getting access data	Fenix platform (LMS/CMS)
Find curriculum / courses	Fenix Platform (LMS/CMS)
Course registration	Fenix Platform (LMS/CMS)
Course learning activities	Fenix Platform (LMS/CMS) Moodle (Learning Management System) v3.11.13 Google classroom Microsoft Teams OpenEdX (Nutmeg release) (MOOC support) Zoom (Main web conference support) Google Meet (Web conference available) Microsoft teams (Web conference available) Kahoot (Game Based Learning) Socrative (Game Based Learning)
Course assessment(s)	Fenix platform (LMS/CMS) OpenEdX (Nutmeg release) Moodle (Learning Management System) v3.11.13
Ending with graduation (issuing the certificate)	Fenix platform (LMS/CMS)
Identity Management and SSO support	Kerberos OpenLDAP CAS SAML 2.0 OAuth OpenID RADIUS/RadSec Microsoft Active Directory

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ftableIn the following, all these systems and tools are described in short.

Fenix Campus Management System

Description	The Fenix Management System provides support for all Campus Administration tasks, including student Enrolment, management of academic records, course and subject management, class schedules, room allocation, registration fees, issuing certificates, etc.
Purpose at our university	Full support of all academic administration tasks
Use	• Student life cycle (application and admission at university, access data, curriculum, course registration, exam registration, certificates, graduation) • Teacher management (course allocation, course offering, exam management, issuing certificates) • Research support (publications) • Space management (room location, scheduling, reservation) • Class and exams schedules • Academic administration (all academic back-office administration tasks) • Generic administrative tasks (find students, faculty and staff roles and contacts, etc).
Additional features	Integrated with the Fenix LMS
Data flow /exchange	Since it is integrated with the Fenix LMS platform, provides automatic data consistency of: • Courses, course enrollments (students, teachers, tutors, ...) • LMS for each subject, automatically provisioned with enrolled students and allocated faculty • Exams, exam participants (examinees, examiners)
Authentication	Fenix Identity Management

Fenix Learning Management System

Description	Fenix Learning Management System provides all essential features of a standard LMS, including a web page for each subject supporting announcements, registration of class summaries and attendance, publication of digital assets (slides, documents), publication of class schedules (automatically available from the Fenix CMS), submission of projects and assignments by students, publication of grades, etc.
Purpose at our university	The Fenix LMS is the main platform interconnecting students and faculty at the subject level. It is use is mandatory, namely the publication of class summaries and attendance, publication of grades, etc.
Use	All course learning activities: • Providing and consuming course materials • Submission of assignments • Group building • Scheduling
Additional features	Integrated with Fenix Campus Management System
Data flow /exchange	Since the Fenix CMS and the Fenix LMS share a single database, student, course, and subject data ate automatically consistent with the Campus Management data. There is no need for data synchronization. Whenever specific features not supported by the Fenix LMS are required, any teacher may instantiate a subject specific entry in the Moodle, Google Classroom or Microsoft Teams systems. In these cases, the Fenix LMS exports the list of students enrolled in the subject to the target system.
Authentication	Fenix Identity Management

Fenix Drive

Description	The Fenix Drive is a distributed storage system, with advanced permission and access management, closely integrated with the Fenix Identity Management
Purpose at our university	Most Fenix LMS and CMS assets (namely documents, forms, etc) are stored in the Fenix Drive. Moreover, any faculty, student or staff may use it as shared storage resource.

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Use	Storage of Fenix LMS/CMS documents and forms Storage of shared materials
Additional features	Integrated with the Fenix LMS/CMS
Data flow /exchange	To and From Fenix LMS/CMS • Documents, forms and other digital assets
authentication	Fenix Identity Management

Fenix Identity Management

Description	The Fenix Identity Management system provides the single user registration database (including ID and role) for support of all authentication platforms and SSO systems
Purpose at our university	To provide the single source of truth regarding user and role information for authentication platforms and SSO systems
Use	All Identity Management Tasks Available at id.tecnico.ulisboa.pt
Additional features	Integrated with the Fenix LMS/CMS
Data flow /exchange	Provides user identities for Kerberos and LDAP platforms, which in turn support several SSO flavours (CAS, SAML 2.0, OAuth, OpenID). Moreover, the LDAP feeds the MS Active Directory platform, which supports both administrative staff authentication and Windows based student labs.
Authentication	None

Moodle

Description	Moodle is an open-source learning management system designed to provide educators, administrators and learners with a single integrated system to create personalized learning environments.
Purpose at our university	The Fenix LMS provides the essential support for the main LMS tasks at ULisboa. However, Moodle provides several specialized tools not included in the Fenix LMS, as well as a more advanced support for online exams and assessment. Therefore, teachers who require more specialized tools may use the Fenix LMS to instantiate a Moodle entry for a given subject, which is automatically provisioned with the list of students enrolled at the subject. Usually, less than 2% of the teachers use the Moodle platform
Use	• Course assessments • Online exams and assessments • Question pool management for offline exams • Learning Analytics • Course learning activities not supported in the Fenix LMS • Available at http://moodle.tecnico.ulisboa.pt/ and https://elearning.ulisboa.pt.
Additional features	Feedback fruits Assessment and feedback, social annotation, etc
Data flow /exchange	To Moodle • Course/subject data • Student identities
authentication	CAS/SAML 2.0

OpenEdX

Description	The OpenEdX platform is a well-known, widely used LMS platform specifically tailored for Massive Open Online Courses.
Purpose at our university	To support the deployment of MOOC courses at IST/ULisboa and remote assessment solutions.
Use	• MOOC support • Remote/online assessment • Online digital exams and assessments. • Used both in remote and in person digital assessment configurations • Question pool management for offline exams; • Automatic or semi-automatic grading

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	• Learning Analytics Available at https://mooc.tecnico.ulisboa.pt/
Additional features	Available on premises and deployed over Tecnico Lisboa local OpenStack virtual infrastructure and cloud management.
Data flow /exchange	Receives student provisioning from the Fenix CMS for specific courses. Provisioning is semi-automated and made on demand, on a case by case basis.
Authentication	CAS/SAML 2.0

Kahoot

Description	A game-based learning platform for deployment of quizzes and on-line, immediate feedback.
Purpose at our university	To provide faculty with an easy, engaging tool for online student assessment and contributing for continuous evaluation processes.
Use	Construction of quizzes for on-line assessment
Additional features	None
Data flow /exchange	None
Authentication	N/A

Socrative

Description	Another game-based learning platform for deployment of quizzes and on-line, immediate feedback.
Purpose at our university	To provide faculty with an easy, engaging tool for online student assessment and contributing for continuous evaluation processes.
Use	Construction of quizzes for on-line assessment
Additional features	None
Data flow /exchange	None
Authentication	N/A

Educast

Description	Educast is a national platform supported by the Portuguese National Science Foundation to store, edit and broadcast scientific and academic videos
Purpose at our university	Non-commercial alternative to YouTube to store and stream scientific and academic videos
Use	Large scale storage and streaming of classes, presentations, and subjects. Available at http://educast.fccn.pt/ Note: there is not a mandatory rule to use this platform at ULisboa; most videos may be stored in local platforms or other available channels (namely YouTube), depending on scope and purpose.
Additional features	Advanced and flexible video editing tools
Data flow /exchange	N/A
Authentication	RCTSaai (National Academic Authentication platform, federated with eduGAIN).

Scholar

Description	Scientific publication repository of Instituto Superior Técnico (IST)/ULisboa, closely integrated with the Fenix CMS/LMS platform
Purpose at our university	Single point of reference to assess scientific publications at IST/ULisboa.
Use	Fenix Scholar is the Master publication repository at Instituto Superior Técnico, providing bibliographic information for faculty, researchers, students and staff. Provides bibliometric information regarding faculty, research and scientific units. Available online at https://scholar.tecnico.ulisboa.pt
Additional features	Automatic harvesting of several external repositories (ORCID, DBLP, SCOPUS, CienciaVitae) Synchronizes with the Portuguese National Scientific Repository (RCAAP) Synchronizes with the central ULisboa repository.

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Data flow /exchange	Receives publication data from ORCID, DBLP, SCOPUS, etc. Exports publication data to the central ULisboa repository (check 1.4.11) and the Portuguese National Scientific Repository (RCAAP)
Authentication	CAS/SAML 2.0

Pure

Description	Research Information Management System (RIMS) / Current Research Information System (CRIS) for the whole University of Lisbon
Purpose at our university	Master Research Information System for the whole ULisboa.
Use	Publication directory and bibliometric analytics for the whole University of Lisbon
Additional features	Provides advanced bibliometric data Pure is a CRIS and it does not provide a repository service. ULisboa makes use of the National Portuguese Scientific Repository (RCAAP) for actual publication storage.
Data flow /exchange	Imports data from the major scientific databases (ORCID, DBPLP, SCOPUS, CienciaViate) Exports data / synchronizes with the National Portuguese Scientific Repository (RCAAP).
Authentication	SAML 2.0

Colibri/Zoom

Description	Colibri is the Zoom based academic video conferencing system subscribed at national level by the Portuguese National Science Foundation. In practice, Colibri is just a web authentication portal that provides academic access to the well-known commercial Zoom platform and that keeps track of the number of simultaneous authorized sessions at national level.
Purpose at our university	Use of web conferencing system for online teaching, conference, thesis defenses and general-purpose meetings.
Use	Online lectures, meetings, and conferences. Available at https://videoconf-colibri.zoom.us
Additional features	Screen sharing, online chat, etc
Data flow /exchange	It may export chats, list of attendees, and recorded videos, but no integrated data exchange with other available platforms
Authentication	RCTSaai (National Academic Authentication platform, eduGAIN federated)

Lime Survey

Description	Lime Survey is an Open-Source platform for quick and anonymous online surveys proving flexible configuration and advanced analytics.
Purpose at our university	To support all required and anonymous internal surveys who target students, faculty and staff and regarding teaching, operational or research subjects not natively supported by the Fenix CMS/LMS platform. Important note: The Fenix CMS/LMS platform has an integrated module to support regular, standard and anonymous student satisfaction surveys, learning quality assessment, teacher evaluation by the students and subject assessment. Being closely integrated with the CMS/LMS platform, provides a simple way to perform “almost” mandatory surveys by appearing immediately after login during the survey period if not filled before. While the user has always the option of skipping and not filling the survey, most users end up answering the survey sooner or later to avoid the intermediate splash screen. However, the Fenix built in survey module is mostly oriented to learning quality assessment and it is not easily adapted to other specific domains. Therefore, Lime Survey is used for all other surveys required at the Faculty or University level.
Use	Performing anonymous, general purpose surveys
Additional features	N/A
Data flow /exchange	N/A
Authentication	CAS / SAML 2.0 for accessing the back office, perform administrative tasks and survey configuration. Authentication is not required by the user to answer any survey.

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Gitlab

Description	Version Control System for all projects development
Purpose at our university	Providing a Version Control System for any type of Project Development
Use	Code submission in specific courses and software development
Additional features	N/A
Data flow /exchange	No data exchange
Authentication	CAS / SAML 2.0

5.7.2 Special features

The Fenix platform is an open project originally developed at Tecnico Lisboa, which was later extended in slightly different flavours to all schools of the University of Lisbon and some other Universities by private companies which offer installation services, addons and built in customization.

There are no national rules regarding the use of open-source platforms, but ULisboa promotes the use of open-source software whenever adequate and convenient.

There is no national student identity number, with the definition of identifiers delegated on each University or Faculty.

The Portuguese National Science Foundation, through the National Research Network (FCCN), maintains several centralized services for common use of Portuguese Academic Institutions. These include:

- Management of the backbone of the National Academic Research Network
- National Federated Authentication (RCTSaai), integrated with eduGAIN;
- National Eduroam authentication backbone;
- Video conference system (through colibri, check section 4.1.12);
- National Scientific Repository (RCAAP, see sections 1.4.10 and 1.4.11);
- Academic access to major on-line scientific resources (available at https://www.b-on.pt);
- Services and platforms for video storage and editing (namely educast, check https://www.b-on.pt)
- Support of general-purpose MOOC courses at the national level (check https://www.nau.edu.pt/)

However, take into account these national services are mostly focused at the infrastructure level or transversal services, do not providing support for specific academic management or learning management processes.

5.7.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 26 to illustrate the journey of students within the system.

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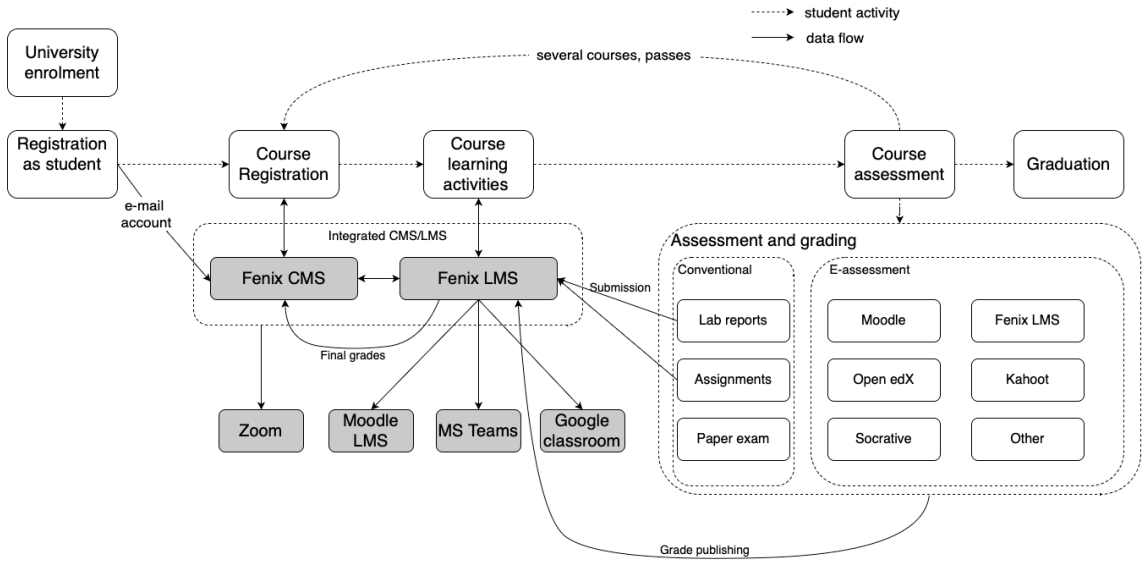

Figure 26: Universidade de Lisboa student's journey within the digital systems at a glance.

The initial registration as a student takes place by creating a user identity. For Portuguese students who originate from the national secondary high school system, this start of the process is semi-automated, since the allocation of students to (public) universities results from a national application process, managed by the Ministry of Education after considering secondary grades, student preferences and number of available positions for each course. In this case, each enrolled student fills a pre-allocated course and slot within the course. In other cases (international students or those originating from other sources), it is used the free vacancies in each course, and enrolment takes place taking into account specific cooperation programs and protocols, as well as some other specific cases.

In any case, the initial enrolment triggers the creation of the user id and the filling of personal data required by the Fenix Campus Management System (CMS). The local e-mail address is created in the same enrolment workflow, when the user identity and some attributes are exported to the local LDAP directory.

While first year students usually have allocated a set of pre-defined of subjects for each course, in the following years or more advanced degrees (MSc and PhD) the student may select the desired subjects within a few scientific areas, depending on the course and course rules. All user selections taken at this step are automatically validated by the Fenix CMS, according to a set of pre-defined rules configurated for each course.

During each class period, the main communication platform between the student and the teacher is the Fenix LMS, where the teacher may publish slides, teaching material, general information, course outline, assignments, general announcements, as well as date, outline and number of students of each individual class and type of class (lab/lecture/exercises, video conference/presential, etc). While the way each teacher uses the Fenix LMS strongly depends on personal preferences and creativity, at least a subset of information is mandatory to publish and to be kept up to date for student information and audit purposes, namely subject planning, date and outline of each individual class, assessment dates and rules, etc. These basic components, which are visible and implicitly validated by the students, enable a preliminary automatic assessment of the way each subject was taught in each academic period.

During the academic period, the teacher may choose to automatically deploy and use alternative learning platforms (Moodle, MS Teams, Google Classroom, etc), but the mandatory information

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must be kept in the Fenix system. During the period, evaluation takes place by conventional means (pen and paper test/exams), class assignments and lab reports (submitted using the Fenix System) or using on-line evaluation platforms (Moodle, Open edX, Kahoot or Socrative for game-based quizzes, etc). At the end of the academic period, the teacher in charge submits the final grades of each subject to the Fenix CMS uploading a CSV file or editing individual grades for each student. After signing the grades, the subject is formally registered as completed in the student record, along with the achieved grade.

At the end of the course, the Fenix CMS automatically validates if the path and subjects completed, as well as the number of ECTS, meet the course minimum requirement. After this step, the Fenix CMS may issue, upon student request, a Course Graduation Certificate.

5.7.4 Current and Future Directions

Planned short term developments include, among others:

- Inclusion of a two-factor authentication for all sensitive operations;
- Support of digital signatures and validation for submitted grades;
- Full support of Erasmus Without Papers and European Student Card;
- Automation of other mobility programs.

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5.8 Universitat Politècnica de Catalunya/BarcelonaTech (UPC)

Mercè Oller, Carles Espadas, Joan Giralt, Sisco Villas (all UPC)

5.8.1 Overview of digital infrastructures for learning and teaching

UPC's e-learning architecture is designed to improve the quality of education by providing an interactive and flexible learning environment. The UPC digital educational system is made up of an ecosystem of applications that combine open-source systems and internally developed systems. The main component is the LMS (Learning Management System) called Atenea Virtual Campus that is based on Moodle that is synchronized with the academic management system called PRISMA. PRISMA is the main system that lends support to the management of academic processes at the UPC, especially aimed at teachers and management staff, and it has an interface for the student, called e-Secretaria. However, UPC is composed of different schools, faculties, services units, etc. and some of them may have their own systems. Only the services considered institutional and shared are described below.

Figure 27 gives an overview of UPC's digital platform and tools.

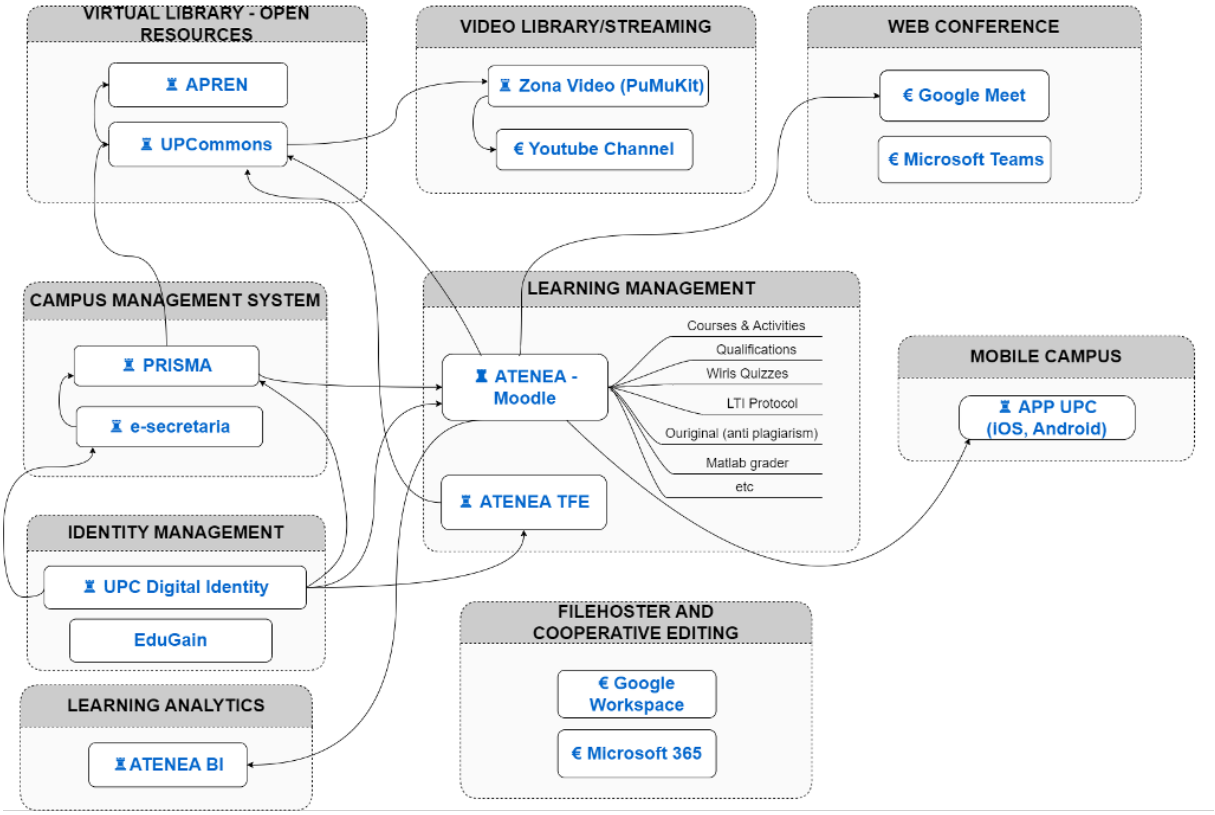

Figure 27: UPC's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 13 gives an overview about UPC's key systems in use in students' life cycle perspective.

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Table 13: UPC's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (sort of system) and version number
Student registration	• e-Secretaria (Academic services for students) • PRISMA (Course Management System)
Getting access data	Students will be automatically signed up in UPC's systems once enrolment is formalized. For the first time, after the enrolment process, they receive an email with the access codes at the e-mail address they provided in the enrolment form.
Find curriculum / courses	• e-Secretaria (Academic services for students) • PRISMA (Course Management System)
Course registration	• e-Secretaria (Academic services for students) • PRISMA (Course Management System)
Course learning activities	• ATENEA – Moodle (Learning Management System) v4.1 • Zonavídeo UPC (Video Web Portal) • PumuKit (Video Platform) (PuMuKIT is 3.8.2??) • APP UPC • Meet (Virtual Classroom) • Google Workspace
Course assessment(s)	ATENEA – Moodle (Learning Management System) v4.1
Ending with graduation (issuing the certificate)	• e-Secretaria (Academic services for students) • PRISMA (Course Management System)
(if) Central authentication platform (SSO, Keycloack, etc.)	UPC Digital Identity (SSO)

In the following, all these systems and tools are described in short.

PRISMA (Course Management System)

Description	PRISMA is a multilingual course management system that lends support to the management of academic processes at UPC. It covers the three main aspects of course management: planning, development, and assessment processes
Purpose at our university	Course management: from the application to the graduation, the complete university administration is managed with it.
Use	Student life cycle (application and admission at university, access data, curriculum, course registration, exam registration, final theses, certificates, graduation) Teacher life cycle (registration, access data, course offering, exam management, issuing certificates, research documentation, publications, surveys) University administration (economic management associated with enrolment, communication with other systems (Spanish Ministry for Education, …), etc.
Additional features	This system is self-developed
Data flow /exchange	Synchronization of following data entities into Moodle: Courses, groups, enrollments (students, teachers, tutors, ...) Details of the bachelor's thesis and master's thesis and information of the persons who are part of the tribunal. Details of the doctoral thesis and master's thesis and information of the persons who are part of the tribunal. From Moodle into PRISMA: Final exam grades Confidentiality information of the bachelor's thesis and master's thesis From PRISMA to UPCommons Submit information about the bachelor's thesis and master's thesis, title, author, studies... The thesis document is loaded into UPCommons directly from ATENEA TFE From PRISMA into Institutional websites (UPC web, UPC schools, UPC Libraries Service, etc) Study programs Teaching guide, etc From PRISMA to Catalonia agencies (AGAUR, AOC, UNEIX…) and Spanish Ministry of Education scholarships, mobility,...
Authentication	University Single Sign On

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ATENEA – Moodle (Learning Management System)

Description	ATENEA is the UPC's virtual teaching environment, which professors use to provide students with teaching material, statements of practical problems, exercises and sample exam papers, etc.
Purpose at our university	Atenea is the Virtual Campus of the Universitat Politècnica de Catalunya (UPC) based on the free software Moodle v4.1. At UPC, Moodle supports teachers with lecture management and performing online exams as well as assessments. Students are supported in their daily learning process such as group building, assignments, self-assessments, etc. The current Atenea is fully integrated into the teaching, Enrolment and academic management processes of the university
Use	As a teacher • Structure an<d publish your subjects • Providing course materials • Create content and activities • Group building • Evaluate the activities • Communication with the students As a student • Access and consuming course materials • Deliver jobs • Check your grades • Communicated with the teaching staff and other classmates • Online exams and assessments
Additional features	• ORIGINAL: Plagiarism detection • WIRIS quizzes: Automatic quiz evaluation of dynamic questions with random parameters and answers based on equations, graphics or text. • Matlab grader: Automatic evaluation of MATLAB code exercises • Geogebra: Allows you to incorporate geometry, algebra and calculus activities into the virtual campus • LTI client: Allows external teaching resources to be incorporated into the subjects via the LTI protocol • Teacher's briefcase: Personal space to try designing teaching activities and content with fictitious students • Google drive: Allows you to use the contents of your personal google drive account • Dropbox: Allows you to use the contents of your personal Dropbox account • PDF generation of questionnaires: It allows generating different PDF versions of the same questionnaire • Publication of teaching content: Allows the teaching staff to publish in the UPCommons institutional repository • Notification of grade updates to students: Automatic notification via the UPC App of changes in the grades that the teaching staff has made public • Learning Analytics
Data flow /exchange	To Moodle • DataWarehoure (for Analytics) • See PRISMA From Moodle • See PRISMA • See APREN • See UPCommons • See App UPC
authentication	University Single Sign On

e-Secretaria

Description	Multilingual portal for students that offers management and procedures related to the academic file. It is part of PRISMA. PRISMA is the global system, especially aimed at teachers and management staff. e-Secretaria is the interface for the student

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Purpose at our university	The e-secretaria intranet is a digital portal that, as a UPC student, you can use to enrol, consult your academic record, apply for certificates, modify your personal and contact details and carry out administrative procedures involving the secretary's office at your school.
Use	It offers the following services related to the academic file: • Enrolment potential consultation (subjects you can enrol in depending on your academic record and the course offer). • Online enrolment • Consultation of the academic record. • Consultation and modification of personal, academic and banking data. • Registration and e-Deposit of the project • Mobility: offer, request, resolution, grants, pre-commitment, credential, etc. • Application for certificates of file status and academic certifications. • Request for instances (related to evaluation, registration, permanence...) • RGPD Authorisations • Documentation: ability to upload documents • Work placement: register of external practices • Other procedures (recognition of activities, group changes, etc.). • Downloading forms and making payments for the available procedures
Additional features	This system is self-developed.
Data flow /exchange	See PRISMA
Authentication	University Single Sign On

ATENEA-TFE

Description	Multilingual portal for Support Platform for bachelor's and master's theses
Purpose at our university	Platform to manage the bachelor's or master's. This tool will help students to follow up and deposit phases (supervisor-student link, documentation, thesis deposit, etc.).
Use	Platform to formally submit the final bachelor's and master's theses Exchange information with the thesis supervisor Once the student has uploaded all the final thesis documents via the Atenea-TFE platform, the thesis supervisor can approve the documents.
Additional features	This system is self-developed based on Moodle
Data flow /exchange	See PRISMA
Authentication	University Single Sign On

UPC Digital Identity (Identity Management)

Description	The UPC identity system collects the identities created in the different source systems (mainly human resources, academic management systems) and offers the standardized data to other applications. Each person (teacher, student, administrative staff and external users) is assigned a unique identity for access to the UPC information systems that is stored in the Identity Management System.
Purpose at our university	Primary source to consult identities and basic information about them
Use	It is mainly responsible for user auto-provisioning in university systems. It is consulted by some administrative users to get information about users but mainly from applications (get valid users, basic authorization, etc.)
Additional features	This system is self-developed Authentication Manages the password policy Upload and manage the photograph Provide a card or access card Digital certificate management to be able to authenticate and sign
Data flow /exchange	Input: • Human resources management system (for Staff) • Academic management system (for Student) • File uploads and manual procedures for other kinds of groups Output: • Single Sign On

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	• Many other applications that consume identity information (Atenea, Libraries, Google mail services, mailing list …)
Authentication	University Single Sign On

Zona Vídeo – Video Web portal

Description	Zonavideo UPC is the platform for the publication of videos on the Internet. Specially designed to provide this service to the UPC community, it allows you to publish teaching videos as well as research dissemination or promotional videos
Purpose at our university	• UPC's audiovisual portal. A Video Portal offering course videos, event videos, and other interesting videos of UPC. • Open publication
Use	• Providing recorded lecture videos, event videos, and other interesting videos to students and the rest of UPC community • Providing live streams about events to the UPC community
Additional features	The video portal is based on PuMuKIT is 3.8.2 an open-source Video platform
Data flow /exchange	To Moodle (ATENEA) • Teaching staff can select the videos published on Zonavídeo from the virtual campus To APRÈN • All the production of educational videos published on Zonavídeo.
Authentication	University Single Sign On

APREN

Description	Aprèn is a portal that provides access to the teaching support materials developed by the teaching staff of the Universitat Politècnica de Catalunya (UPC). Aprèn contains the teaching content that UPC teaching staff incorporate into UPCommons, the UPC's open knowledge portal, and Zonavideo, the UPC's audiovisual portal
Purpose at our university	• To improve the visibility and impact of the teaching output of UPC teaching staff with an integrating platform that standardises access and search. • To add value to the teaching output of UPC teaching staff. • To increase open access publishing of the teaching content produced by UPC teaching and research staff and make it easier for the content to be reused to improve teaching. • To identify the authors of the teaching content unambiguously, both in terms of their personal name and their institutional affiliation. • To promote the use of UPCommons as the institutional repository for collecting and preserving all of the UPC's academic output.
Use	Aprèn can be used to consult the UPC's teaching content by choosing one of the options listed below. • Teaching staff: consult the teaching content produced by UPC teaching staff. • Organization: consult the teaching content produced or supervised by the members of a UPC unit (schools or departments). • Subjects: consult the teaching content related to a subject taught at the UPC. • Degrees: consult the teaching content related to a bachelor's, master's or doctoral degree taught at the UPC. • Content: consult all the teaching content available on UPCommons. • Open access: consult all the teaching content available on UPCommons and Zonavídeo that has been published in open access on the internet. • Bachelor's and master's theses: consult bachelor's and master's theses produced by UPC students as a final work and summary of the knowledge and competencies that they have gained at the UPC. • Videos: consult the audiovisual content linked to teaching activities at the UPC.
Additional features	A Moodle plugin allows teachers to publish their educational content available on Atenea to UPCommons and Aprèn.
Data flow /exchange	From UPCommons • The teaching content that UPC teaching staff incorporate into UPCommons From ZonaVideo: • The videos from Zonavídeo can also be accessed on UPCommons. The educational videos are also incorporated into Aprèn.

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Authentication	No user authentication

UPCommons

Description	UPC's institutional repository implemented with DSpace 6.4
Purpose at our university	• To increase the visibility of the teaching and research output of the University's authors. • To add value to the teaching and research output through standardized citations, query statistics, permanent addresses and preservation mechanisms.
Use	Collects, manages, disseminates and preserves the teaching and research output of the members of the university community in open access: journal articles, research reports, conference papers, final theses, bachelor's theses, doctoral theses, teaching materials and other academic documents.
Additional features	• UPCommons uses the interoperability protocol Open Archives Initiative (OAI-PMH) to increase the visibility of the documents deposited. • This protocol allows other applications to collect metadata items to make other products improving their visibility and impact.
Data flow /exchange	• Teaching content can be incorporated into UPCommons directly from Atenea. (Moodle) • Integrated with Prisma and AteneaTFE to publish the final study projects. • Retrieve and publish the metadata of the videos deposited in ZonaVideo.
Authentication	University Single Sign On

Google Meet

Description	Google Meet is a commercial software for web conferencing. https://meet.google.com/
Purpose at our university	Use of web conferencing system for teaching online and also for meetings.
Use	Webconferencing
Additional features	• Record meetings • Create rooms in a meeting • Create polls
Data flow /exchange	After a meeting you receive an email with the attendance
Authentication	University Single Sign On

Microsoft Teams

Description	Microsoft teams is a commercial web conferencing and team collaboration system. https://en.wikipedia.org/wiki/Cisco_Webex
Purpose at our university	We only use it as a conferencing system (not team collaboration) especially for online presence teaching or meetings with other organisations. The official web conference system is Google Meet.
Use	Online sessions / Meetings
Additional features	No
Data flow /exchange	No data exchange
Authentication	University Single Sign On

Google Workspace

Description	Google Workspace is an online cloud storage and collaboration tool that provides users the ability to create, share and collaborate using Google applications. Google Workspace is a commercial collaboration set of tools https://workspace.google.com/
Purpose at our university	Collaboration among students or staff.
Use	• Webconference & jamboard • Email, groups & chat

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	• Document, forms, spreadsheets, slides and website edition, storage and sharing • Task, notes & calendar
Additional features	No
Data flow /exchange	No data exchange
Authentication	University Single Sign On

Microsoft 365

Description	Microsoft 365 is a commercial collaboration set of tools https://www.office.com/
Purpose at our university	Collaboration among students and staff. The official tool is Google Workspace but this one is also available.
Use	• Webconference • email & chat • document, forms, spreadsheets, slides and website edition, storage and sharing • task, notes & calendar
Additional features	No
Data flow /exchange	No data exchange
Authentication	University Single Sign On

App UPC

Description	App UPC is the mobile application aimed at PDI, PAS, Students and Future Students of the UPC. Includes access to information, functionalities and specific services for each group.
Purpose at our university	Offers information and practical resources for the day-to-day life of the different groups that make up the UPC community (Students, PDI and PAS of the UPC)
Use	For Student: • UPC Virtual Card • Check marks • Timetables • Scholarships • Notifications • UPC news • UPC agenda • Location maps • UPC libraries
Additional features	This system is self-developed
Data flow /exchange	• Student marks are transferred from PRISMA • Student timetables are transferred from the UPC academics Data Warehouse • Access to the UPC library occupation information via Rest API • News and agenda are obtained from the UPC's corporate website via Rest API • Integration with the University's Identity Service for the generation of the UPC virtual card
Authentication	University Single Sign On

ATENEA BI

Description	ATENEA BI is a tool for Business Intelligence.
Purpose at our university	Collects indicators of use of the UPC's teaching platform, Atenea (sessions, activities, ...). The platform allows to consult the indicators on the use of the Atenea virtual campus by the UPC community through the application of business intelligence tools (Business intelligence).
Use	Aggregate the indicators about • sessions, connected and active users of ATENEA platform • Resources created by professors and readed by students • Grades • Courses created and taken

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	Download KPIs in spreadsheets • See the KPIs for each course displayed in ATENEA The data can be filtered by groups (students, PDI and pass), by units (teaching centers and departments), by studies (degree and master's) and by time intervals (one hour, one day, one week or one month) . Compare the KPIs for different time periods, as well as to visualize, by means of bar diagrams, the relative weight of each indicator by groups, units and degrees
Additional features	No
Data flow /exchange	The data is feeded to ATENEA BI through a webservice called by ATENEA
Authentication	University Single Sign On

5.8.2 Special features

At the UPC we are currently incorporating 2FA into our systems.

5.8.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 28 to illustrate the journey of students within the system.

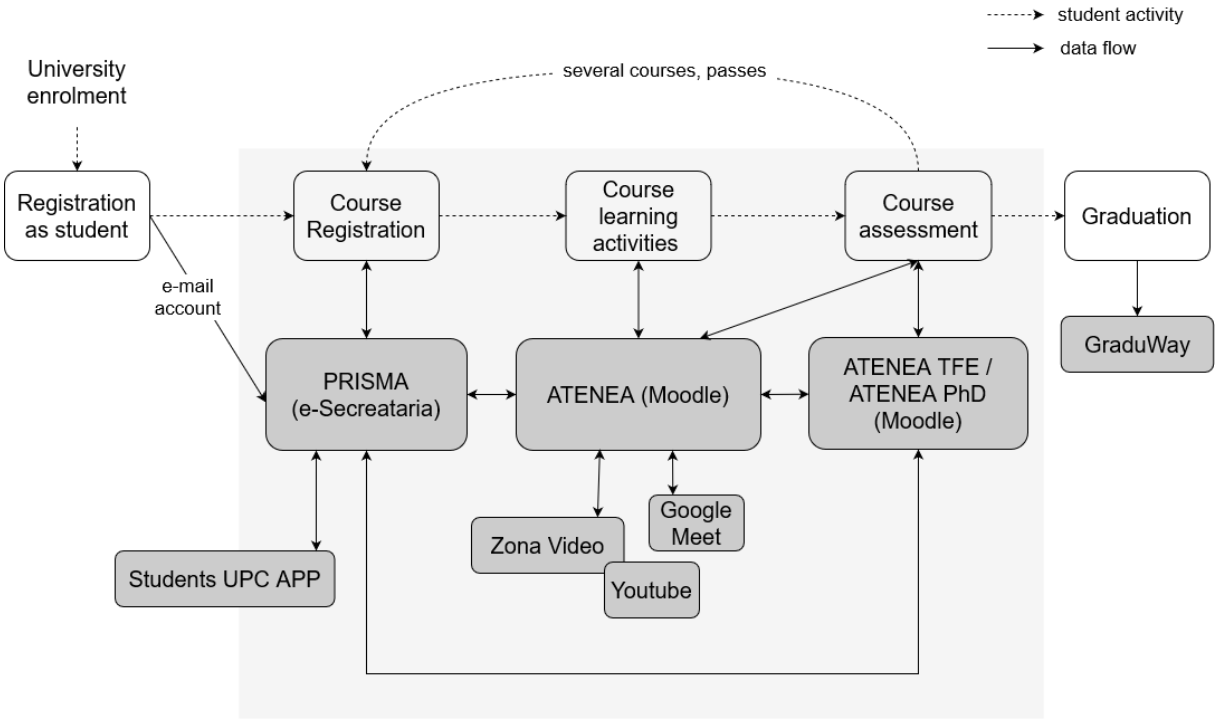

Figure 28: UPC's student's journey within the digital systems at a glance.

To study at the UPC, candidates must complete the university pre-enrolment process through the Catalan University Admissions Advisory Office (Spanish), which is responsible for processing admission to all Catalan public universities. Master's and doctoral students do this process through a UPC-specific system, with which applications and their documentation are managed.

Once the student is admitted, their data is uploaded to Prisma, which is the UPC system for managing student data and their records from the time they are admitted until they graduate. Students enrol in the academic service portal, e-Secretaria, which is a part of the Prisma system for processes and procedures related to academic records, such as enrolment, request for certificates, mobility application, provide documentation, register, and deposit the final study project, register external internships, consult all your data and information that the university has and finally the degree application.

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After registering as a student, an account and an email address are assigned and the students will be automatically signed up in UPC's systems (Atenea, e-Secretaria, Eduroam…). New students will receive the access codes at the e-mail address they provided in the enrolment form.

The registration info is automatically synchronized to ATENEA, the Learning Management System (LMS). In ATENEA there are virtual classrooms corresponding to the subjects and professors use to provide students with teaching material, deliver works, earning activities, qualifications etc.. There is an additional system, ATENEA-TFE, a virtual platform to help with the management of end-of-studies, bachelor's or master's projects, at the time of their delivery.

Once the students have been evaluated and have finished their studies, they request their official degree in the e-Secretaria and they are incorporated into the alumni database if they request it.

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5.9 Technical University of Darmstadt (TUDa)

Christian Hoppe, Annelore Schmidt, Klaus Steitz, Astrid Würz (TU Darmstadt)

5.9.1 Overview of digital infrastructures for learning and teaching

TU Darmstadt offers its lecturers and students a variety of systems and tools for the implementation and use of digitally supported teaching and learning scenarios. The central and leading system at TU Darmstadt is the campus management system TUCaN (based on CampusNet). For learning management and e-assessments, the open-source system Moodle is centrally operated and offered. The open-source system Mahara, which is linked to Moodle, is available for the creation of e-portfolios. Panopto, also linked to Moodle, is used as a video content management system. It is licensed university-wide, as is the web meeting software Zoom. For the publication of Open Educational Resources, lecturers can use the self-developed platform OpenLearnWare. All e-learning systems used are maintained by the e-learning working group (consisting of teams within the Center of Educational Development and Technology and the IT Service Center).

Figure 29 gives an overview of TU Darmstadt's digital platform and tools.

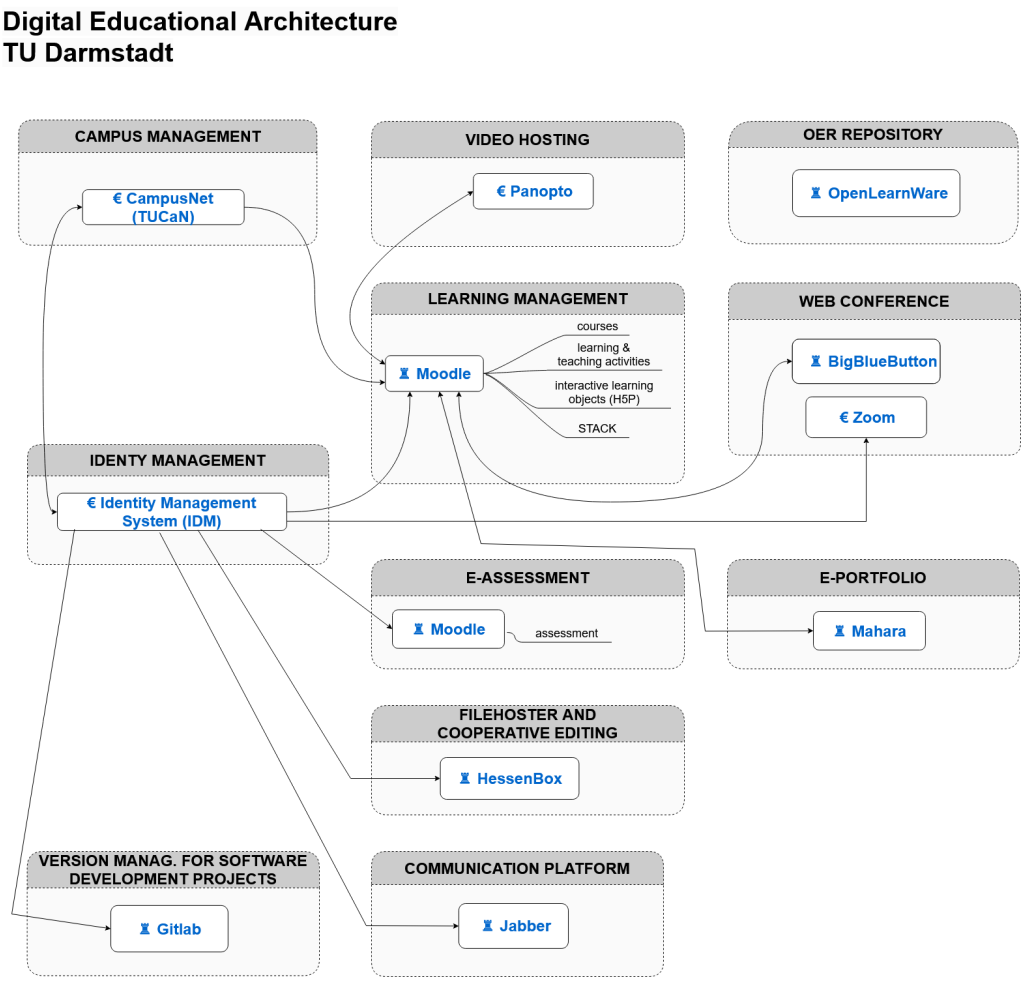

Figure 29: TU Darmstadt's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 14 gives an overview about TU Darmstadt's key systems in use in students' life cycle perspective.

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Table 14: TU Darmstadt's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (version number)
Student registration	• TUCaN (Campus Management System), CampusNet 2022 SP4 Classic
Getting access data	• TUCaN (Campus Management System), CampusNet 2022 SP4 Classic
Find curriculum / courses	• TUCaN (Campus Management System), CampusNet 2022 SP4 Classic
Course registration	• TUCaN (Campus Management System), CampusNet 2022 SP4 Classic
Course learning activities	• Moodle (Learning Management System) v3.11.14 • Mahara (e-portfolio software) • BigBlueButon (Virtual Classroom) • Zoom (Web Conferencing)
Course assessment(s)	• Moodle (Learning Management System) v3.11.14
Ending with graduation (issuing the certificate)	• TUCaN (Campus Management System), CampusNet 2022 SP4 Classic
(if) Central authentication platform (SSO, Keycloack, etc.)	SSO via Shibboleth (supports SAML2, CAS and OIDC) v4.3.1

In the following, all these systems and tools are described in short.

TUCaN (Campus Management System)

Description	TUCaN is the campus management system of TU Darmstadt. It is based on standard software CampusNet (Datenlotsen).
Purpose at our university	The entire student life cycle is managed with TUCaN from the application via enrolment, course and exam registration, credits, and certificates up to exmatriculation.
Use	• Applicants apply via TUCaN. • Students register for modules, courses, and exams via TUCaN. They are informed, when and where the courses take place. They see their ratings and credits. • Lecturers and examiners are informed, when and where the courses take place and which students are registered for their courses. They enter the ratings in TUCaN. • Administrative staff manages student status, semester fees etc.
Additional features	Interface to Moodle
Data flow /exchange	• Data Source for Employee data is IDM. • TUCaN provides Student data to IDM. • TUCaN provides course data, lecturers, registered students to Moodle.
Authentication	TU-ID

TU-ID (Identity Management)

Description	At TU Darmstadt, the central digital identity for all persons is generated by the Identity Management System (IDM) of HRZ and is called TU-ID. For this purpose, data from source systems (e.g., human resources management or the student administration system) is taken from a natural person and the TU-ID is generated directly. Guests or Partners of TU-Darmstadt who are not registered via the human resources management or the student administration system can be entered manually and given a TU-ID. This enables every member and member of the TU to receive a TU-ID.
Purpose at our university	central user ID for access to various systems of the TU-Darmstadt, for example TUCaN, Moodle and e-mail
Use	All members for authentication Guest TU-ID with legitimate interest in access to the IT systems of the TU Darmstadt

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Additional features	Athena-Card : personalised card for the use of several offers, facilities etc. IDM-Portal: self-developed web-frontend for Account-Management, groups, addressbook and similar
Data flow /exchange	Data Source for Student data ist TUCaN. Data Source for Employee data is SAP-HCM. Data is collected by IDM System an provisioned to LDAP and AD. Services can access data via LDAP oder AD only.
Authentication	Single sign on (SSO) via TU-ID and for Service Provider (SP) if protocol SAML2, CAS, OIDC is supported. TU-Darmstadt provides as Identity Provider Shibboleth.

Moodle (Learning Management System)

Description	Moodle is an open-source learning management system designed to provide educators, administrators and learners with a single integrated system to create personalized learning environments, see: https://docs.moodle.org/en/Features
Purpose at our university	At TU Darmstadt several Moodle installations are in use. Moodle supports teachers with lecture management and performing online exams as well as assessments. Students are supported in their daily learning process such as group building, assignments, self-assessments, etc.
Use	Course learning activities: • Providing and consuming course materials • Submission of assignments • Group building • Scheduling • Integration of BigBlueButton • Integration of Panopto (Upload and consume videos) • Integration of other learning tools via LTI (e.g., Matlab, etc) Course assessments • Online exams and assessments
Additional features	Due to Moodle's modular architecture, its functionality can be extended by plugins and adapted to desired requirements. TU Darmstadt has developed following Moodle plugins to fulfil its needs, some shared with community: https://moodle.org/plugins/tool_supporter https://github.com/eLearning-TUDarmstadt/moodle-local_categorybackup Interface with TUCaN (Campus Management System) moodle-statistics Internal local-Plugins (local_littlehelpers, local_categorybackup)
Data flow /exchange	To Moodle • See TUCaN • See Identity Management System • See Panopto From Moodle • See BigBlueButton • See Mahara • See Panopto
Authentication	CAS and SAML2

Mahara (e-portfolio software)

Description	Mahara is open-source and can be used for many different e-portfolio purposes, such as study, professional development, work-integrated learning, assessment, showcase and presentation, and employability. https://mahara.org/
Purpose at our university	Mahara is used to document learning processes, reflect, receive feedback or present competences
Use	Students and teaching stuff, mostly for Teacher education and training (Center for Teacher Education)
Additional features	no
Data flow /exchange	Transfer of user identifier through Login-Process via Moodle
Authentication	Through Moodle

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Panopto (Video Content Management System)

Description	The web-based video platform Panopto is used for video management and provision. However, integrated recorders also facilitate the recording and editing of screen recording videos. The platform can also be used for live streams (called "webcasts" in Panopto) as an alternative to YouTube and Co.
Purpose at our university	Panopto is campus-licensed and available at the TU Darmstadt since October 15th, 2020. Panopto is linked to the learning platform Moodle so that a login via TU-ID is possible as well as easy integration of videos into Moodle courses.
Use	All members use Panopto for video management and delivery and benefit from the easy integration of videos in Moodle courses
Additional features	no
Data flow /exchange	Transfer of user identifier through Login-Prozess via Moodle
Authentication	Through Moodle

OpenLearnWare (OER repository)

Description	OpenLearnWare (OLW) is the TU Darmstadt's online platform for free access to learning materials. It supports the worldwide initiative "Open Educational Resources (OER)". Openness in teaching and education possibilities for everybody are the main goals.
Purpose at our university	• an online platform for free access to and exchange of digital learning material from courses for interested parties • visibility of teaching
Use	As a lecturer at TU Darmstadt, you can publish your learning materials on the OpenLearnWare Platform. These can be, for example, lecture recordings, presentation slides, scripts, or audio files. Students use the materials.
Additional features	Platform own-developed in Java, but migration to Panopto plus WordPress-Frontend in progress, due to problems in maintaining the code
Data flow /exchange	Not automated, only manually linking to materials e.g., from Moodle (also using an self-developed Moodle-Plugin)
Authentication	Only for admins

BigBlueButton (Web Conferencing)

Description	BigBlueButton (BBB) is an open-source web conferencing tool for online meetings, offered in a privacy-compliant manner in collaboration with Darmstadt University of Applied Sciences (h_da).
Purpose at our university	With BigBlueButton, web conferences can be carried out in a browser; the installation of a special client is not necessary for this. The tool offers numerous functions to support online offerings in teaching as well as online collaboration at TU Darmstadt.
Use	• Using BBB in teaching: BBB meetings can be created from within Moodle courses. • The use of BBB by employees and students: BBB can be used by staff and students for scheduled or ad-hoc video conferencing.
Additional features	no
Data flow /exchange	• Transfer of user authorisation from Moodle within course context • Transfer of user authorisation from BugBlueButton within plugin context
Authentication	Via Moodle or TU-ID login for use outside Moodle

Zoom (Web Conferencing)

Description	Zoom is a clearly arranged and easy-to-use tool for web conferences. The cloud service supports different usage scenarios – from virtual teamwork to online presentations and online lectures.
Purpose at our university	It can be used to conduct courses in an online live format instead of face-to-face or to integrate online meetings in addition to traditional face-to-face teaching – for example, for online consultations or international collaborations. In addition, Zoom's campus license can be used for online meetings in the context of mobile working at TU Darmstadt.

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Use	All members may use Zoom, or BBB as alternative
Additional features	no
Data flow /exchange	
Authentication	Zoom-Account based on TU-Darmstadt mail-address

Jabber (Unified Communications Client)

Description	Jabber is a UC client (Unified Communications Client), which combines all relevant communication services in a central user interface.
Purpose at our university	The Jabber client offers telephony, video call, chat function, screen sharing and data exchange. Via jabber you can quickly find and dial the numbers of all TU Darmstadt employees. Furthermore, Jabber offers you an encrypted chat function between individual users and in group chat rooms.
Use	TU Staff for chatting. TU staff members with a personal telephone number can also use the Jabber client for the telephony service.
Additional features	Screensharing, voicemail, collective call number
Data flow /exchange	You can synchronize your availability status with your appointments in Outlook, i.e. as soon as you are in an appointment that is set in Outlook, you will automatically be marked as absent / busy in the Jabber client.
Authentication	TU-ID

Matrix (Communication Protocol / Chat)

Description	Open-source system for secure, decentralized communication – https://matrix.org/
Purpose at our university	data protection compliant chat via self-hosted servers
Use	All members may use it for chatting
Additional features	no
Data flow /exchange	No data exchange
Authentication	SSO using TU-ID

Hessenbox (sync & share system)

Description	As a sync & share system, Hessenbox-DA offers employees and students of the TU Darmstadt an alternative to commercial services that complies with data protection and copyright laws. Based on the Software “Powerfolder”.
Purpose at our university	Hessenbox-DA allows files such as projects, presentations, scripts, or homework to be stored online and to be synchronized between different devices. Therefore, information is always available in its most up-to-date form, regardless of whether you want to access it in the lecture hall, on campus, on a PC or on the road via notebooks or smartphones. It is also possible to specifically share and release files to support collaborative editing.
Use	• Employees of TU Darmstadt have a storage capacity of 100 GB at their disposal. • Students of TU Darmstadt have a storage capacity of 30 GB at their disposal. • Guests can register to the system. They do not have their own memory but can access memory that has been released for them by employees. • External users (without a TU-ID) can use Hessenbox-DA if employees have set up access to the system for them.
Additional features	Online editing of documents with OnlyOffice in a web browser
Data flow /exchange	No data exchange
Authentication	SSO using TU-ID

Gitlab (DevOps platform / Version Control System)

Description	With GitLab, the focus lies on code management to track which changes were made to content such as source code, LaTex files, or scripts, and to track when these changes were made. You maintain an overview of your projects and data and thereby increase their quality. Collaboration with RWTH Aachen, which hosts gitlab.

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Purpose at our university	GitLab is a web application for version management of software projects based on Git. It offers various management and bug tracking functionalities.
Use	Mainly used by developers for code management and documentation, sometimes using the wiki
Additional features	no
Data flow /exchange	No data exchange
Authentication	DFN-AAI Single Sign-On (for TU-users: TU-ID)

5.9.2 Special features

None.

5.9.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 30 to illustrate the journey of students within the system.

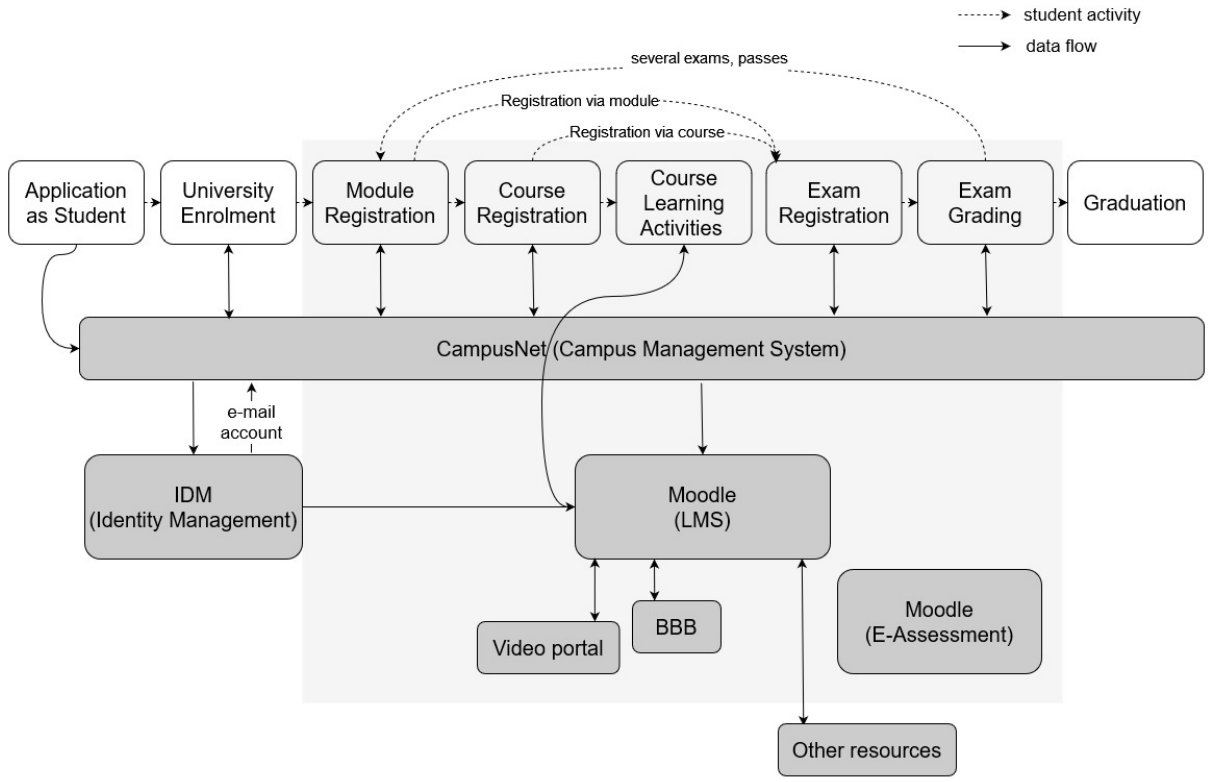

Figure 30: TU Darmstadt's student's journey within the digital systems at a glance.

Prospective students who would like to apply for a study program at the TU Darmstadt create an applicant account in the Campus Management System (CaMS). They use this account to apply for a degree program. If they are admitted to the program, they will receive information via the CaMS with a request to pay the semester fees. As soon as the payment is received, they are automatically enrolled in the desired study program in CaMS. The data of the enrolled students is automatically forwarded to the IDM (interface CaMS <-> IDM) and the account in CaMS is converted from an applicant account to a student account. Via the student account, students register in CaMS for the modules offered as part of their studies, then for courses and for exams. Instructors can have a Moodle course automatically created in CaMS for their courses. By registering for a course, students are automatically (CaMS -> Moodle interface) also registered for the Moodle course associated with that course (if a Moodle course was requested by the instructor) and can participate in learning activities via Moodle. Professors/lecturers post the grades of the examinees

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in CaMS. As soon as all necessary achievements have been made to pass the degree, the graduation documents (certificate + diploma etc.) are created via CaMS and issued to the students. The student account is deactivated in IDM and CaMS after a grace period of currently 90 days.

5.9.4 Current and Future Directions

Currently, there are numerous projects in the area of digitization of teaching, administration and corresponding processes (e.g., document management, archive systems). These will have an impact on the future digital educational system of the TU Darmstadt, which, however, is not yet fully foreseeable at this point. In the area of systems for digitally supported teaching (e.g., LMS, VCMS) no fundamental changes are planned in the short and medium term.

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5.10 Wroclaw University of Science and Technology (Wroclaw Tech)

Agnieszka Herczak-Ciara, Jarosław Krysiak, Rafał Tadaszak, Agnieszka Szymańska-Kwiecień, Beata Cybulska (all Wroclaw University of Science and Technology)

5.10.1 Overview of digital infrastructures for learning and teaching

Wroclaw University of Science and Technology (Wroclaw Tech) offers lecturers and students a variety of systems and tools for supporting the teaching and learning process. The central system for managing the study process is USOS, used in almost 90 universities and high education institutions in Poland. The staff and students use a unified email based on the commercial Gmail solution. The central Moodle platform is used for sharing learning materials, as well as MS Office products (Teams, OneDrive, Sharepoint), and Google (Drive). ZOOM and VC, MS Teams and Google Meet are used as video conferencing tools. The IT Department is responsible for supporting most of the systems. The seven-person e-learning team, which is a part of the IT Department, is responsible for Moodle, OER, courses development and staff training.

Figure 31 gives an overview of Wroclaw Tech's digital platform and tools.

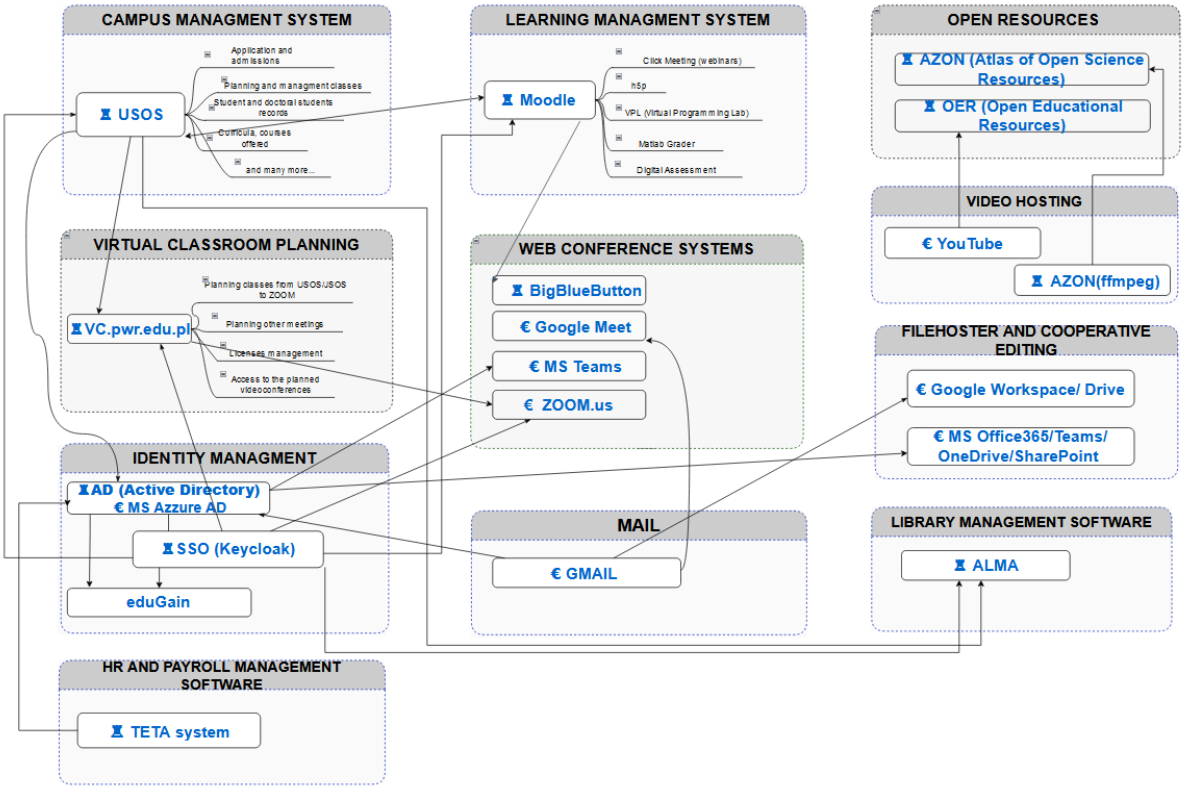

Figure 31: Wroclaw Tech's digital platforms and tools at a glance. Note: € stands for non-premises tools and the tower sign for on-premises tools.

Table 15 gives an overview about Wroclaw Techs key systems in use in students' life cycle perspective.

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Table 15: Wroclaw Tech's key systems in use in students' life cycle perspective

Areas/Fields	Systems and tools in use (version number)
Student registration	• USOS IRK and IRC (for foreign applicants)
Getting access data	• USOS
Find curriculum / courses	• USOS
Course registration	• USOS
Course learning activities	• Moodle 3.11 • ZOOM • Google Workspace/Drive/Meet • MS Office365/Teams/OneDrive/SharePoint
Course assessment(s)	• Moodle 3.11 • MS Teams • (examinations on campus, on paper)
Ending with graduation (issuing the certificate)	• USOS
(if) Central authentication platform (SSO, Keycloack, etc.)	• SSO (Keycloack)

In the following, all these systems and tools are described in short.

USOS (Campus Management System)

Description	University Study-Oriented System (called USOS) is a student management information system used in almost 90 Polish universities, technical universities, and other types of high education institutions. USOS is the result of cooperation between the largest Polish universities which are among the stakeholders of the Inter-University Computerisation Centre or MUCI-affiliated universities in the USOS project and is the result of the need for a comprehensive IT tool for managing student affairs in higher education. https://www.usos.edu.pl/about-usos
Purpose at our university	The system provides a complex service for students, doctoral students, and graduates, as well as for the university's employees, including the improvement of operations related to the handling of the teaching process. The main task carried out by USOS is administrative support of the teaching and learning process, which begins with the recruitment and ends with a presentation of diplomas.
Use	The main functional parts (subsystems) of USOS are the following. • Online Registration of Candidates (IRK) supports the admission process for bachelor's and master's degree programmes, post-graduate studies, doctoral schools, short-term studies and gives full information about status of the qualification for registered candidates. • USOSadm – application for administrative staff is an interface of management system for handling most aspects of university education like students and teachers personal data, matriculation, study programs, plans and requirements, course of study, electronic Student, Doctoral and Teacher Cards, degree certificates (all processes support ECTS credit system and diploma supplements), student financials (scholarships and fees), teaching lessons, survey and reporting • USOSweb ("virtual deanery") – service for students, teaching staff, graduates is a web-based student and academic-centred user interface with the large number of services. It provides many electronic operations and procedures performed by academic teachers and students concerning documentation of the study. It provides students with a timetable of classes, an overview of grades and passes, enrolment for classes and examinations, submission of applications, completion of questionnaires on the teaching process, information on payments and scholarships, communication with participants in the same classes and instructors. For academic teachers, the service allows them to manage the results of examinations, issue grades and passes, fill in assessment protocol for classes, send messages to participants in the classes.

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	• Course and Diploma Catalog (APD) are systems which are fully compliant with requirements of the Bologna Declaration. The first of them as an electronic brochure contains essential information about the university, programs of study offered by the university, recruitment, and practical information for students. The next one is used for the following purposes: management of data on graduate thesis, information about the topics, authors, search, and view thesis, carrying out the process of review and evaluate thesis authorized by a person and storing electronic versions of written reviews
Additional features	USOS is gradually gaining the reputation of a 'standard' solution for a higher education institution in Poland. USOS and its subsystems are installed locally at each university, member of MUCI. Source code is open for institutions participating in the project, which helps to keep good quality and debug it faster. The system grows steadily achieving higher level of integration. Inter-university initiatives stimulate new activities, giving rise to new quality solutions. The USOS Working Group, based at the University of Warsaw, is responsible for the development and maintenance of the system
Data flow /exchange	MOODLE Synchronisation of following data entities into Moodle: • Courses, course enrolments (students, teachers), • The course categories in Moodle are structured according to the USOS structure faculty-degree-semester-course. From Moodle into USOS: • Exam grades VC.pwr.edu.pl • batch import of data about classes and their participants into the VC MS Teams • batch import of data about classes and their participants into the MS Teams AD • import students' data from USOS into AD database ALMA • import users' data from USOS into ALMA database
Authentication	SSO [Keycloack]

Moodle (Learning Management System)

Description	Moodle is an open-source learning management system, see: https://docs.moodle.org/311/en/Main_page Moodle version 3.11 (version 4.1 scheduled)
Purpose at our university	At Wroclaw Tech Moodle (https://ePortal.pwr.edu.pl) is a central and main tool (but not obligatory) for sharing learning materials, checking student knowledge. It is managed by the e-learning team.
Use	Teachers and students use it for educational purposes: • Providing and consuming course materials • Preparing, evaluating activities • Knowledge testing Other employees: • access online training (including remote OHS) • access to materials from various EU projects
Additional features	Nonstandard plugins: • Matlab Grader: automatic evaluation of MATLAB code exercises • VPL: an activity module to manage programming assignments. • CodeRunner: is a free open-source question-type plug-in for Moodle that can run program code submitted by students in answer to a wide range of programming questions in many different languages. • Click Meeting is a browser-based platform for hosting webinars and training sessions • H5P: It enables educators to create content such as interactive videos, quizzes and presentations
Data flow /exchange	• To Moodle: See USOS • From Moodle: See USOS

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Authentication	SSO (Keycloak)

Virtual Classroom Planning (VC)

Description	The Virtual Classroom Planning (VC) allows teachers to plan classes and other meetings in the form of ZOOM videoconferences. VC is developed by Wroclaw Tech programmers.
Purpose at our university	The tool was developed during the covid pandemic to improve the management of remote classes and ZOOM licenses.
Use	• The teacher can see their classes scheduled in USOS and has the option to create an online meeting for them in ZOOM. Class participants automatically receive a link to the meeting. • Student can see his scheduled meetings. • Other staff also can use it to plan ZOOM meetings.
Additional features	During the scheduled meeting, the user becomes a licensed user of ZOOM.
Data flow /exchange	From USOS • data about classes and their participants (see USOS) To ZOOM • classes data, participants data, time of scheduled meeting
Authentication	SSO (Keycloack)

OER Open Educational Resources Platform

Description	OER is a platform with online courses available to everyone. There are video courses available, as well as interactive courses with exercises to test your knowledge yourself. https://oze.pwr.edu.pl/
Purpose at our university	It was designed and programmed by an E-learning Section to provide video courses with an interactive table of contents for each video.
Use	The E-learning section publishes courses from authors who agreed to make them available under the CC licence.
Additional features	System uses Youtube as video hosting.
Data flow /exchange	-
Authentication	No login required. The OER does not introduce any restrictions on access to resources. All users with access to the Internet can use them, and they are made available without fees and registration

AZON – The Atlas of Open Science Resources

Description	The Atlas of Open Science Resources (AZON) provides scientific resources in open digital form to anyone interested. The resources were collected, prepared, and made available by the following universities: Wrocław University of Science and Technology, Wrocław University of Environmental and Life Sciences, Wrocław Medical University, and the University of Physical Education in Wrocław as well as the Institute of System Research PAS in Warsaw. Almost tens of thousands of resources have already been accumulated on the platform and their number is still growing. These are books, magazines, scientific articles, scripts, sketches, photos, conference materials, audio and video files, 3D models and many other scientific materials. All resources are available openly and free of charge. The project was financed by the European Union under the Operational Program Digital Poland. https://zasobynauki.pl/projekt-azon-1/ https://zasobynauki.pl/projekt-azon-2/
Purpose at our university	Publishing data and scientific resources
Use	Employees of five organizations – project Partners – can deposit their works on the AZON platform
Additional features	AZON has also been adapted to the needs of the visually impaired and deaf people thanks to the use of, among others, transcription, speech synthesis, sign language teacher or subtitles.

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	The system uses a video hosting module based on ffmpeg library (located on premises).
Data flow /exchange	-
Authentication	No login required. The Atlas of Open Science Resources does not introduce any restrictions on access to resources. All users with access to the Internet can use them, and they are made available without fees and registration.

SSO (Keycloack)

Description	It is a single sign-on point (SSO). This service allows, for all user groups, i.e., staff, postgraduates and students, access to most systems using a single set of credentials. ActiveDirectory credentials are required for successful login.
Purpose at our university	User identities in Wroclaw Tech is managed with this system
Use	Used by all user groups, i.e., staff, postgraduates, and students for accessing to most systems
Additional features	-
Data flow /exchange	Synchronisation of users into many university systems: • USOS • Moodle • VC.pwr.edu.pl • ALMA (scheduled)
Authentication	

BigBlueButton

Description	BigBlueButton is an open-source web conferencing system. https://en.wikipedia.org/wiki/BigBlueButton
Purpose at our university	Use of the web conferencing system particularly for the defence of theses with classified topics
Use	Academic staff and students
Additional features	-
Data flow /exchange	Transfer of user authorisation from Moodle within course context
Authentication	Moodle

ZOOM

Description	ZOOM is a commercial web conferencing system. https://zoom.us/
Purpose at our university	Use of the web conferencing system
Use	Staff and students use ZOOM for video conferencing (online classes)
Additional features	see VC.pwr.edu.pl
Data flow /exchange	Data about classes and their participants from USOS (see VC.pwr.edu.pl)
Authentication	SSO

MS Teams & MS Office 365

Description	As part of the Enterprise Enrolment for Education Solutions (EES) contract, Wrocław University of Technology has been granted access to Microsoft Office365/MS Teams. Users have access to all Office365/MS Teams applications, which can be installed on up to 5 PC or Mac computers, 5 tablets and 5 smartphones. https://teams.microsoft.com/
Purpose at our university	Use of the web conferencing system, sharing materials, group work
Use	Staff and students use MS Teams for video conferencing (online classes), group work, sharing of teaching materials and knowledge testing
Additional features	-
Data flow /exchange	Data from USOS (see USOS)
Authentication	Logging with MS Azzure AD

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Gmail + Google Meet (Google Workspace For Education Plus)

Description	Collaboration tools including Classroom, Docs, Sheets, Slides, Forms Communication tools including Google Meet, Gmail, Chat Google Drive https://workspace.google.com/
Purpose at our university	Use of the mail, web conferencing system, sharing materials, group work
Use	The staff and students use a unified email based on the commercial Gmail solution. Staff and students use Google Workspace for video conferencing (online classes), group work and sharing of teaching materials.
Additional features	-
Data flow /exchange	-
Authentication	Gmail account

TETA

Description	TETA HR is a system for comprehensive HR and payroll processes and human resources management
Purpose at our university	Automation of activities related to employee matters (contracts, salaries, holidays, time records, social issues)
Use	• HR management – the tool designed for the HR and payroll area supports processes related to the employment of new employees and the ongoing updating of all personal data. The HR department has full access to information on the course of employment. • Payroll – a module supporting processes related to the calculation of salaries for employees.
Additional features	TETA ME – mobile application designed for employees and managers
Data flow /exchange	staff data from TETA to AD (database for SSO)
Authentication	SSO

5.10.2 Special features

There are no national requirements or proposals for the use of IT systems at public universities, the choice and use are up to the universities. The use of cloud solutions is permitted under the condition of compliance with the GPRD. Most Polish universities generally use the USOS system for the management of the study process (see USOS) and Moodle as an e-learning platform due to its open-source status. As there is no national student identity number, each university uses its own identifiers.

Polish law does not allow for fully remote studies. The regulation of the Ministry of Science and Higher Education specifies what percentages of ECTS points can be awarded for classes conducted in the form of e-learning. It is only 50 percent credits (for studies with a practical profile) and 75 percent credits (for studies with a general academic profile).

The Wroclaw Tech students are provided with access to the supercomputer for running simulations during classes with use of specific applications/software.

5.10.3 Students' Journey at a glance

The digital infrastructure is depicted in Figure 32 to illustrate the journey of students within the system.

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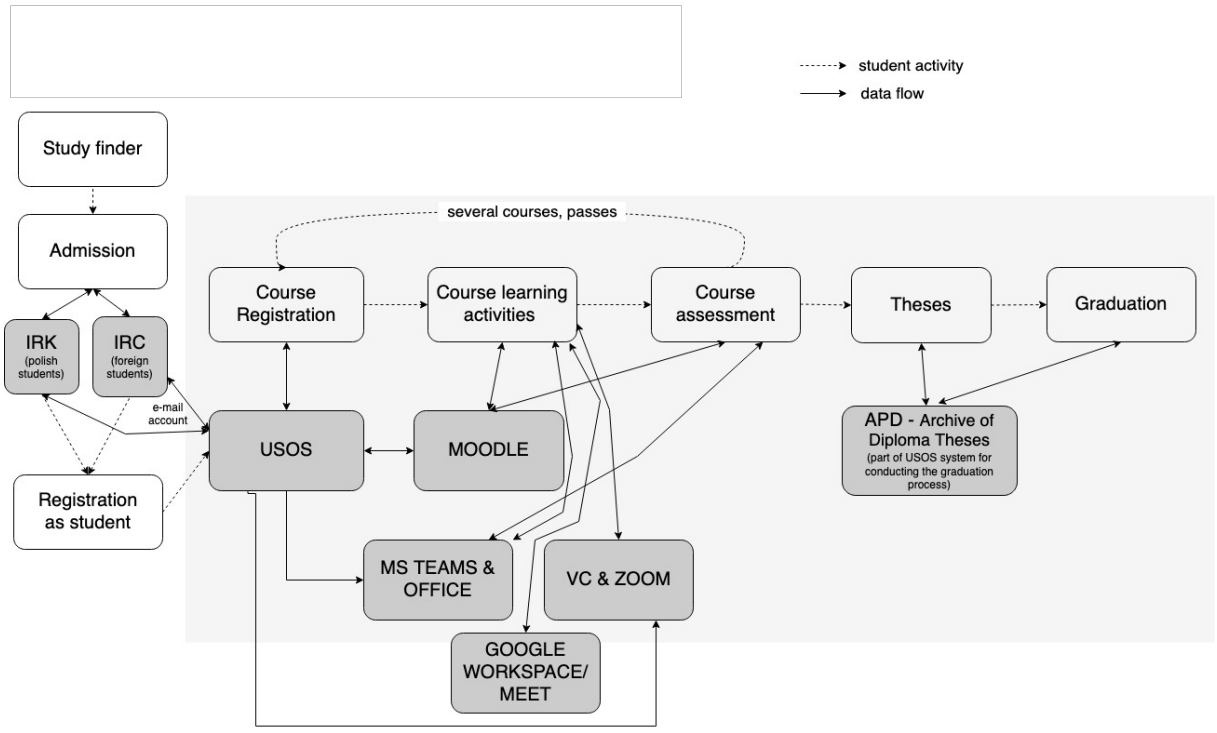

Figure 32: Wroclaw Tech's student's journey within the digital systems at a glance.

A candidate for a bachelor's or master's degree programme fills in a registration form in the IRK USOS system or IRC (for foreigners). In addition to the primary field of study, the candidate may indicate two reserve fields of study (in case he/she is not admitted to the selected one). An account linked to the candidate's PESEL (Polish Personal Id Number)/passport number is created in the registration system. The candidate fills it in with data. The candidate (with a secondary school certificate from outside Poland) has the option of taking voluntary examinations in mathematics and physics to increase his/her chance of qualification, while he/she must pass an examination in drawing to become an architecture student.

Based on the results of the National Matriculation Examination (data is taken from the national central system) and optional examinations, a list of qualified candidates is created. The candidate receives qualification information in the IRK USOS/IRC system. The qualified candidate delivers original documents to the university's head office for confirmation of enrolment. After this, the candidate is registered as a student and given a unique album/index number and an associated e-mail address. The university e-mail address allows the student to activate the AD account (for SSO), which opens access to many university services.

Registration information is automatically synchronized with USOS, which is the system for managing student data and records from admission to graduation. In USOS system the student registers for classes.

Information from USOS is automatically synchronized with MOODLE, the learning management system (LMS). The use of Moodle is not mandatory. From USOS, a teacher can create a course in Moodle for his/her class and automatically enrol students in it (according to the list of those who have enrolled in his/her classes).

Examinations usually take place on campus and on paper. Teachers then enter the students' grades into USOS (either through an application or by importing from a file/ Moodle). Upon graduation and defence of the thesis, the student is awarded a diploma.

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5.10.4 Current and Future Directions

Soon, we will develop and implement further proprietary and commercial tools related to the study management system (e.g., a system for managing course cards). Already in 2023, we plan to integrate this system with the EWP API, thus resigning from using the EWP Dashboard. We are also planning full possible automation of data exchange between Wrocław University of Science and Technology and other Universities and institutions. As part of this work, we also plan to implement the European Student Card. We also want to increase integration between the various applications and cloud tools we use, such as Office365, the library system and the Google email service. There are also plans to create a university GIT repository made available to employees and students for the purposes of classes and other projects. We want to connect all services to a central SSO login point.

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5.11 Overview of LMS infrastructures in the Unite! alliance

Juha Martikainen, Martin Ebner, Fernando Mira da Silva, Sandra Schön

The descriptions of the digital infrastructures for learning and teaching of all partners shows that information systems are very homogeneous in their functions, but very heterogeneous in their software implementation. We also see major differences in how self-sufficient or networked the universities are in a national context, for example in terms of specific IT applications or selection policies.

As an overview, the following Table 16: Overview of key issues concerning LMS in partner institutions of Unite! (10/2023) condensed the current infrastructure perspective on core learning management systems and features as they are the most consensual building blocks.

Table 16: Overview of key issues concerning LMS in partner institutions of Unite! (10/2023)

	Main LMS	Open-Source	Secondary LMS	LTI interface	MOOC platform	EduGAIN
TU Graz	Moodle	YES	-	YES	Moodle	YES
ULisboa	Fenix Platform	YES	Moodle, Open edX	NO (Moodle: YES)	Open edX	YES
UPC	Moodle	YES	-	YES	-	YES
PoliTO	DIDATTICA	YES	Moodle	YES	Open edX	YES
UGA-INP	Moodle	YES	Chamilo	YES	-	YES
TUDa	Moodle	YES	-	YES	-	YES
Wroclaw Tech	Moodle	YES	-	YES	-	YES
KTH	Canvas	NO	-	YES	Open edX	YES
Aalto	Moodle	YES	-	YES	Moodle	YES

The table shows that there is great homogeneity about the learning management system of almost all universities. Since, as already mentioned, the common federated LMS is also based on Moodle, this is of course a major challenge, especially for universities with less Moodle experience – both in terms of technology and use by teachers and students.

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6. Implementation of European Student Card Initiative (ESCI) and mobility software of all partners within Unite!

Etienne Langevin, Romain Laurent, Martin Ebner, Sandra Schön

The European Student Card Initiative (ESCI) has supported priorities and activities set out in the European Education Area (EEA): Digital Education Action Plan, Erasmus+ Initiative and European Strategy for Universities. ESCI is a key element in the European Education Area by 2025 to unlock the full potential of the EEA by:

- promoting student mobility and participation in educational and cultural activities,
- making the management of mobility easier, more efficient, and greener and
- promoting a strong European Student Identity.

In parallel, ESCI also supports the objectives of the Digital Education Action Plan 2021-2027, launched in 2020 under the same Education Package as EEA. In this framework, ESCI plays a key role in simplifying the management of the student mobility through streamlined electronic exchange and verification of student data.

Under the Erasmus+ Programme 2021-2027 (European Commission, 2023b). ESCI is expected to contribute to the priorities of the new Erasmus+ Programme under “Key Action 2 Cooperation Among Organisations and Institutions" by being a facilitator of learning mobility. In 2022, ESCI received a strong institutional endorsement as one of the four flagships of the Communication on a European Strategy for Universities (European Commission, 2023a) to boost the European dimension in higher education and research. The Council Recommendation on building bridges for effective European Higher Education Cooperation invites Member States to adopt and support the development and dissemination of ESCI. In practice, this means that it will progressively become mandatory for Erasmus+ chart signing higher education institutions to use the ESCI building blocks. This will allow the applicants to provide common infrastructure and processes for mobilities through the entire Erasmus community.

This initiative presents three building blocks: Erasmus Without Paper, The European Student Card, and Erasmus+ App.

6.1 Erasmus without paper

Traditional management of Erasmus+ mobility can be a cumbersome, complex, and costly process for higher education institutions (HEIs). The Erasmus Without Paper (EWP) project paves the way to manage mobilities more efficiently by letting higher education institutions exchange information around their students’ mobility swiftly and securely (European Commission, 2023c). EWP does this through an online exchange network that connects HEIs participating in Erasmus exchanges. It allows higher education institutions using the network to exchange student data in a more secure and efficient way than traditional paper-based methods.

The EWP network, while still in development, is already in production and used by thousands of higher education institutions and is going to be mandatory to manage mobilities for all Erasmus charter signing higher education institutions. The main EWP platform is stored on EU commission servers. But only the manifests register is centralized, and a client can build a local copy to avoid slow down. This platform is used by connecting to the EWP APIs (Application Programming Interface). HEIs are managing mobilities using a Mobility Management System (MMS) and mobility management systems use the EWP APIs to share mobilities between HEIs according to the following Figure 33.

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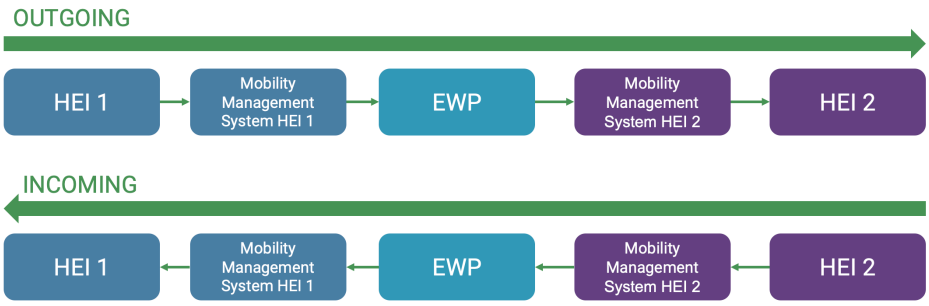

Figure 33: Incoming and outgoing mobility flowcharts

Mobility Management Systems (MMS) can be of two sorts, namely in-house software, or third-party software (e.g., MoveOn, Mobility Online). Another MMS called EWP dashboard has been developed and is free to use but should be reserved for HEIs that have difficulties having an MMS (European Commission, 2023d).

The EWP network APIs are divided as follow:

- Inter-Institutional Agreement (IIA)
- Outgoing, Incoming mobility
- Nomination
- Transcript of records

All EWP API Implementation of higher education institution can be found in the official EWP HEI/API coverage matrix (Erasmus without paper, 2023). The current data (from 10/2023) of Unite! partner universities is shown in Table 17 to Table 19.

Table 17: State of EWP API implementation by all Unite! members – Part I/III. Source: 10/2023 state of EWP APIs implementation by all Unite! members such as found on the official EWP HEI/API coverage matrix https://registry.erasmuswithoutpaper.eu/coverage.

Institution	Primary Network APIs			General Purpose APIs		
	discov.	echo	inst.	ounits	courses	courses replic.
TU Graz	6.0.0		2.2.0	2.1.1		
ULisboa	6.0.0		2.1.0	2.1.0		
UPC	6.0.0	2.0.1	2.2.0	2.1.1		
PoliTO	6.0.0	2.0.1	2.2.0	2.1.1	0.7.1	1.0.0
INP	6.0.0	2.0.1	2.2.0	2.1.1		
UGA	6.0.0	2.0.1	2.2.0	2.1.1		
TUDa	6.0.0	2.0.1	2.2.0	2.1.1		
Wroclaw Tech	6.0.0		2.1.0	2.1.0		
KTH	6.0.0		2.2.0	2.1.1		
Aalto	6.0.0	2.0.1	2.2.0	2.1.1		

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Table 18: State of EWP API implementation by all Unite! members – Part I/III. Source: 10/2023 state of EWP APIs implementation by all Unite! members such as found on the official EWP HEI/API coverage matrix https://registry.erasmuswithoutpaper.eu/coverage.

Institution	IIAs			IIAs Approval		
	file	ver.	CNR	fact.	ver.	CNR
TU Graz		6.2.0	2.0.3	1.1.0	1.1.0	1.1.0
ULisboa		6.2.0	2.0.3		1.1.0	1.1.0
UPC						
PoliTO		6.2.0	2.0.3	1.1.0	1.0.0	1.0.0
INP	1.0.0	6.2.0	2.0.3	1.1.0	1.1.0	1.1.0
UGA	1.0.0	6.2.0	2.0.3	1.1.0	1.1.0	1.1.0
TUDa	1.0.0	6.2.0	2.0.3		1.1.0	1.1.0
Wroclaw Tech		6.2.0	2.0.3	1.1.0	1.0.0	1.0.0
KTH		6.1.0	2.0.3	1.1.0	1.1.0	1.1.0
Aalto	1.0.0	6.2.0	2.0.3		1.1.0	1.1.0

Table 19: State of EWP API implementation by all Unite! members – Part III/III. Source: 10/2023 state of EWP APIs implementation by all Unite! members such as found on the official EWP HEI/API coverage matrix https://registry.erasmuswithoutpaper.eu/coverage.

Institution	OMobilities		OMobilityLAs		IMobilities		IMobilities ToRs		Other APIs
	ver.	CNR	ver.	CNR	ver.	CNR	ver.	CNR	
TU Graz	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0			
ULisboa	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0	2.0.0	1.0.0	
UPC			1.2.0	1.1.0					
PoliTO									
INP	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0			
UGA	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0			
TUDa	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0			
Wroclaw Tech	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0	2.0.0	1.0.0	
KTH	2.0.0	1.0.0	1.1.0	1.1.0	1.0.0	1.0.0	2.0.0	1.0.0	
Aalto	2.0.0	1.0.0	1.2.0	1.1.0	1.0.0	1.0.0			

6.2 European Student Card

The journey of the European Student Card (ESC) began in 2016 as an EU-funded project. It gave students an easy access to services across Europe with no need to create a new student card during their mobility. Since then, the ESC has been scaled-up to become a building block of the European Student Card Initiative (European Commission, 2023d). The ESC simplifies student mobility in Europe. It enables higher education institutions to verify a student's status seamlessly and reliably at European level.

Student status verification means confirming that a student is currently enrolled at a university or other higher education institution and, where applicable, manage related rights. By joining the ESC system and building upon existing physical or digital student cards, higher education institutions can centralise specific student card data, cut paperwork and promote green and digital transition. Students travelling across Europe for their education will get easier access to services – both on and off campus – offered by their host institution. This means a better, more connected mobility experience and a sense of belonging to the European higher education community.

The target for 2025 is that as many European students as possible can benefit from an ESC in their pocket, or digitally on their phone, making their access to on- and off-campus services (e.g., access

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to building, libraries services, discounts on transports) easier and their Erasmus mobility experience simpler.

During 2022-2025, the European Student Card should

- become more widely available in all Erasmus+ programme countries,
- bring more possibilities for validation of student status by higher education institutions and student service providers,
- become more widely used by higher education institutions and student service providers, and
- increase the offer of digital student cards by higher education institutions in all Erasmus+ programme countries.

Implementing the ESC allow HEI to:

- Avoid the need to create a new student card for mobility students if the home institution is also part of the ESC,
- Validate the student status from incoming mobility students securely,
- Give students a “European student” status, and
- Give students a more easily access student services during their mobility experience.

The European Student Card was initially a complementary layer to the already existing student cards adding both a hologram, to give a “European student” status, and a QR code, to validate student status. Presently, the European Student Card is being digitalized so that the hologram and QR code will be accessible and ESC functionalities delivered by using an e-card running on a smartphone application (which may lead to interoperability problems).

6.3 ESC-Router

ESC-Router serves as the centralized database for the European Student Card project, providing an online interface for administrative and technical staff. It offers APIs for seamless integration.

This is a database which:

- allows participating institutions to generate a European Student Card,
- enables card validation between the information systems of card issuers in Europe, and
- identifies the student and their status across Erasmus+ programme countries.

10/2023 state of ESC-R connection for Unite! members in shown in Table 20.

Table 20: State of ESC-R connection for Unite! members (12/2023).

Institution	Unique registration number (PIC code)	Top Website Domain of the institution (Schac code)	ESC-R
UGA	924833212	univ-grenoble-alpes.fr	OK
INP	999875225	grenoble-inp.fr	OK
UPC	999976202	upc.edu	OK
TU Graz	999977948	tugraz.at	OK
TUDa	999986581	tu-darmstadt.de	OK
Polito	999977754	polito.it	OK
ULisboa		ulisboa.pt	NO
Wroclaw Tech		pwr.edu.pl	NO
KTH		kth.se	NO
Aalto	939575951	aalto.fi	OK

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The Unite! universities are pursuing the objectives of ESCI by releasing the ESC as required, valuing the schacPersonalUniqueCode attribute as specified. Additionally, some partners make the data available on students' personal pages. Regarding the issuance of physical cards in Unite!, universities have decided not to issue them for various reasons:

- Difficulty in modifying the card layout, often determined not only by the university but also by third-party entities and a result of compromises to indicate all services supported by it.
- Costs of replacing the entire card park.

The situation regarding the issuance of virtual cards is more varied. Some universities plan to release the QR code and logo concurrently with the introduction of the university's dematerialized card. A critical aspect has arisen from the decision to adopt QR code technology for encoding information: While commendable, it becomes challenging for universities that have instead invested in magnetic stripe information storage. Equipping all necessary reading points with the required technology is not seen as a feasible path.

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Erasmus without paper (2023). EWP Registry Service. URL: https://registry.erasmuswithoutpaper.eu/coverage (2023-11-06)

European Commission (2023a). Commission Communication on a European strategy for universities. URL: https://education.ec.europa.eu/document/commission-communication-on-a-european-strategy-for-universities (2023-11-06)

European Commission (2023b). Erasmus+ Programme 2021-2027. URL: https://erasmus-plus.ec.europa.eu/about-erasmus/what-is-erasmus (2023-11-06)

European Commission (2023c). Erasmus Without Paper. https://erasmus-plus.ec.europa.eu/european-student-card-initiative/ewp (2023-11-06)

European Commission (2023d). European Student Card Initiative. URL: https://erasmus-plus.ec.europa.eu/european-student-card-initiative/card (2023-11-06)

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7. Blueprint for evolution of the digital campus: Key prerequisites

Martin Ebner, Roberto Bertonasco, Joakim Petersson, Etienne Langevin, Romain Laurent, Sandra Schön, Fernando M. da Silva

In our journey towards creating a cohesive, forward-thinking European digital campus, it is paramount to understand and enumerate the diverse technological, organizational, and legal imperatives that stand at the forefront. The objective of this requirement analysis is not merely to chronicle these needs but to construct a robust scaffold upon which the digital campus can be meticulously built. Drawing insights from extensive desk research, complemented by data from online surveys and vital stakeholder interactions across the Unite! alliance, we have embarked on a comprehensive exploration. This chapter is dedicated to capturing the quintessence of this research, laying out the fundamental pillars that will guide the subsequent stages of the digital campus project, from planning and design to its eventual implementation.

7.1 Interoperability amongst the digital infrastructures of partners and with European standards

As outlined in chapter 2, there are numerous legal requirements, such as GDPR concerns, as well as developments in the interoperability of higher education in Europe. The scope is not limited to just technical aspects; it encompasses legal, semantic, and various other developments. To ensure that future technical decisions are made soundly and robustly, it is essential to monitor these standards and their evolutions, and subsequently integrate them into practice.

With the present description (esp. in chapter 5), we have succeeded in gaining a clearer understanding of the IT infrastructure, the systems, and their differences. We can take these detailed descriptions into account in future developments.

Key of considerations are from our technical perspective interoperability issues.

Interoperability amongst partners' infrastructures requires e.g.

- Seamless integration and compatibility between existing systems across member universities, especially concerning the learning management systems.
- API (Application Programming Interface) availability for custom solutions.
- GDPR-compliance for student and staff data.
- Robust encryption methods during data transmission and storage.

From the perspective of users this includes e.g.

- User-friendly interfaces tailored to the diverse user base, including students, faculty, and administrative staff.
- Compliance with accessibility standards for users with disabilities.
- Dedicated IT support for troubleshooting and addressing issues.
- Regular system updates without causing major disruptions.
- Training materials and resources for new users.

In the following, we have addressed requirements that pertain to the processes and support that the Unite! Community 2 Digital Campus needs to effectively carry out its work and objectives.

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7.2 Implementation of decision-making concerning IT infrastructure for digital campus: The Technical Commission

The establishment of governance structures in European university alliances is not trivial (Gorski & Waligóra, 2021). The same is true for decision-making concerning the IT-infrastructure. Nevertheless, implementation of decision-making concerning IT infrastructure is important for effective and efficient processes. The process of implementing decisions related to the IT infrastructure for our European university alliance's digital campus is a technical, collaborative, and strategic one. Here's why this collaborative decision-making in Community 2 Digital Campus approach is crucial:

- **Inclusive Participation**: given the alliance's collective nature, it is essential that every partner institution has a say in decision-making in Community 2 Digital Campus. This ensures that the resulting IT systems cater to the specific needs and nuances of each member, fostering genuine buy-in from all involved.
- **Interoperable Systems:** as each partner may already have existing IT systems, any decisions should consider their integration capabilities. Ensuring interoperability means that diverse systems can communicate and operate cohesively, essential for a seamless digital experience across the alliance.
- **Resource Consideration**: every institution within the alliance possesses varying levels of resources, both in terms of technological assets and financial capacities. Decisions must be equitable, considering the resources at hand, and ensuring that no member is disproportionately burdened or side-lined.
- **Technical Urgency and User Needs Alignment**: while immediate technical needs might push for quick solutions, it is crucial to align them with anticipated user numbers. Balancing technical urgency with projected usage ensures that the infrastructure is neither underutilized nor overwhelmed.
- **Transparent Communication**: given the diversity and range of stakeholders, it is essential to maintain transparent communication throughout the decision-making process. This ensures that all members are informed, aligned, and in agreement, making the implementation phase smoother.
- **Cost-Benefit Analysis**: implementing IT infrastructure comes with costs, both immediate and long-term. Ensuring that all partners partake in cost-benefit analyses can guarantee that the chosen solutions offer maximum value for the entire alliance.

In sum, the shared vision of the European university alliance can only be realized if all partners collaboratively shape its digital landscape. Through inclusive, transparent, and strategic decision-making, the alliance can ensure that its IT infrastructure serves as a robust foundation for collective success.

In response to the needs identified within our project, we have taken steps to enhance the transparency of our feature request process. Now, all stakeholders are asked to articulate their digital campus requirements using an online form. If needed, these inputs are further clarified through initial discussions with our staff, ensuring a comprehensive understanding of the needs. Once it is evident that the request aligns with the definition of a “Feature Request”, be it the integration of plugins on the Metacampus or the development of new technical solutions such as a repository for teaching materials, the request is presented to the Technical Commission (see Figure 34).

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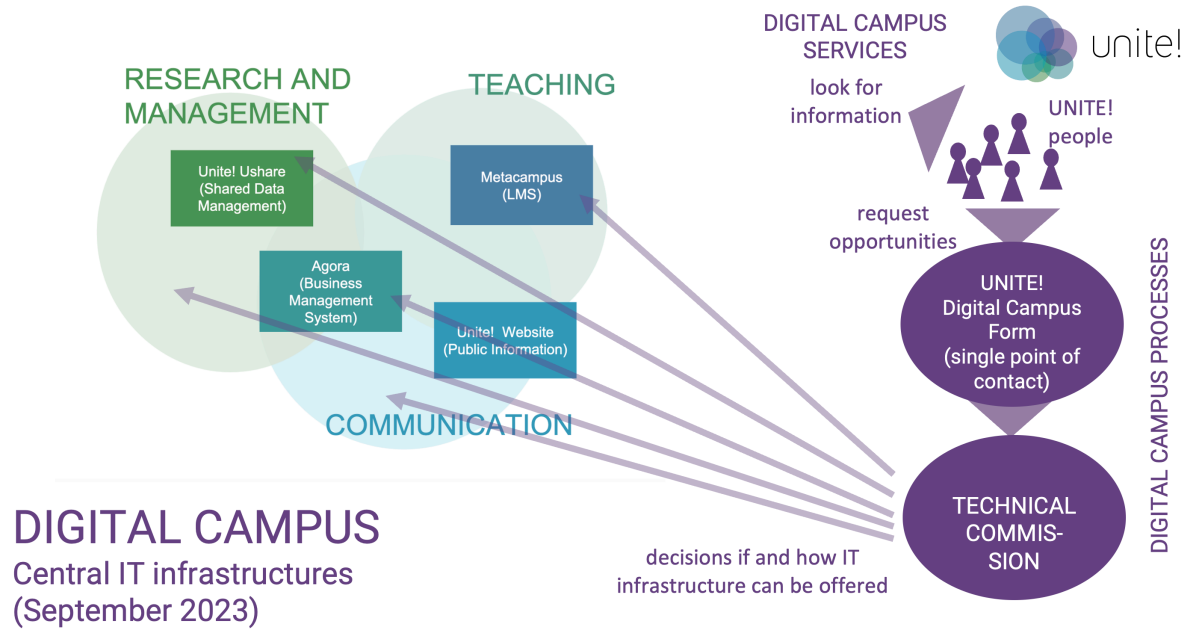

Figure 34: The Unite! Digital campus form and the technical commission as essential feature of the digital campus processes

The Unite! Digital Campus Technical Commission was established within the first months of 2023, comprising decision-making representatives from all partner institutions. This body reviews all feature requests, determining the subsequent course of action for each. The commission held its inaugural meeting in September 2023, with subsequent meetings scheduled monthly.

The outcomes of the consultations are documented in a transparent manner, as stipulated by our principle of clear communication. These findings are then communicated as necessary, especially when feedback from other stakeholders within Unite! is required.

7.3 Strategic support for the effective utilization of existing IT systems, especially the Metacampus

There is a pressing need to delineate the specific responsibilities of the Community 2 Digital Campus work package to ensure clarity and streamlined operations. In our case, our primary focus is on establishing and maintaining the IT infrastructure that supports digital learning, alongside offering related support, with learning management systems as core building block. Our mandate extends to supporting Cm.4 and Cm.5 and all others offer educational offerings in Unite!.

The urgency for strategic support or the effective utilization of existing IT systems, especially the Metacampus, cannot be overstated. Recognizing the development of online courses or instructional events on the Metacampus as a strategic is paramount. This strategic vision necessitates designated stakeholders and individuals across various sectors of the alliance, tasked with ensuring that these objectives are met. As previously outlined, there is not an inherent incentive for educators to make their courses accessible to external students from the alliance. While initiatives like the Seedfund projects (Unite!, 2023) are commendable steps in the right direction, there is a palpable need to intensify efforts geared towards achieving the overarching goal of fully harnessing the potential of the Metacampus.

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7.4 Clarifying future (learning) scenarios, mobility, and other issues for IT infrastructure development

In our initial draft for the requirement analysis, we also included "Identification of stakeholders and relevant learning scenarios." For instance, we researched where specific scenarios were described in the proposal and requested those responsible to approach us—e.g., by using the provided form—to gain a clearer understanding of whether and how topics such as Microcredentials, Joint Programs, etc., are relevant and precisely what is meant by them. Concerning our analysis, these are (Unite!, 2022):

- **Staff development** (blended, online): Trainings are offered for Unite! employees and faculty at the central Metacampus for Unite!-relevant topics such as multilingualism, interculturalism, development of educational programmes and offerings. (e.g., Cm.4 including T4.3, T4.4, T6.2, T6.6)
- **Joint courses** (2 or more Unite! Partners plan courses together, announce them in their universities and use Metacampus as central platform. (e.g., Cm. 4 and Cm.7)
- **Joint programs** are central objectives for European universities in general and as well for the Unite! alliance: Joint programmes should enrich and broaden the possibilities for students to learn beyond their own campus. (e.g., Cm.4 and T4.2., Cm.)
- **Extra-curricular trainings and offers:** Additional to joint courses and programmes, extra-curricular offers such as summer schools, workshops and trainings on relevant topics should be offered for either the whole Unite! community or a specific group of learners. (e.g., T3.3, T3.4, Cm.4, T.5,2, T6.5)
- **MOOC** (Cm.2 description) are directly addressed within the Erasmus+ project description in Cm.2.
- **Microcredentials** (Cm.2 description) are directly addressed within the Erasmus+ project description in Cm.2, and as well in T8.5 for LLL programmes.

However, the picture that emerged is quite varied and still unclear.

For the Unite! digital campus, it is vital that we gain a precise understanding of what is specifically intended. Only with such clarity we can plan potential IT system developments effectively. Pragmatically, Community Digital Campus does not see itself in the position or responsible for decision-making but may support discussions about common understandings and solutions for (future) learning scenarios within Unite! However, we are interested in potentially accompanying such processes with our technical perspective.

From our perspective, Unite! require an initiative to determine the future scenarios that our IT infrastructure should address. This involves understanding preferences, pinpointing what appears to be especially crucial, especially in the context of accommodating large numbers of users.

7.5 Budgetary considerations for federated systems development and maintenance

Federated systems, characterized by the integration and collaboration of multiple distinct entities, demand not only technical precision but also thoughtful budgetary planning. Such systems, especially in the realm of evolving technologies, come with an inherent requirement for continuous development and adaptation. Ensuring that these platforms remain relevant, efficient, and secure often means factoring in costs for periodic updates, potential scalability, and unforeseen challenges. Therefore, it is imperative for organizations or alliances considering federated systems to allocate an adequate budget, not only for the initial setup but also for ongoing developmental needs, to ensure sustainable and effective operation over time.

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It is striking that the federated IT infrastructure can be financed through project funds. While this usually allows for the financing of further developments or new innovations, it scarcely covers the maintenance of existing systems.

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8. Learning and Mobility with the Digital Campus: What's Next

Martin Ebner, Joakim Petersson, Roberto Bertonasco, Sandra Schön, Etienne Langevin, Romain Laurent, Fernando M. da Silva

In our overview about the existing digital infrastructures of the Unite! alliance, we highlighted that the Cm.2 work package holds partial responsibility for addressing digital campus matters within the Unite! alliance, as Cm.2 is primarily responsible for the IT infrastructure for learning and teaching support. Now, for this final chapter we will delve into the detailed work plan for the development of the digital campus under the Erasmus+ project and describe current developments and future directions of the tasks.

8.1 The workplan and organisational structure for Community 2 Digital Campus

Figure 35 shows the three key strands that are addressed in Community 2 Digital Campus in the time frame from 11/2024 till 10/2028.

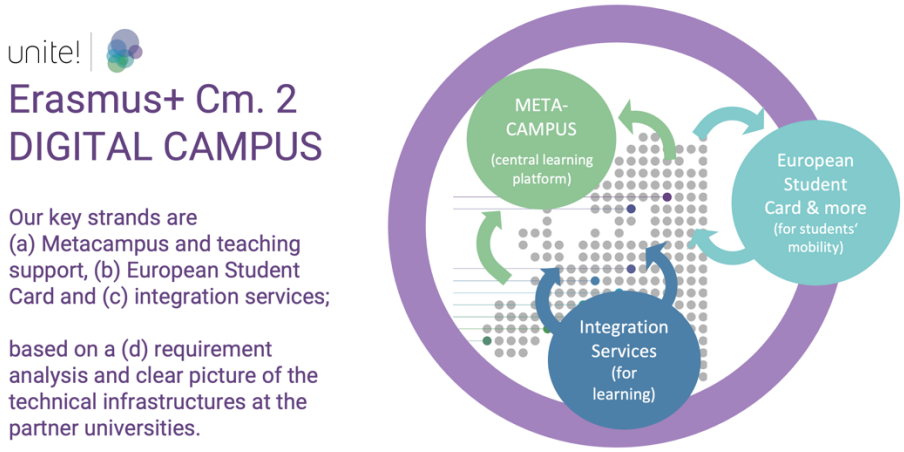

Figure 35: Overview of Cm.2 Digital Campus key strands: Metacampus, European Student Card and Integration Services

Below in Figure 36 you will find an overview of the organizational structure within the Cm.2 work package, outlining its tasks and responsibilities. This breakdown will provide a clear understanding of how the work package is structured to effectively address the development of the digital campus within the project.

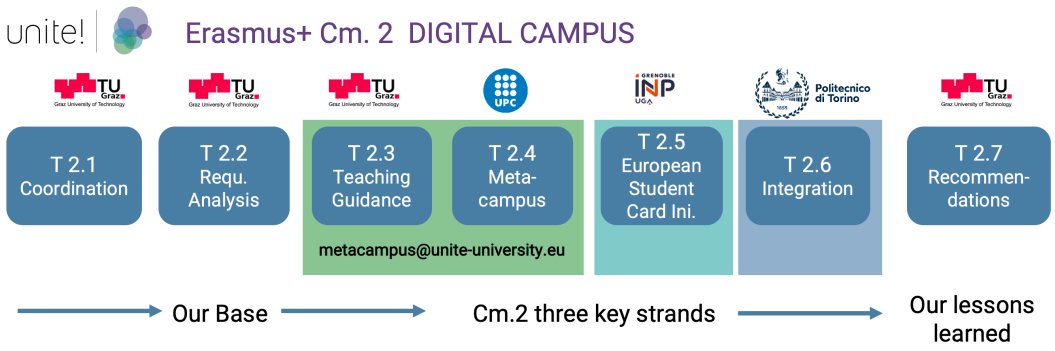

Figure 36: Overview of Cm.2 Digital Campus different tasks and responsibilities

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This requirement analysis was a collaborative effort involving Task 2.1 and Tasks 2.3 to 2.6. It serves as a foundation for assessing existing infrastructures, identifying necessary developments, and identifying challenges. While some of these may not be addressed within our current work plan or are not in the scope or responsibility of our community, we recognize the importance of this analysis as a valuable reference for future projects within the alliance.

As mentioned in the introduction of this report key of considerations and development is to aim to establish a digital infrastructure that enable Unite! students to have a seamless journey through digital learning and teaching offers of the alliance and its partners (see Unite!, 2022).

In the following, we want to highlight topics and issues for Unite! Community “Digital Campus” and its tasks which we believe to be relevant for the next steps.

8.2 Further development of Metacampus support and resources (T2.3)

In T2.3, the exchange between those responsible for digital teaching issues among the partners will be expanded in the future and offers will be created to address the described needs. In October 2023, a course was launched on the Metacampus in an initial version, which explains and introduces the use of the Moodle system (see Figure 37).

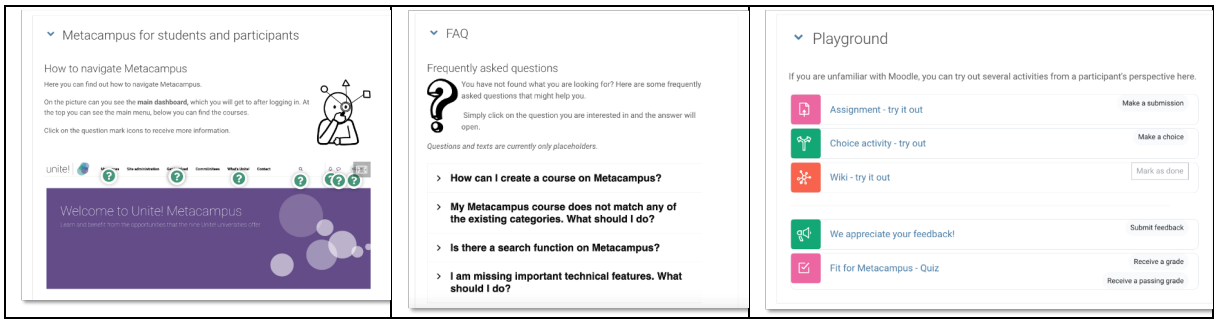

Figure 37: Parts of the online course “How to Use the Metacampus”. Source: Screenshot 09/2023

To systematically explain the usage scenarios for the Metacampus and the additional offerings from Cm.2, the development of "teaching management patterns" was initiated. An initial outcome is the creation of a decision tree to determine in which instances the Metacampus is the appropriate tool. The course, the decision tree, and other materials for users and support teams will be tested, improved, and further developed in the coming months.

8.3 Update of Metacampus and organisational development of support requests (T2.4)

During the initial months of the project, a significant challenge was to carry out the update of the Metacampus (to version 4.1.3). In addition to handling and addressing support inquiries, the system for assigning and managing these tasks was also expanded and modified (e.g., using now Agora). Future extensions or adaptations of the system will be made with the involvement of the Technical Commission (see chapter 7).

8.4 ESCI: Improvement of service (T2.5)

The main goals of the ESCI are to offer better services for students all around EU countries and to reduce the workload for mobilities staff. To do that, the European Commission set up a common

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infrastructure and is directing the development of centralised solutions to manage mobilities as seamlessly as possible in a digitalized way. Those goals can only be achieved by the total integration of this common European level infrastructure into every HEI local digital infrastructure, and this is where, as a European alliance, we can bring an added value.

We first need to connect to and to implement all European commission tools that have already been deployed and that are part of the ESCI network. This means, implementing EWP APIs through the Mobility Management Systems (MMS), connecting every member to the ESC Router, providing for each student a European Student Card, either physically or digitally, implementing into eduGAIN the ESI provided attribute. Moreover, we need to digitalize and automatize our own digital infrastructures and especially the connections between the MMS, the ESC Router and the rest of the digital infrastructure while ensuring interoperability between our infrastructures.

8.5 eduGAIN maintenance and further development (T2.6)

eduGAIN technology has already been successfully implemented, proving its efficacy in various scenarios. However, due to, for example, role definitions by the eduGAIN consortium and their interpretation at the national or university level, or due to changes or updates from individual Identity Providers, occasional errors and challenges arise. To address these concerns, a working group has been established in Cm.2. This group provides a platform for stakeholders to exchange insights and experiences, ensuring that everyone can benefit from the collective knowledge and troubleshoot issues more effectively.

8.6 Piloting LTI and integration of MOOCs (T2.6)

Learning Tools Interoperability" (LTI) It is a standard developed by the IMS Global Learning Consortium that allows different learning systems to connect to external service tools in a standardized way. As this analysis shows, LTI can be seen as key factor to ensure future interoperability of Unite! partner systems and federated systems. As described, LTI was technically provided at the Metacampus. To work further, we now need to pilot the implementation and usage. Therefore, a working group dedicated to LTI (Learning Tools Interoperability) was established. This group will conduct pilots to explore the extent to which LTI can be utilized on the Metacampus and among partners. As part of this endeavour, there are plans to integrate MOOC (Massive Open Online Course) platforms, further expanding the possibilities for enhancing digital learning experiences. As we consider not only technical issues, a first exploration describes potential challenge of this integration (see Table 21, Ebner et al., 2023).

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Table 21: Challenges and potential solutions for using MOOCs in European university alliances. Slightly adapted. Source: Ebner et al., 2023, table 2, licensed under CC BY 3.0 (https://creativecommons.org/licenses/by/3.0/)

	Challenge	Potential solutions
Legal	Usage of content and MOOC must be permitted. (by contract e.g.)	Allowed usage, if openly licensed.
	Translation of the materials should be possible	Allowed usage, if openly licensed.
Organizational	Different curricula and MOOCs need to be aligned.	Standards as ECTS and another curriculum framework might help
	Multilingual user guidance and support.	Staff of partner universities might be integrated in user support
Technical	Simple registration needed	EduGAIN
	MOOC content and achievements should be accessible for partner universities	LTI interface need to be implemented and adapted for all universities and/or a common campus. A federated LMS might be helpful.
	Clarify the possible exchange of user data	Needs a clear description of ALL existing systems and potential interfaces and/or a common campus according to GDPR.

8.7 Meta-data standard implementation for course description (T2.5, T2.6)

The development of a “course catalogue” necessitates the inter-university sharing of data. With all participating institutions presently engaged in the enhancement of their procedures for the 'Erasmus without Papers' (EWP) project, the decision was made to utilize the API (Application Programming Interface) standards corresponding to the courses. Therefore, a strong need for a common description of all courses is needed to elaborate the exchange within all platforms. In a first step a European meta-data-standard must be chosen or developed and discussed within the partners.

The course catalogue's implementation is, however, contingent on the availability of an updated version of the API (Alcober & Mohammadali, 2023). It is currently apparent that there are not only technically different possibilities, and it is also not yet clear for which purposes the course catalogue will be used in the future.

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8.8 Supporting openness and innovation (T2.1)

In this requirement analysis for Unite!'s digital campus, we have outlined the technical prerequisites we bring to the table. It is crucial to recognize that the associated organizational and financial challenges of a federated infrastructure are distinct and multifaceted. In conclusion, it is essential to emphasize our self-perception as a highly technically innovative and open-minded group. We envision our working group as an avenue for mutual learning and growth, actively fostering this through initiatives such as our “Cm.2 Technical MeetUps”. These sessions, held at least twice a year, delve into contemporary technical topics that may not yet be ripe for the entire alliance's consideration but remain paramount for forward-thinking and innovation.

References

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Appendix

Checklist

Reference	Working file – Part of D2.1 from WP2 in Unite! Erasmus+
Status	Was delivered to check if anything notable is included within the future descriptions
Responsible	Behnam Taraghi, Sandra Schön
Contributors	partner
Copyright	Public version will be shared under CC BY 4.0 International. Please check your input carefully if it meets the needs.

Goals of this check list:

- The deliverable will include the sketches of each partner together with a textual description of all. Each partner should simply be able to understand and read the information from the sketches and their descriptions of all the other partners. To achieve this goal and in order not to leave any points out, we have prepared a check list which covers all points we have been addressing in our sketches so far.
- Please ensure that the sketches and the description cover these points.

Check list (infrastructure):

- Which services / applications are in use by students and teachers and what are they responsible for. List all applications in student life cycle.
- beginning with the student registration at Unite! partner
- Find curriculum / courses
- Course registration
- Course teaching & learning activities
- Course assessment(s)
- Repositories (e.g. for course materials)
- Ending with graduation (issuing the certificate)
- (Personal) Data saved in these applications
- Which data (e.g. user provisioning, course (enrolment) synchronisation, etc)
- Data flow
- from which data source the applications are fed with data
- Or which applications act as data source for other applications
- Authentication to these applications
- Is there a central Authentication platform (SSO, Keycloack, etc)

Check list (student life cycle):

- which steps should a student go through in order to study and access the e-learning platforms.
- beginning with the student registration at Unite! partner
- Getting access data
- Find curriculum / courses
- Course registration
- Course learning activities
- Course assessment(s)
- Ending with graduation (issuing the certificate)

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Check list (teacher):

- which steps should a teacher go through in order to teach and access the e-learning platforms.
- Teacher registration at Unite! partner.
- Course offering / implementation for registration
- Course registration
- Course teaching activities
- Course assessment(s)
- Issuing the certificate

General notes

The description should as well include (in short):

- its reach, especially if it is limited (only fitting for one faculty/not the whole university)
- where/how national solutions/necessities are used/included
- which national/other policies are prominent for the (selection of) tools used (e.g. Open-source selected by a national committee in France, national tools in Finland)
- all other issues we have seen but are specific for one or few partners (e.g. different tools and rights for students and staff in Grenoble)

When describing the landscape of the digital educational system of a university, the structure can vary depending on the specific context and focus of the description.

Overall, the structure should aim to provide a comprehensive and coherent overview of the digital educational system of the university.

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