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Article

Best Practices for Sustainable Inter-Institutional Hybrid Learning at CHARM European University

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Abstract: CHARM European University offers an inter-institutional Master's (MSc) in Global Challenges for Sustainability across five European university campuses using innovative, challenge-based, transdisciplinary, and student-centered pedagogies. However, delivering modules across multiple locations at the same time poses a major challenge. Multiple hybrid classrooms solve this challenge by offering spaces for students and staff to teach and learn locally and remotely. This study describes the first Participatory Action Research (PAR) cycle iteration of the design, implementation, testing, and delivery of hybrid classrooms within a European university alliance. Hybrid classroom collaboration was facilitated through videoconference software, and this research describes a collaborative space design for transdisciplinary teamwork within this environment. Perspectives from a technical expert on virtual learning environments, an educationalist who supports teaching staff, and a classroom-based teaching assistant are presented. Integrating educational principles and module learning outcomes, aligning physical build specifications, testing hardware and software, identifying pedagogical needs, facilitating professional development, and ensuring adequate time for testing is crucial for successful hybrid classroom delivery. This research contributes practical use cases and recommendations for educational and support staff delivering digital transformation through hybrid classrooms across inter-institutional co-operations.

Keywords: hybrid classroom; inter-institutional collaboration; blended learning; instructional design

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1. Introduction

Higher education institutional (HEI) co-operations (e.g., European Universities Initiative) are growing and can improve innovation, inclusivity, mobility, academic teaching, and competitiveness between universities [1]. They are a key strategic driver for HEIs [2] and international higher education organizations [3] to address major 21st-century societal challenges, transition to a more digitalized world, and prepare for the Fourth Industrial Revolution [4]. Rising HEI cooperation has increased the need for digital transformation projects to achieve inter-institutional educational goals. Thus, best practices for educational digital transformation in this space are required.

The term "digital transformation" has commonly been used within business [5], healthcare [6], computer science [7], and industry-focused [8] disciplines. However, definitional unclarity surrounds the term, with authors providing differing conceptions of what it entails. Many definitions contain elements of technological, organizational, or social perspectives [9], which "*aim to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies*" [7].

Digital transformation in HEIs encompasses these perspectives through administration, teaching, governance, infrastructure, research, and curriculum dimensions [10] (e.g., data analytics, smart technologies, virtual learning environments, student information systems, chatbots, digital procurement, digital payments, library databases, and teaching applications). This broad spectrum of dimensions has been a conduit for growing research and application of educational digital transformation, including the COVID-19 impact on online teaching provision [11], the need for greater sustainability education [12], improving student digital competencies [13], and facilitating innovation change in HEIs [14]. However, HEIs face many challenges in digital transformation, including situational and environmental challenges, prevailing negative attitudes towards digital learning, absence of economic or budgetary sources, IT infrastructure, student and staff digital literacy, student motivation, and digital divides [15]. These challenges are difficult to solve within a single institution but become even more pronounced when multiple HEIs co-operate on a single digital transformation endeavor.

Given the growth of educational digital transformation and HEI co-operations, it is evident that empirical evidence from practitioners is needed. Exploring how HEI co-operations design, develop, and implement digital transformation is critical for realizing strategic goals within European and international policies, identifying best practices, and expanding this research space. This research provides recommendations on a digital transformation project within an HEI co-operation, the CHARM-EU hybrid classroom, to support researchers, practitioners, students, and other HEI co-operations to better realize digital transformations.

1.1. CHARM European University

CHARM-EU (Challenge-based, Accessible, Research-based, Mobile European University) is one of 44 European University Initiatives seeking to strengthen collaboration between HEIs and deliver a new university model. Curricula are delivered jointly by five European universities, the University of Barcelona, Trinity College Dublin, Utrecht University, Eötvös Loránd University, and the University of Montpellier. CHARM-EU educational programmes are driven by educational principles, guiding concepts that underpin the design of a CHARM-EU educational experience, form the foundation for teaching and learning practice, and provide guidance for teachers, educational designers, assessors, and students; namely, transdisciplinarity, sustainability, challenge-driven, inclusive, transnational and intercultural learning, authentic situated learning, technology-enhanced, transversal skills, and student-centered (Figure 1).

A first step towards the realization of this European university is the design and delivery of a pilot Master's (MSc) in Global Challenges for Sustainability, which embed these educational principles. This joint MSc programme offers a unique international learning opportunity where students explore and collaboratively address sustainability challenges in a transdisciplinary environment. Three distinct phases, Preparatory (Phase 1), Flexible (Phase 2), and Capstone (Phase 3), are used to structure the MSc. The Preparatory phase focuses on transversal skill development and provides content and activities to ensure that all students receive a common grounding in key skills and content required for the challenges ahead. In the Flexible phase, students develop more understanding of a specific challenge-related theme that they choose: Water, Life and Health, or Food. Finally, in the Capstone phase, they apply their knowledge from previous phases to real-life challenges in their student projects where they engage with extra-academic actors (external stakeholders such as business and societal organizations).

Planning and organizing the delivery of the MSc was challenging. Students and teaching staff were divided over the five locations while all stakeholders had to be able to participate simultaneously in the programme, from their individual various/additional locations. In addition to logistical and practical challenges, innovative approaches to address the educational principles in the curriculum had to be developed. Hybrid learning using a hybrid classroom was explored as a potential solution to address these challenges.

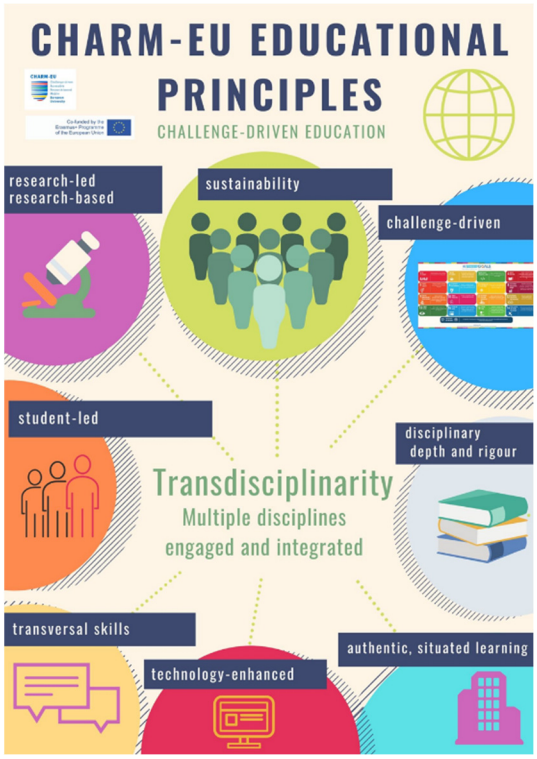

Figure 1. The CHARM-EU educational principles.

1.2. Hybrid Learning via a Hybrid Classroom in an HEI Co-Operation

Hybrid learning was first attempted in the late 1990s and is considered one of the three major types of blended learning in higher education: technology-enhanced courses, hybrid courses, and blended programs or degrees (Ross and Gage, 2006). A well-designed hybrid classroom is described as a space in which students can interact synchronously online, either from another campus or at home, as well as in class [16–18]. This way, on-site and remote students, teachers, and stakeholders, can engage in education at the same time [17]. Other terminologies are sometimes used in the literature to address hybrid classrooms, such as blended synchronous learning environments [19,20], hybrid virtual classrooms [21], synchronous hybrid learning environments [22], hybrid synchro modal classes [23], and mobile learning environments [24–26], suggesting it is a broad field within the area of digital transformation. Learners in hybrid classrooms can interact in an online environment through simulations, electronic content, or interaction with peers outside the classroom. A benefit of hybrid learning is that more sophisticated and complex educational approaches can be offered, combining all the above-mentioned means; going beyond the locus of learning; and balancing between formal/informal, vocational, and recreational teaching approaches [27].

There is increasing pressure on universities to support hybrid teaching delivery, a need that has become stronger due to the COVID-19 pandemic [18]. However, in doing so, many universities have run into challenges concerning human and material investments and the (re)design of existing or new classrooms. Examples of hybrid classroom implementations can be found in educational programmes from science, engineering, and information technology [28]; information systems [29]; business administration and public administration [22]; and doctoral education [30]. A vital element in the implementation of hybrid classrooms is to define and consider the purpose and characteristics of the design. Even though technological equipment and facilities are one of the requirements to facilitate a hybrid classroom, that should not be the focus of a design. Instead, the goal is to use technology to design an engaging, interactive and effective learning and teaching experience during or outside the classroom. It is therefore, the educational designers' freedom to

choose for any method of teaching and learning that is not necessarily linked to only online or in-class, but rather proven to fit the content being taught [16].

CHARM-EU's educational principles (Figure 1) focus on developing and supporting students in becoming active learners, taking the initiative in their own development, becoming more and more familiar with technology, transdisciplinary collaborations, and communication, as well as learning within a participatory manner (challenge-based learning). Therefore, the educational designers had to take these pillars into consideration while selecting the optimal environment for facilitating such an education.

Hybrid classroom environments encourage active student participation and collaboration among students, the teacher, and other stakeholders [16], and they are particularly fitting for outcome-based teaching and learning arising in multiple environments. This type of learning was found to be most suitable for implementation in the MSc due to its flexibility, necessary for courses that are based on challenge-based learning approaches, and the increased access to participants from various different locations [23,31]. Moreover, a social learning experience on campus can stimulate a sense of connection with peers [20], which is a great benefit compared to a fully online teaching model.

These characteristics and benefits of hybrid classrooms strongly align with the CHARM-EU educational principles; four key reasons can be identified: (1) hybrid classrooms, if well-implemented, provide a physical, human layer to technology and can trigger a more engaging and interactive learning experience (technology-enhanced); (2) students, staff and external stakeholders work remotely from different locations bridging national and cultural boundaries (transnational and intercultural learning); (3) discussions and interpersonal connections by working on transdisciplinary sustainability challenges are instigated while developing skills such as critical thinking, collaboration and communication (transdisciplinarity, sustainability, challenge-driven, transversal skills); and (4) a flexible teaching approach allows aligning with needs from students and staff (student-centered, inclusive, virtual mobility).

2. Methodology: Participatory Action Research

The CHARM-EU hybrid learning environment offers many opportunities to work with a wide range of stakeholders, including technical, administrative, and academic staff, as well as students, in a practical way to co-develop and continually improve the learning experience. The development of the MSc in Global Challenges for Sustainability espouses PAR as a practical approach wherein stakeholder involvement becomes an essential element in the evolution of our courseware and teaching practice.

The goal of PAR is to inform practice while contributing to scholarly knowledge on a topic [32,33]. PAR emerged from Kurt Lewin's work on Organizational Development [34], which recognized the importance of tacit knowledge within an organization. Stakeholder perspectives are seen similarly as a rich source of insights that teachers might not have considered. Stakeholders involved in the design and support of the programme actively engage with the foundational PAR principles of participation (life in society and democracy), action (engagement with experience and history), and research (soundness in thought and the growth of knowledge) [35]. PAR is seen as the nexus of these concepts, where research can result in profound and meaningful outputs that ultimately benefit learners, teachers, and the wider society.

As part of the PAR methodology used in this study, perspectives from three key actors involved in the design, implementation, and delivery of the hybrid classroom are presented below. These perspectives range from a technical expert on virtual learning environments, an educationalist who supports academic staff, and a classroom-based Teaching Assistant, together known as the Virtual Learning Environment (VLE) team. These roles ensure coverage across the design, implementation, and delivery of the initiative. These perspectives are supplemented by a review by other colleagues involved in the wider design of the project, including the CHARM-EU educational principles. This research only

focuses on the first cycle of the PAR model from 2020 to 2022 (see Figure 2); however, future work will build on this work in the next iteration of the programme (CHARM8).

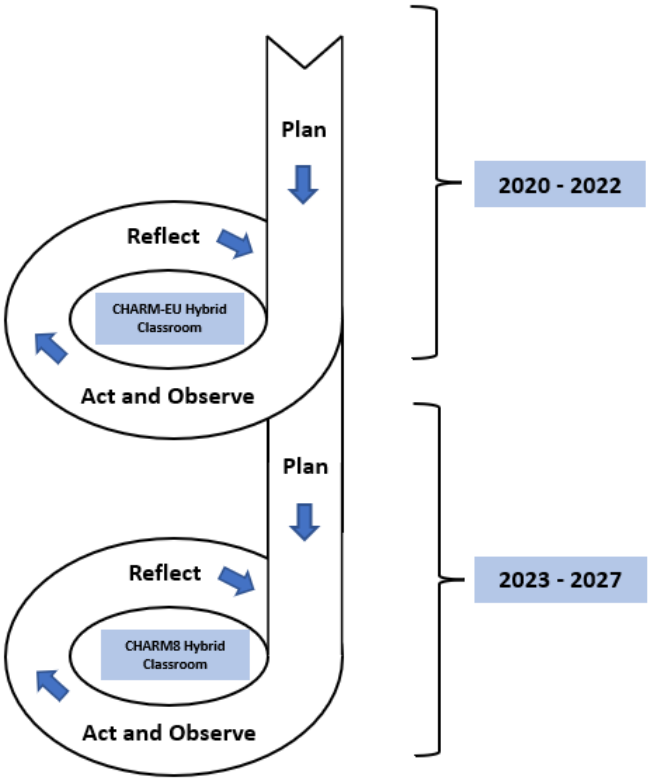

Figure 2. PAR cycles of Plan, Act & Observe and Reflect related to the CHARM-EU hybrid classroom.

Positionality and Methods Used

PAR is inherently a qualitative approach, meaning that it always needs to be subjectively considered. As the researchers are also participants in the activities being studied, we need to consider the impact this might have on the outputs of the research. PAR was used as a methodology as it embraces the fact that the perspectives of practitioners are valuable for capturing the subtleties present in complex scenarios. The inclusion of multiple perspectives from different expertise and experiences goes some way to address individual subjectivity.

One participant also changed roles during the process, moving from the design phase to actively participating in the delivery of the programme as a teaching assistant. This provided a unique opportunity as this individual had greater insights into the original plans and could critically evaluate how these plans were implemented in practice. The central methods used in this study were reviewing working documents, reports on what happened during delivery, including artefacts and general usage statistics, and a group reflection.

For the reflections, the three key actors critically reflected on the delivery and amalgamated their responses, broadly looking at the main elements that went well and could be improved in terms of the design and delivery of the programme. These reflections are then summarized to focus on implications for the next cycle of the PAR process.

3. Results: PAR Cycle

3.1. Plan (Design of the Hybrid Classroom)

The CHARM-EU hybrid classroom design process followed a combination of recognized best practices, student needs feedback, and engagement with the CHARM-EU community, including the Knowledge Creating Teams (a collaborative group of academics, researchers, and extra-academic actors who work together within broad, transdisciplinary themes to create educational content and joint research initiatives) and staff networks. Following the identification of learning needs from this process, a Hybrid Classroom Design

Team was established to ensure that hybrid classroom building works could be completed in time for the launch of the pilot MSc programme. This team was responsible for the build and implementation of the classroom and met weekly in the months preceding the launch. Their expertise was essential in identifying technical implementation hurdles and creating physical specifications for the hybrid classroom, including microphone levels and placement, optimal camera pre-sets, and practical guidelines for teachers to support a mixture of online and on-campus students.

One aspect that the team also tried to ensure was to offer the most uniform solution viable in terms of equipment to guarantee all students the most similar teaching and learning experience. Weekly meetings followed a set pattern beginning each session with an Agile-style stand-up where members gave a five-minute update on their university's progress over the preceding week. Any upcoming issues or blockers were identified, and the team discussed these as a group to find solutions.

In tandem with the Hybrid Classroom Design Team, the VLE Team (responsible for the delivery of the hybrid classroom) created a layout guide that would best support hybrid learning, and mock-up diagrams were produced to help guide the conversation (see Figure 3). Although each space was physically different, the general intent of the layout was achieved in each classroom.

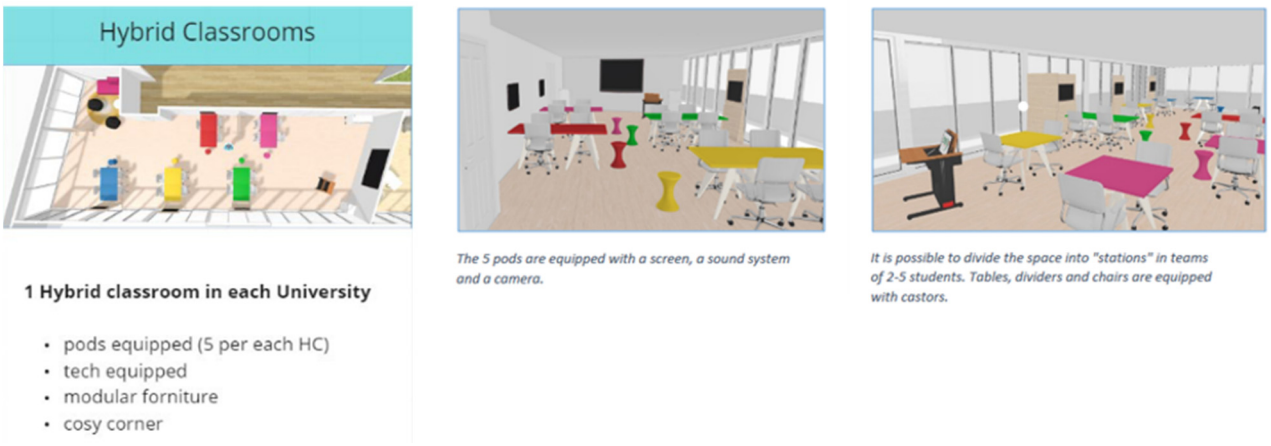

Figure 3. Hybrid classroom proposed layouts.

3.1.1. Educational Principles Integration

A vital step in the design and implementation process was to take the CHARM-EU educational principles as a starting point and integrate them into the hybrid classroom design. These principles were considered in light of pedagogical needs, identifying key elements needed to deliver a CHARM-EU student learning experience. This step ensured alignment with the teaching philosophy and supported the designed learning activities by teaching staff and educational designers.

For example, the educational principles of "challenge-based" and "transversal skills" were integrated into the design by creating pods with shared tables to facilitate student local group work. Interactive learning activities could be provided by teaching staff where students worked locally on real-life challenges, developing transversal skills through peer interaction such as communication and collaboration. An important design requirement was, therefore, that students could work in teams without disturbing other teams in parallel.

Another example of educational principle integration was how the hybrid classrooms were accessible and that students were supported by a local teaching assistant to discuss personal or professional issues, meeting the educational principles of "inclusive" and "student-centered". The teaching assistant also fostered a sense of belonging within the local group. Inclusivity was factored into the design through Universal Design for Learning (UDL) guidelines, which were incorporated into requirements specification documents, and integrated following discussions with CHARM-EU inclusivity experts.

3.1.2. Physical Build

Each classroom space at all five universities had minor differences due to local situations. For example, Utrecht University was able to secure a pre-built hybrid space that only required minor modifications to meet the specification, whereas other locations needed to repurpose or refurbish existing rooms. Securing a classroom space was also difficult for some universities due to local constraints, which resulted in a protracted delay before beginning the physical build. A maximum number of 20 students based on four pods was agreed upon.

Recognizing that the classroom needed to be flexible led us to follow the model in use within Utrecht University, where hybrid classrooms can be easily reconfigured with modular furniture. Each space has at least one large screen for hybrid plenary classes, and desks are typically arranged in pods of up to six students for breakout sessions. Each pod includes a desk screen, camera, and microphone, as well as a laptop or integrated computer. Students are also encouraged to connect their own devices in place of the supplied laptop.

3.1.3. Software Tools

Internal CHARM-EU technology experts contributed to the design of the software tools suite used in the hybrid classroom, and teaching staff were encouraged to suggest any specific tools that they felt would be useful. The VLE team designed and configured core software tools and "flexible apps", while other CHARM-EU experts evangelized for less established software tools identified as having high educational potential. Tools were scored and evaluated using Anstey and Watson's [36] rubric for eLearning Tool Evaluation, with additional criteria from CHARM-EU, including GDPR compliance and a preference for open-source solutions.

3.1.4. Pedagogical Needs Analysis of Transdisciplinary Teams

Transdisciplinary work requires a move beyond discipline-specific approaches for transdisciplinary teams to develop a synthesis of their disciplinary perspectives. This process involves team discussion and reflection for team members to begin to see their project scope from a new perspective. Teams that engage in this work have unique requirements; to collaborate effectively in their own learning space while having the ability to invite a variety of external stakeholders into their conversations. The needs of these stakeholders were also relevant to the student's success which led the VLE team to create a set of personas for users of the hybrid classrooms, including lecturers, teaching assistants, guests, and other stakeholders. This was a useful process to help understand the activities that everyone would need to engage in within the hybrid learning environment.

The hybrid classroom also needed to support several different teaching modalities, including plenary activities with the entire cohort, focused teamwork, and meetings with smaller groups (see Figure 4). Teaching needed to be possible either in class, virtually, or in a combination, with everyone connecting to one space simultaneously or breaking out into smaller sessions. Each scenario was diagrammed to support our design discussions.

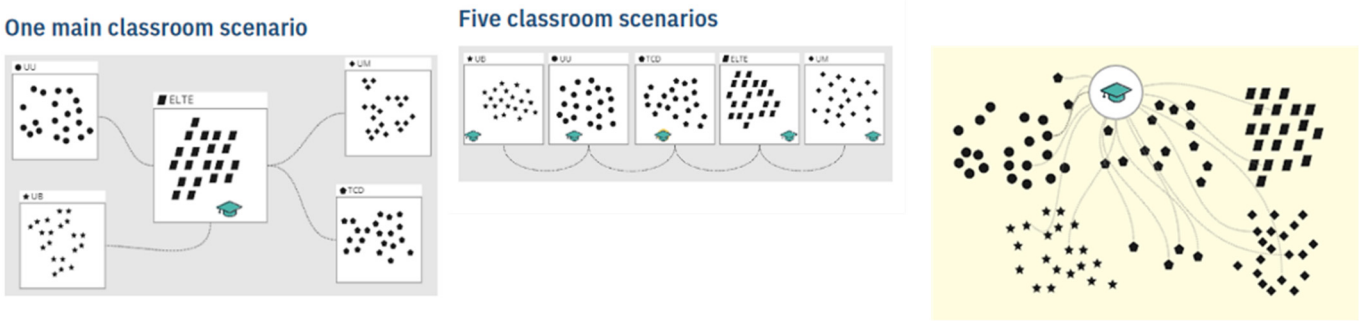

Figure 4. Teaching scenario example diagrams.

3.2. Act (Implementation of the Hybrid Classroom)

The first draft of the hybrid classroom project was submitted to CHARM-EU Project Managers in March 2021, and weekly meetings with the Hybrid Classroom Design Team (one member per partner university) were held between April 2021 and delivery in August 2021. Software and hardware testing was conducted in August 2021, and the hybrid classroom was implemented for the MSc in September 2021. This ambitious timeline shows how quickly the final hybrid classroom construction was delivered, although this would not have been possible without the considerable amount of pre-planning involved.

3.2.1. Staff Roles and Training Materials

As part of our implementation process, the VLE team developed a complete list of all hybrid classroom users, including students, staff, and external stakeholders. A set of guides and related documentation were developed to support these users and were published in an open access format on the CHARM-EU toolkit.

In addition to these resources, the VLE team worked with the professional development team to deliver training sessions and initiatives to staff over the summer of 2021 (see Table 1). The sessions also included enough space for teaching staff to discuss any queries that they had about the technology. The teaching staff were supported in their module design by educationalists, who guarded the implementation of the educational principles, including technology-enhanced learning. In-class support from a teaching assistant who was trained to provide technical support was also provided. The professional development team also conducted module design sessions and a final staff orientation session in the days prior to launch to ensure that staff were ready to begin once the students arrived.

Table 1. Overview of professional development activities from the VLE team.

Professional Development Activity	Short Description	Implementation Date
Inspiration session: Delivery modality and technology-enhanced learning	Participants learned about modalities to deliver their modules and the tools and platforms they can use for this.	4 February 2021
Workshop Virtual Learning Environment	Participants learned about the core platforms used in CHARM-EU.	8 April 2021
Interactive working session: Hybrid classroom experts	With guidance from technology experts, teaching staff worked on their module design and discussed questions and needs.	25–28 May 2021
Interactive working session: Emerging technology	With guidance from technology experts, teaching staff worked on their module design and discussed questions and needs.	14–18 June 2021
E-learning Virtual Learning Environment	An e-learning module on Moodle was created for CHARM-EU staff on the theory and practice of the VLE used in CHARM-EU.	September 2021

3.2.2. Alignment with Module Learning Outcomes

Hybrid learning environments are required to support a variety of learning modalities, module learning outcomes, and educational activities. The VLE team worked with module coordinators to understand their proposed learning activities and consider how they might be best addressed. For example, one of the Phase 1 modules, Sustainability, includes regular intra- and inter-classroom debates, which was a factor in using modular furniture to reconfigure the room more easily.

3.2.3. Testing

Testing the hybrid classroom hardware and software was key to ensuring a quality learning experience for students. The test team was composed of internal CHARM-EU technology experts and Hybrid Classroom Design Team members from all alliance partners.

Testing took place in two phases; software and VLE testing in the summer of 2021, with a focus on the final set of tools delivered during the week of August 23rd to 27th, and physical and hardware tests on August 26th across all partner sites. Acoustic issues were uncovered as a result of these tests, and some minor adjustments were required. A set of follow-up tests were therefore carried out on August 30th to confirm that the issues had been resolved.

A VLE software test plan was developed to cover each of the software tools that the Module Coordinators had selected for their modules. Topics for testing were grouped by individual learning activity, and a list of user actions was produced for each. A corresponding set of test assertions was created by the VLE team to define exactly which actions/functions needed to be confirmed, and this document ensured that all testers focused on the important elements.

Physical testing of the hardware focused primarily on the sound quality within each hybrid classroom, as well as typical physical tests to confirm that the equipment functioned as expected.

3.3. Observe (Delivery of the Hybrid Classroom for CHARM-EU MSc)

Following the design and implementation phases, hybrid classrooms were used by MSc teaching staff and 73 MSc students in five university locations. During the first phase of the MSc programme (September 2021–February 2022), hybrid classrooms were used three days a week for three Phase 1 modules (Sustainability, Social Innovation, and Transdisciplinary Research Methods). Phase 1 and 2 teaching staff of the MSc. programme taught from their home university but also engaged in staff mobility to meet students at other universities. Classrooms were connected via MS Teams: on the main screen of each classroom, students were able to see other hybrid classrooms; the Pan Tilt and Zoom (PTZ) camera of each room captured the image. An overview of activities in MS Teams is demonstrated in Table 2. Note: Data were collected over 58 teaching days in phase 1 (September 2021–February 2022) and an average of 56.3 teaching days in phase 2 across the three themes student could take (February 2022–June 2022).

Table 2. Activity in the MS Teams channels used in the hybrid classrooms in CHARM-EU.

Phase	Messages in Meetings	Files Shared	Recorded Meetings	Users
1	4403	760	48	332
2	5469	1474	223	275

In some classrooms, pods were equipped with cameras, allowing users to see students in smaller groups, raising the opportunity for direct contact, and increasing the perception of being in the same space. Each hybrid classroom was managed by a teaching assistant that launched the main meeting and mirrored/supported the activity. A weekly alignment meeting with module coordinators and teaching assistants was held for the whole semester.

Use Cases

Many different teaching activities were used in the hybrid classroom. Table 3 provides details of these.

Table 3. Use case hybrid classroom teaching activities.

Activity Title	Description	Used for	Technology in Use
General brainstorming and plenary discussions	Teachers and students talk to each other. Questions and answers are facilitated, and everyone participates (on location or remotely) in the discussion. Three meeting spaces were arranged in MS Teams, one per module, with weekly recursive meetings. Three separate "chats" allowed students to send instant questions to teaching staff and keep records of the activity.	Module lectures, workshops and plenary explanations.	Hybrid classroom, MS Teams.
Workgroups and hybrid student teams	Students, teachers, and extra academic staff members are spread across multiple universities and collaborate with each other. Collaboration is a key transversal skill for CHARM-EU students, and activities are run in groups. Groups are represented in MS Teams using channels; students can launch meetings and use a dedicated chat, and files can be stored in the channel folder. A virtual whiteboard and One Note notebook were used during these activities so that team members could note and interact live on the same platform.	Workgroup meetings and synchronous or asynchronous activities. Design thinking challenge-ideation activity, systems thinking, stakeholder mapping.	Hybrid classroom (not mandatory), MS Teams, One Note, Whiteboard.
Flipped classroom	Students prepare for their class by completing a set of readings. Each class splits into two groups, "For" and "Against", on a weekly topic. The debate takes place first locally and then remotely with two of the teams, which are selected at random.	Debate, presentations, communication.	Hybrid classroom (and local whiteboard), MS Teams.
Guest lecturers and workshops/Meet the expert	Guests, including members of NGOs and non-CHARM-EU teaching staff, join the classroom physically (local hybrid classroom) or via MS Teams. These workshops introduce tools and techniques to students; however, students are not expected to absorb all of the material but use the sessions to spark ideas for project work.	Lectures, workshops, question and answer sessions.	Hybrid classroom, MS Teams.
WorldCafé	Students meet stakeholders in a World Café format. Virtual tables (MS Teams Channels) with a host (the facilitator), external actors, and students are created. At every table, a specific UN Sustainable Development Goal (SDG) theme is discussed (e.g., healthy nutrition, safety in cities). Students can join the table for a discussion on the theme with external actors. At the end of the session, the problem space is further defined, and important factors, actors, variables, and elements are identified. When the time is up, students leave and join another table for the next round.	Debate in small groups, stakeholders participation.	Hybrid classroom (not mandatory), MS Teams

3.4. Reflect

This section describes perspectives from the three key actors involved in the design, implementation, and delivery of the hybrid classroom: a VLE technical expert, an Educationalist supporting academic staff, and a classroom-based Teaching Assistant (i.e., the VLE team).

3.4.1. What Went Well

Planning

The CHARM-EU approach to hybrid learning frames the VLE as an extension of the physical hybrid classroom. Learning happens within a liminal space at the intersection of the virtual and physical environments, and our design reflects this viewpoint.

The VLE team began planning the technology from the perspective that open-source technology solutions would provide the most sustainable platform to deliver the necessary functionality while giving us the potential to build and expand our IT environment offering over time. Reuse of tools already in use in our own universities was also recommended to manage costs and reduce the implementation and training needs of staff. Our preparation started with an inventory of our existing systems and the creation of a wish list for new tools.

Through exploratory testing, we found that open-source solutions often needed more dedicated support and a considerable amount of time to perfect. The presence of a proprietary tool already in use at the university; for which support and induction were already in place (support and induction for open-source tools were deemed too expensive), and some customizations of the open-source tool that are difficult to replicate in a new installation are both reasons that led to choosing closed tools for some of our needed functionalities. Our final learning environment design encompasses both the VLE and the physical space and is a mixture of open and closed systems, which gives us a good level of flexibility with the added peace of mind that third-party support can be found if needed.

Finding a physical space was extremely challenging for some partners due to a general lack of availability on campus. This issue was eventually resolved thanks to close cooperation with the CHARM-EU Project Management Team, who secured spaces through local contacts.

Sound problems were identified during the first day of testing, with echo and feedback occurring due to ineffective noise cancellation and some layout issues in the spaces. We overcame these issues with some rework and conducted a follow-up set of tests before admitting students into the space. As several overlapping conversations might cause audio feedback or make it difficult to concentrate, we opted not to offer speakers in pods and instead asked students to access breakout sessions and small meetings with personal sets of headphones.

Delivery

Both teaching and support staff learned a lot over the first iteration of the MSc, and different roles have more knowledge regarding how to use the environment. One of the key roles is the teaching assistant. Our educationalists developed a deeper insight into our Programmatic Assessment approach by gaining a high-level view of the overall programme. Teachers needed support at the beginning of each phase, but it is evident that their confidence grew with practice, and this is reflected in our staff survey, where numerous teachers indicated that they would need less support in the future.

3.4.2. What Could Be Improved

Improvements in communication around staff teaching responsibilities and the functionality of the hybrid classroom were noted. While the staff responsible for Phase 1 modules were very open to educational technologies, we noted a level of reluctance and apprehension about technology in general from the Phase 2 teachers. This may be due to different staff profiles, lack of time for teaching staff, or the anticipated level of support in

different universities. Hybrid teaching is a new experience for many, and the idea can be somewhat overwhelming for non-technical staff.

The VLE Team felt that testing hardware and software should have been completed far earlier, during the summer of 2021, to build in capacity to react to any problems, test more fully, and give us greater confidence in our implementation. This was not possible due to significant delays from hardware suppliers citing a silicone and plastic shortage during the COVID-19 pandemic. We note that staff and students were very understanding that the programme is a pilot and that some experimental features of the technology stack might need further work. Earlier testing would have also allowed us to engage with the inclusivity team in a more meaningful way by letting them see technical challenges firsthand and give timely feedback. It was difficult to express this before the classrooms were built, and our inclusivity team was only able to provide general feedback while they struggled to understand any issues that we highlighted as being potentially problematic.

Each university managed to get close to the hybrid classroom specifications; however, some differences were apparent due to local design decisions that had to be made due to physical constraints in each space (e.g., not all hybrid classrooms have pods due to the size of the local room and t-bone microphones are not available everywhere, so alternative models were used). Each university also had its own set of preferred suppliers, resulting in different equipment being provided and some divergences from the planned works.

The acoustic properties of each space differ considerably, and some acoustic design issues exist in the audio setup of classrooms, which can sometimes result in a less-than-ideal audio connection unless actively managed during class. This issue was exasperated by the COVID-19 public health situation, which made engaging with suppliers challenging and caused global supply shortages for computer chips and plastics. Once again, time was our biggest challenge, and we learned to recognize that lead times are not guarantees. Despite the challenges, the construction of the hybrid learning spaces was a very rewarding experience where the team learned a lot about audio systems and sound design. Our weekly hybrid classroom build meetings helped to support our team learning through exchange and advice among the international team's members. This was an invaluable experience that allowed us to find creative solutions and a positive result.

Time was also a large consideration for planning, and delays in the student enrollment process made it difficult to plan the technology roll-out. Moreover, aligning the entire VLE across the alliance required a dedicated contact person in each university; in some cases, this name was missing or changed at the very last moment, and some alignment sessions were required with new staff. This resulted in considerable pressure on the VLE team and an unnecessarily heavy workload prior to the launch.

3.4.3. Implication for Future Plans/Cycles

Planning

Earlier engagement with teaching staff is essential to mitigate reluctance and apprehension about technology, and we particularly want to emphasize that educationalists supporting curriculum development need to understand the purpose of learning technologies and their place in the CHARM-EU strategy before they can offer guidance on how technology can be best used to support the learning. The best approach to engage people is showing some meaningful examples of technologies (use cases) and constantly supporting teaching staff while designing technology-related teaching experiences.

For professional development, a "practice what you preach" approach may help to prepare teachers for hybrid teaching, i.e., use hybrid classrooms in the delivery of professional development. Due to the late completion of the hybrid classrooms at each campus, this was only feasible after the MSc program had already started. Due to the hybrid approach across five universities being new for everyone, we could not quite predict what kind of learning activities would work well and which would not.

The time needed to set up the software should not be underestimated, and we learned that any administrative details should be completed well in advance to reduce stress levels

in the team. The creation of onboarding documentation will help throughout the process of welcoming and updating new team members.

Delivery

We learned that the hybrid classroom approach in CHARM-EU was unsuitable for long lectures in which the teacher did most of the talking. It takes considerable effort and creativity to re-design learning activities that work in cross-campus hybrid teaching and learning.

4. Discussion: Lessons Learned and Recommendations for Future Practice

Digital transformations within inter-institutional cooperation require collaboration, diplomacy, planning, and time. From the CHARM-EU hybrid classroom case study, the following recommendations for practitioners are advised:

Design:

- Explore the pedagogical, structural, financial, and organizational needs of the educational award being delivered in the hybrid classroom from the perspective of all stakeholders (e.g., curriculum and instructional designers, hardware and software specialists, institutional IT departments support, VLE experts, teaching, administration, quality, policy, and finance staff).
- Collaboratively produce a layout guide with key requirements with individuals from each hybrid classroom. Although the hybrid classroom space may differ in each location, discussing what elements are essential and viable across each location is crucial.
- Inclusivity experts should be consulted during the design phase to ensure Universal Design for Learning (UDL) principles are integrated.
- Accept that differences in quality will arise across hybrid classroom spaces due to localized factors (e.g., audio, bandwidth, environmental factors). Aim to mitigate these issues through support and collaboration across institutions.
- Classroom furniture should be easily reconfigured to allow for different types of classroom activities.
- Create user profiles for each person working in the hybrid classroom (e.g., teachers, Teaching Assistants, VLE support, guest speakers, and students). This supports both pedagogical and organizational design.
- Consider the teaching modalities that will be used in your hybrid classroom and adjust design requirements accordingly. For example, will all teachers be on site or accessing remotely? Will students be working in groups, individually, or accessing the classroom online?
- Engage with Module Coordinators and teachers to plan for teaching activities in the hybrid classroom. Identify what requirements they need to align with their activities.
- Ensure adequate time and planning for testing across and within each hybrid classroom.

Development:

- Invest in high-quality audio equipment, including microphones and speakers. Audio hardware that includes a built-in noise-cancellation feature is recommended.
- Aim to have the same or similar hardware across all hybrid classrooms to ensure consistency of learning. This can be challenging due to preferred suppliers and tendering across universities. A minimum viable product should be agreed upon across all universities.
- Make the hybrid classroom an inviting space for students. Consider comfortable furniture, plants, and posters.
- Ensure that all teaching staff prepares and adheres to a well-prepared lesson plan. Sessions should be broken down into small sections, with clear instructions both spoken and documented on screen.
- Ensure that the teaching staff are trained in the hardware and software used in the hybrid classroom. Both static documentation and practical hands-on training sessions before the teacher delivers their content are recommended. Provide support or

professional development for teachers to align their design with the educational or pedagogical philosophy and hybrid learning principles.

- Implementation:
- Technical and teaching support staff are crucial to smooth implementation. Ensure that each hybrid classroom always has on-site support staff during teaching activities.
- Be transparent with students if technical problems arise. Explain the issue and provide a short, localized task for students while the problem is being rectified.
- Communicate with students about the location of the session and where to access files before the session. If they experience technical issues, they are aware of where they need to reconnect to.
- Teachers should avoid jumping to and from multiple applications without a clear explanation in a session.
- Teachers should prepare local fall-back activities in case of technical failures across hybrid classrooms.
- Teachers should minimize movement when in the classroom to avoid issues with lighting, bandwidth, and sound.
- Consider inclusivity in the hybrid classroom.
- Communicate to students and teaching staff about what hardware they need for the hybrid classroom (i.e., headphones, laptop). Aim to support students in need if they lack these resources.
- The time required to address technical support issues exceeded our expectations considerably in the first weeks of the programme. Capacity planning should be prioritized to reduce staff stress and foster technical knowledge across a wider range of staff members.

These recommendations contribute to the nascent field of digital transformations within inter-institutional collaborations and describe how cooperation and collaboration are key skills to ensure successful delivery.

Future Research

Future research will collect perspectives from other stakeholders involved in the hybrid classroom, including students, teachers, and KCT members. These perspectives will make up future iterations of the PAR cycles. In addition, research into how to support student blended cooperation and teamwork informed by Cultural Historical Activity Theory [37,38] is in progress by one of the teaching assistants based on their experiences in the classroom.

5. Conclusions

Designing, implementing, and delivering an inter-institutional hybrid classroom as a digital transformation process is a complex and challenging activity. These challenges are intractably linked to broader higher education challenges, including developing transdisciplinary academic knowledge, establishing inter-institutional policy, fostering educational innovation in teachers, and enhancing student experiences for attaining 21st Century skills and competencies. An agile approach based on distributed leadership can support a collaborative working style, which can be a model for the delivery of future higher education joint programmes. Inter-institutional collaborations such as the CHARM-EU hybrid classroom demonstrate how we can push the boundaries of contemporary education, traditional academic culture, pedagogical innovations, and transdisciplinary student engagement. However, without financial, resource, strategic, and leadership support, the long-term viability of these spaces may be questioned.

The experiences of CHARM-EU have provided best practices and guidelines for other inter-institutional cooperation to deliver educational programmes via this innovative approach successfully. Inter-institutional cooperations seeking to embark on a hybrid classroom project should focus on integrating educational principles, physical build alignment, appropriate software tools, pedagogical needs analysis, professional development, alignment with module learning outcomes, and adequate time for testing. If these rec-

ommendations are addressed, the possibility of a successful hybrid classroom can be achieved and potentially address, in a small part, some of the challenges facing higher education today.

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education sciences

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Project Report

Online Support for Education in Entrepreneurial and Intrapreneurial Competences: A Proposal for an Assessment Tool and Support for Tailor-Made Training

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Abstract: Higher education institutions across Europe are called to offer entrepreneurship education. Despite the rising interest and the increased offerings in the last decades, entrepreneurship education is yet not as mature as other disciplines, and it is still underdeveloped in some faculties and institutions. One way of embedding entrepreneurship education within different disciplines is to take a broader approach beyond teaching how to start up and focusing on developing the entrepreneurial competences of students, which equip them to provide value to society (either economic, social, or cultural). This article describes an online platform—named EICAA—that supports educators and trainers aiming at teaching/guiding/coaching students or employees in developing entre/intrapreneurial competences. The platform is based on a Competence Framework built upon a systematic literature review, which defines 18 key competences grouped in three competence areas. The platform allows the educator to assess the entrepreneurial competences of a group of students/participants, via the so-called Competence Monitor and provides tailor-made training with the Competence Development Kit. The platform is being used in five European universities and is open to be used by any higher education institution or organisation aiming at developing the entrepreneurial competences of their students and/or employees. Future developments of the tool can be enriched from the experiences of the participant institutions and could become an open collaborative online tool.

Keywords: entrepreneurship education; entrepreneurial competences; intrapreneurship; digital platform; assessment

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1. Introduction

Entrepreneurship and innovation are considered important engines of growth in developed economies. Based on the awareness of this, the formulation of policies and programs that aim to stimulate the creation of new ventures is an objective of roughly every country focussed on the economic development [1–3]. This is the case of the European Union, and initiatives such as fostering the entrepreneurial capacity of European citizens and organizations occupy the central stage of the political agenda [4]. In this vein, the European Commission appointed the key role of higher education institutions (HEIs) in entrepreneurship education (EE) and training.

Thus, HEIs across Europe have been called upon to offer entrepreneurship education, stimulate the entrepreneurial competences among its students, and become more entrepreneurial [5–7]. Although it is true that entrepreneurs learn from multiples sources [8], entrepreneurship education contributes to enhancing the ability to detect opportunities and give creative responses to them [3,9]. It also contributes to the entrepreneurship self-efficacy

(ESA), i.e., the beliefs of individuals about their capacity to start a venture [10–12]. Additionally, several empirical studies [13,14] have found a positive relationship between entrepreneurship education and entrepreneurship intention (EI). Therefore, as ESA and EI are good predictors of entrepreneurship behaviour, the efforts of HEIs to educate and train entrepreneurs—or in a broader perspective, students with entrepreneurial competences—are recognised and well-known.

Nevertheless, despite all the efforts in the last decade [15], education in entrepreneurship is not yet as mature as in other disciplines due to uncertainties in the definition of entrepreneurship itself, the aim of entrepreneurship education, and the variety of contents and teaching methodologies (what needs to be learnt and how) [16,17]. With respect to the definition of entrepreneurship, while pioneer approaches were predominantly framed under a narrow perspective of entrepreneurship as starting up new business, there is an increasing tendency of undertaking broader approaches to entrepreneurship as "providing value to others" [18,19]. That is, in narrow terms, entrepreneurship is understood as an occupational option measured mostly through self-employment of individuals [20], while broader perspectives include a broader set of initiatives defining entrepreneurship, e.g., as "acting upon opportunities and ideas and transform them into (financial, cultural, or social) value for others" [21]. The latter perspective also includes providing value in existing organisations through innovation, a term which is well-known as intrapreneurship [22,23]. Along with this broader perspective, there is a need to devise and implement ways of teaching entrepreneurship as a broad concept within the HEI system which relies on the development of entre/intrapreneurship competences of students [19,24–26] far beyond teaching how to start up a new business. Along with this broader perspective, there is a need to devise and implement ways of teaching entrepreneurship as a broad concept within the HEI system, which relies on the development of entre/intrapreneurship competences of students [19,24–26] far beyond teaching how to start up a new business.

Within this context, the European Commission developed EntreComp (European Entrepreneurship Competence Framework) as the reference framework of competences for entrepreneurship education which was established on the basis of a comprehensive multi-step mixed-method approach [21]. The main theoretical rationale and, ultimately, justification for relying on a broader conceptual view of entrepreneurship in EntreComp, however, has resulted in the study "Entrepreneurship Competence: An overview of existing concepts, policies and initiatives (OvEnt)" [19] funded by the Institute for Prospective Technological Studies of the European Commission's Joint Research Centre. As a result of this study, entrepreneurship is considered as a "transversal competence, which applies to all spheres of life: from nurturing personal development, to actively participating in society, to (re)entering the job market as an employee or as a self-employed person, and also to starting up ventures (cultural, social or commercial)" [21]. By adhering to this broader perspective, education of entrepreneurship and, thus, of their associated competences, can be better integrated and accepted in educational programs and faculties beyond business schools. For example, students in the humanities are typically more interested in social entrepreneurship, because of the social value and non-profit dimensions [27].

EntreComp is an exhaustive and complete framework encompassing 15 competences, 60 threads, and 442 learning outcomes. It is designed as a reference framework for educators aiming at designing and implementing entrepreneurship educational programs. However, its translation into practical course contents and methods may require some effort and guidance due to its exhaustivity.

Furthermore, the advent of online learning and its rapid acceleration during the COVID-19 pandemic have shown the benefits of online education and have moved students to feel more inclined towards this type of training [28,29]. Online learning offers new opportunities, such as innovative methods of teaching, assessment and monitoring, and personalised education [28]. A recent literature review [29] found three main innovative approaches to online entrepreneurship education: social media (i.e., Wiki), serious games (to engage and motivate students), and Massive Open Online Courses (as a platform of

high-quality educational resources) [30]. Another initiative used an online assessment to examine students' entrepreneurship traits and proved that students became more aware of their developmental needs. In addition, it allowed educators to tailor their teaching approaches to the personality traits of their students [31]. Despite these pioneering and innovative approaches, the offer of online entrepreneurship education is still lower than in other disciplines and it is underreported in scientific publications as well [28]. One of the attributed causes is the belief, supported by evidence, that learning entrepreneurship is better achieved through hands-on activities, experiential approaches, and real-world immersive experiences [32]. However, blended approaches can benefit from both online and experiential approaches and provide enhanced teaching and learning opportunities to educators and students [28,32].

In this contribution, we present the EICAA, an initiative based on the research in entre/intrapreneurship competences that delivers an open online platform for educators and trainers aiming at teaching/guiding/coaching students or employees in developing entre/intrapreneurial competences. EICAA stands for Entrepreneurial and Intrapreneurial Competences Assessment Alliance and is being developed under an Erasmus+ project funding (European Commission). In short, the EICAA provides a revised entrepreneurship competence framework, a self-assessment survey for students or employees, and a competence development kit. The EICAA Competence Framework presents a revised and exhaustive competence framework, built upon a systematic literature review, taking EntreComp as a reference framework and benchmarking with other frameworks [33–36]. The EICAA Competence Framework enhances EntreComp with new competences related to current methods of entrepreneurship and, at the same time, reduces its complexity to make it more accessible to educators. In addition, EICAA provides a validated entrepreneurship survey, where the educator analyses the stage of development of the entrepreneurial competences of their group. Additionally, the educator obtains recommendations of teaching modules which are tailored to the group. These teaching recommendations can be either online or experiential and face-to-face activities, depending on the adequacy of the methodology to the characteristics of every entrepreneurship competence and its learning goals. The platform allows the teacher/trainer the flexibility to use the recommendations or access the full repository of learning modules. Every learning module follows the same design methodology with hands-on activities, resources, and suggestions for competence development and assessment. After some promising pilot tests, the platform is fully deployed and further tested in the winter semester 2022/23 within the five universities that belong to the consortium as well as within businesses associated to the project.

2. Background, Methods, and Objectives

The lack of information on entrepreneurial proficiency levels of learners creates a variety of challenges for HEI educators and trainers with regard to outlining entrepreneurial learning activities appropriately. Knowing which entrepreneurial competences need to be developed, as well as to what level, facilitates the planning of entrepreneurial learning activities and, most likely, increases the efficiency of entrepreneurship education. Without such information, a good match between what is offered by educators and what is needed by learners may be difficult to achieve.

The same is true for determining entrepreneurial competences on an organisational level. Organisations that are knowledgeable of their entrepreneurial competence portfolio are in a better position to identify and address present entrepreneurial skills gaps—within or outside the organisation—as well as to determine whether internal staff development plans with regard to entrepreneurial traits have been achieved.

The EICAA project has been established to address these "black-box-like" phenomena. The underlying logic of the platform is to provide tailored learning recommendations for groups of students/employees based on their current entrepreneurial competence assessment. It builds a digital platform for the assessment and development of entre/intrapreneurial competences. The platform consists of three main components, the

Entrepreneurship Competence Framework, the Competence Monitor, and the Competence Development Kit. By identifying developmental needs of their target group(s) through a competence assessment, the EICAA platform enables educators and trainers to better customize entrepreneurship education activities. Additionally, teachers/trainers can track the progress of their group as well as benchmark different groups. The EICAA Digital Platform suggests entrepreneurial learning interventions upon which the users can improve the proficiency level within the group that underwent the self-assessment. These suggestions are derived from the self-assessment results. Its resources have been designed to be ready for micro-credential uptake, following the guidelines of the European Commission Higher Education Consultation Group [37] and of the OpenU project [38].

The methods followed to build the three components of EICAA Digital Platform are:

1. Entrepreneurship Competence Framework: developed after a systematic literature review of a sample of 138 documents, both from scientific literature and grey literature. The review was coded using NVivo software tool and the identified competences were matched with the existing EntreComp framework. Then, the team of researchers studied new additions and simplifications of the EntreComp framework and synthesized a proposal which was refined in several iterations.
2. Competence Monitor: consists of a survey for self-assessment of entre/intrapreneurial competences. The development of the EICAA Competence Monitor followed a mixed-method approach. In the first stage, it consisted of the development and iterative refinement of a rubric system. Then, item statements were elaborated and refined using a Delphi process with 15 educational and entrepreneurship researchers and experts. The survey was tested in several rounds with several samples of students.
3. Competence Development Kit: the repository of stackable learning modules targeting every competence at basic and advanced levels, designed under the micro-credential guidelines [38].

The objectives of the EICAA Digital Platform are to offer providers of entrepreneurship education (e.g., educators or trainers) and senior management representatives or human resource managers inside and outside higher education the possibility to gain a better understanding of the entrepreneurial proficiency of any group of individuals. It also allows for the exploitation of this knowledge to tailor entrepreneurial teaching activities that better fit the actual learning needs. This facilitates entrepreneurship education and provides an instrumental basis for a more efficient development of entrepreneurial competences inside universities, enterprises, and other types of organisations.

On the long run, EICAA bears the potential to offer guidance for policy makers once a critical mass of organisations has exploited the Digital Platform or are regularly making use of it. This would enable the EICAA consortium to provide (policy) reports that summarise entrepreneurial competence proficiencies on state or country level (e.g., of enterprises or universities) or to compare aggregated entrepreneurial proficiency levels between regions and states.

3. Construction of the Competence Framework, the Competence Monitor, and the Competence Development Kit

As follows, we describe the three components of the EICAA Digital Platform, i.e., the Competence Framework, the Competence Monitor, and the Competence Development Kit.

3.1. Construction of EICAA Competence Framework

The EICAA Competence Framework is built upon a systematic literature review [1,39,40] of entrepreneurial and intrapreneurial competences, taking EntreComp as a reference framework. The aim of the review was to identify the competences of entrepreneurs and intrapreneurs that lead to successful ventures. Throughout the paper, competence refers to the "proven ability to use knowledge, skills and personal, social and /or methodological abilities in work or study situations and in professional and personal development", as defined by the European Qualification Framework (EQF) [41]. Herein, we understand venture in the broad sense, i.e., as

an initiative that is undertaken by an entrepreneur or intrapreneur to provide value to others. Although it is true that the success of a new venture does depend on many factors—contextual, personal, and circumstantial factors—the literature covers extensive research on the traits and actions of the individual that are mostly related to successful ventures. By identifying these individual competences, educational programs can be aligned and designed to help students and would-be entrepreneurs develop these competences.

The sample consisted of research papers obtained with a systematic search in databases Web of Science, Scopus, and Inform/ProQuest. The search terms were combinations of terms entrep* or intrap*, appearing as the topic of the paper. The search was performed as of December 2020, and no limits were set on the year of publication. We narrowed the search by selecting papers of type review and having more than 100 citations. We merged the results from the searches and eliminated duplicates, resulting in a sample of 139 articles. After we screened the title and abstract, 84 relevant papers were ultimately retained. Finally, to include the perspective of relevant bodies, we included grey literature as recommended by some authors [42], such as literature from the European Commission which has published a rich set of documents on entrepreneurship education and competences. Thus, we added a total of 54 additional documents to the initial sample, resulting in a final sample of 138 documents.

To identify the relevant factors that lead to successful ventures, we established a protocol of content analysis which was implemented through the software tool NVivo. The protocol was based on a combination of deductive and inductive coding. We initially defined a set of 15 codes, representing the 15 competences of EntreComp, which are grouped into three competence areas, namely "Ideas & opportunities", "Resources" and "Into action", and we added new categories if the factors identified in the literature were not covered by EntreComp.

A team of reviewers supervised by three senior researchers conducted the coding, and intercoder reliability was taken into account by having regular meetings and discussions on potential disagreements. To further confirm the competence framework, the list of competences of EntreComp was compared with six relevant competence frameworks of the literature: Bird (1995/2019) [43], Mitchelmore and Rowley (2010) [44], Morris et al. (2013) [33], Rasmusen and Nybye (2013) [34], Bolzani and Luppi (2020) [35], and Tittel and Terzidis (2020) [36]. All the competences included in these competence frameworks were matched with EntreComp and the competences that were not already covered by EntreComp were considered as new competences (or new threads in the existing competences).

The synthesis phase was performed by the three senior researchers, who put forth a proposal for the competence framework, which was debated in a workshop with the remaining team of researchers and progressively refined in several iterations. The final competence framework is briefly presented in Section 4.1.

3.2. Construction of EICAA Competence Monitor

The EICAA Competence Framework sets the taxonomy (structure and list of competences and threads) that theoretically supports the EICAA Competence Monitor. The development of the EICAA Competence Monitor followed a mixed-method approach [45]. In a first stage, the EICAA Competence Framework was the basis for the development and iterative refinement of a rubric system. A rubric system is a course or curriculum evaluation matrix defining observable aspects of the targeted competences at different proficiency levels. Due to the rubric systems' high reliance on rich, qualitative descriptions of competence proficiency level attributes, it was instrumental in ensuring content validity of the instrument [46]. To further ensure face validity, effectiveness, and sustainability of the instrument, formulations were further refined using a Delphi process with 15 educational and entrepreneurship researchers and experts in four iterations before consensus was reached.

The rich descriptions of the rubric system then served as a basis to develop alternative survey versions which were validated with an even broader set of 31 educational and

entrepreneurship researchers, teachers, and experts. In total, five versions of the survey were developed: one using shortened versions of the rubric as answer options, one using rich descriptions of a thread as statement and cognitive proficiency levels based on Bloom's taxonomy [47], one employing five EntreComp-inspired proficiency levels (none, basic, intermediate, advanced, and expert), and finally, a streamlined version of the latter. Each version was developed through a combination of at least one focus group with the evaluators and a Delphi process with asynchronous review rounds. In the final version, item statements from the third version were reduced in length and lexically simplified, and, where necessary, a responsive hint was added to clarify the meanings of the terms used.

The fourth version of the survey was subjected to a first quantitative preliminary test round (N = 72). The participants of this test and the one that followed were students across different disciplines and different educational levels (Bachelor's, Master's, and Doctoral programs) at the five higher education institutions of the EICAA Consortium.

During this first test round, one competence was found to exhibit reliability issues and five indicated normality issues. Otherwise, reliability ranged between 0.669 and 0.926 for Cronbach alpha, between 0.610 and 0.918 for split half consistency, and between 0.721 and 0.927 for omega. The result of this round led to the development of the fifth version, which was subjected to a second test round (N = 202), this time including exploratory and confirmatory factor analysis, as well as average variances extracted. In this round, one competence was still investigated further due to potential reliability, and six for normality, or one-dimensionality. Reliability scores in this round for the other competences ranged between 0.651 and 0.914 (Cronbach's alpha), between 0.733 and 0.914 (omega), between 0.656 and 0.915 (split half) and between 0.63 and 0.91 (composite reliability). Moreover, an analysis of the average variance extracted (AVE) resulted in issues for the competences Creativity (AVE = 0.48) and Self Awareness and Self Efficacy (AVE = 0.48).

The results of the second test triggered a last qualitative review round to discuss items that revealed internal consistency issues, as well as preliminary patterns observed in reliability and covariance scores. This last review round also entailed a detailed check of the item formulations with the Competence Framework, as the many iterations of the dialectical Delphi process risked leading to discursive operationalisations that no longer fully reflected the original concept.

3.3. Construction of EICAA Competence Development Kit

The EICAA Competence Development Kit is a catalogue of entrepreneurial learning intervention resources for both HEI teaching interventions targeted at students as well as for enterprise training interventions targeted at employees. The overall aim is to improve performance measures in competence areas where score outcomes in the EICAA Competence Monitor are considered suboptimal through the development of suitable (teaching/learning) intervention resources that promote entrepreneurial and intrapreneurial competence development within HEI study programmes and employee training.

The EICAA Competence Development Kit relies upon the methodological approach of teaching through entrepreneurship [48]. Thus, the teaching interventions are designed as hands-on experiences where the students or employees are immersed in simulated or real-world scenarios tailored to a given competence. These scenarios are associated with the different stages of the entrepreneurial process, such as identifying problems or opportunities in a given domain, generating and valuing ideas, drawing a business plan, and reflecting on the ethical and sustainable issues, among others. By interacting and engaging with these scenarios, the students further develop the associated entrepreneurial competences. "Through" also means that entrepreneurship can be taught/learnt through other subjects beyond entrepreneurship courses. The educator or trainer can choose a given learning module in the context of any course to help the students/individuals develop a particular competence (e.g., using module "spotting opportunities" in a course on industrial design).

The logic of the EICAA Competence Development Kit is based on a five-stage process:

1. Designing: includes reviewing and analysing findings of the EICAA Competence Framework and the Competence Monitor, as well as screening other EU projects to identify "focus competence(s) (areas)", then selecting a number of modules (~10+) per side (i.e., HEIs and enterprises).
2. Developing: refers to revising the literature, developing resources (modules/units) for the HEI and enterprise side (structure, content, and/or presentation on digital platform) as well as providing module recommendations for users.
3. Scaling: points at embedding the EICAA Competence Development Kit as OER (open educational resources) into the digital platform as well as its dissemination.
4. Sustaining: relates to sustaining the EICAA Competence Development Kit post-project-lifetime and providing the possibility for other institutions to add resources and share their ideas.
5. Implementation and reflection: finally aims at establishing a standardized feedback cycle (subgroups), testing through the application of modules (pilot-testing), and analysing feedback, as well as revising the EICAA Competence Development Kit, where necessary.

The structure is based on a modular approach, with each structured module giving an overview on the following: main competence and additional competences, learning outcomes, target group (students or employees), proficiency level (basic/foundation, intermediate, or advanced), workload (ECTS credits and certificate), assessment, and format. After the module overview, an instructor's manual describes how the module should be facilitated, including teaching and learning methods and indicating the learning path, contents, learning activity, assignments, and instructions for educators/business trainers. Additionally, we provide resources for educators and enterprise trainers to teach the module, including checklists, literature, links, number of educators/trainers necessary, preparation for educators, room set up, and requirements—flip charts, video projector, etc.

4. Results

4.1. EICAA Competence Framework

The EICAA Competence Framework relies upon the systematic literature review detailed in Section 3.1. It is structured in three competence areas, with a total of 15 competences, each further divided in several threads, which, in turn, are deployed in eight progression levels, resulting in a total of 442 learning outcomes. The EICAA Competence Framework provides an updated version of EntreComp (see Table 1), maintaining the same structure as EntreComp, with the addition of three new competences, the revision of some threads, and the reduction of the progression levels to four.

In summary, the EICAA Competence Framework brings:

- A stronger focus on design and customer discovery: customer discovery, co-creation, and market view of the new venture (or value-creating activity).
- Agile and incremental entrepreneurship: stronger focus on testing and experimentation; and realization that a new venture (or value-creating activity) is based on hypotheses or assumptions that need to be continually tested and revised (i.e., scientific approach to entrepreneurship).
- Digital competences associated with the creation of new ventures (or creation of value), from having basic digital skills to being aware of the safety and privacy issues related to digitalization.
- More emphasis on the process view of entrepreneurship, including iterative cycles and adaptability to the phases; and management of the process of the value creating activity.

Table 1. Structure of EICAA Competence Framework.

Competence Area	Competence
Ideas and opportunities	Spotting opportunities Creativity Vision Valuing ideas Ethical and sustainable thinking Design *
Resources	Self-awareness and self-efficacy Motivation and perseverance Mobilising resources Financial and economic literacy Mobilizing others Digital management *
Into action	Taking the initiative Planning and management Process management * Coping with uncertainty, ambiguity, and risk Working with others Learning through experience

* New competences added in comparison with EntreComp.

The three new competences included in the framework are Design (in competence area "Ideas and opportunities"), Digital management (in competence area "Resources"), and Process management (in "Into action"). These new competences are decomposed into several threads each, following the same structure as EntreComp, and four progression levels:

- Competence "Design" is defined as the ability to interact with customers (or the target group) and other stakeholders to identify needs, prototype, test, and co-create. Thus, it includes threads "Immerse with your users", "Identify needs", "Prototype and test", and "Co-create".
- "Digital management" involves the confident, critical, and responsible use of, and engagement with, digital technologies for the value-creating activity. It includes the following threads: "General digital competences at work", "Digital competences for the value creating activity", "Information and data literacy", and "Safety and cybersecurity".
- Competence "Process management" is contextualised under the concept that entrepreneurship is a process which is dynamic, iterative, and feedback-driven [9,19,49,50]. The competence emphasizes the ownership of the process by the entrepreneur. Thus, it includes threads "Monitor progress", "Be flexible", "Redirect your strategy", "Manage transitions", and "Work agile".

Figure 1 depicts the visual representation of the EICAA Competence Framework, which holds the idea of the process of entre/intrapreneurship from ideas and opportunities to taking action, by means of a set of resources. EICAA Digital Framework supports the assessment, analysis, and improvement of these competences (the full public report can be accessed through the web site of the project www.eicaa.eu, accessed on 15 September 2022).

4.2. Validation of the Survey

Confirmatory factor analysis was performed using AMOS 28 on each of the three domains separately, as the competences in each domain are expected to show greater internal consistency than between domains. Variable inflation factor (VIF) for all factors were below 0.64, showing no collinearity issues. We built the initial models on the basis of the structure in the Competence Framework, the parameters of which were borderline or not acceptable in some cases. On further modelling, we could identify trends which suggested the trimming or splitting of factors, for example, Design in the domain Ideas and opportunities. Based on original models, Figures 2–4 convey the standardised loadings

(numbers on the one-sided arrows) between the variables and the factors for the three domains, respectively, describing the influence of each variable on their respective factors. The figures also display the estimated variances for each factor (numbers above the factor) and the estimated covariances between factors (numbers on the double-sided arrows). From these, we can foresee improvements to further optimise the models and obtain a better fit, including calibrating each model using a stripping logic, starting from the full hypothetical model, then stripping the nonsignificant paths. This will be further investigated in a follow-up publication.

Appendix A displays the statements of the survey. The complete survey can also be accessed through the web site of the EICAA project (www.eicaa.eu, accessed on 15 September 2022).

4.3. Platform Overview

The EICAA Digital Platform addresses mainly educators of higher education and enterprise trainer/coaches who seek to develop entrepreneurial competences of learners. The platform is developed as a free-of-charge and publicly available instrument. However, all users are required to register before entering the core part of the platform. This core consists of two main components: (a) the EICAA Competence Monitor and (b) the EICAA Competence Development Kit (see above for details). It is recommended that the two components are used sequentially to let the platform unfold its full potential. This means that registered users ought to do the following:

Step 1. Decide whether to create a student or employee self-assessment survey for which a link is created subsequently that can be used to bring participants to the survey.

1. Select a set of survey features as: start/end date from/until the survey is running, name the survey, select a survey language (English, Spanish, French, German, Dutch, Hungarian, and Catalan are currently being planned for availability).
2. Preview the survey prior to sending the survey link to the group of interest.
3. Send the survey out via link to the target group (Figure 5 shows a screen shot of the survey as seen by the participant).
4. While running: track survey performance in terms of completed questionnaires displayed in histogram (y-axis = number of submissions and x-axis = date) and pause, stop, or extend duration of survey (if needed)—see Figure 6.
5. Close the survey (manually or as defined by date).

Step 2. After a survey has been closed, the results dashboard of the Competence Monitor generates:

6. A set of graphically displayed metrics allowing the user to see how the self-assessed group "performed" along the competences of the EICAA Competence Framework.
7. A list of competences that are recommended to be the focus of follow-up learning/training interventions.
8. Suggested teaching/training interventions from the EICAA Competence Development Kit that can be used for that latter purpose.

Step 3. Naturally, it is up to the user whether to follow the recommendations provided by the dashboard of the EICAA Competence Monitor. If the user decides to do so:

9. All details for the recommended interventions are provided within the EICAA Competence Development Kit section of the platform.
10. The user will be directed to respective sections via click on the recommendations of the dashboard (see Figure 7).
11. The user may also navigate freely inside the Competence Development Kit to search for more interventions. The platform will present a variety of filters to facilitate the search for interventions (e.g., competence area, competence, and difficulty of intervention).

Figure 1. Visual representation of the EICAA Competence Framework.

Essentially, Steps 1 and 2 feature the Competence Monitor and always go together once a user begins and completes a self-assessment of a group. In contrast, the EICAA Competence Development Kit (step 3) can also be exploited autonomously by navigating to it on the platform without prior self-assessment of any group.

Furthermore, users are not limited to creating one self-assessment exercise only. Rather, additional surveys for other groups of learners (or the same group at a different time) can be added at any time. To keep order of all self-assessments, the platform also presents an archive section where all finished surveys and corresponding data can be accessed and downloaded by the user.

The Competence Development Kit (educational intervention) consists of a set of modules with activities that are aimed at developing a given competence, as depicted in Figure 7. Every learning module has the same structure: Overview of the module, Educator Tasks, Resources, and Rating. The Module Overview is structured into learning goals, competences that are developed under this module (main competence and additional competences), target group, students' workload, and format (online or face-to-face activity). The Educator Tasks contains the details of how to conduct the activity (contextualisation of the activity, information and resources for materials and documents necessary to develop the activity, step-by-step process of the activity, and guidelines to grade the students). The Resources section provides links to complementary resources related to the activity or the competence and Rating represents the score of the activity as valued by the educators who had accessed and tested the learning module.

The platform, which will be available in English only (apart from the self-assessment survey), is currently still under development. A beta version is expected by the end of 2022. Once publicly accessible, the platform will be licensed under the European Union Public Licence v.1.2, conditioned by the Commons Clause. The hosting of the platform and storage of all user data is carried out within the European Union under full compliance of the General Data Protection Regulation (GDPR).

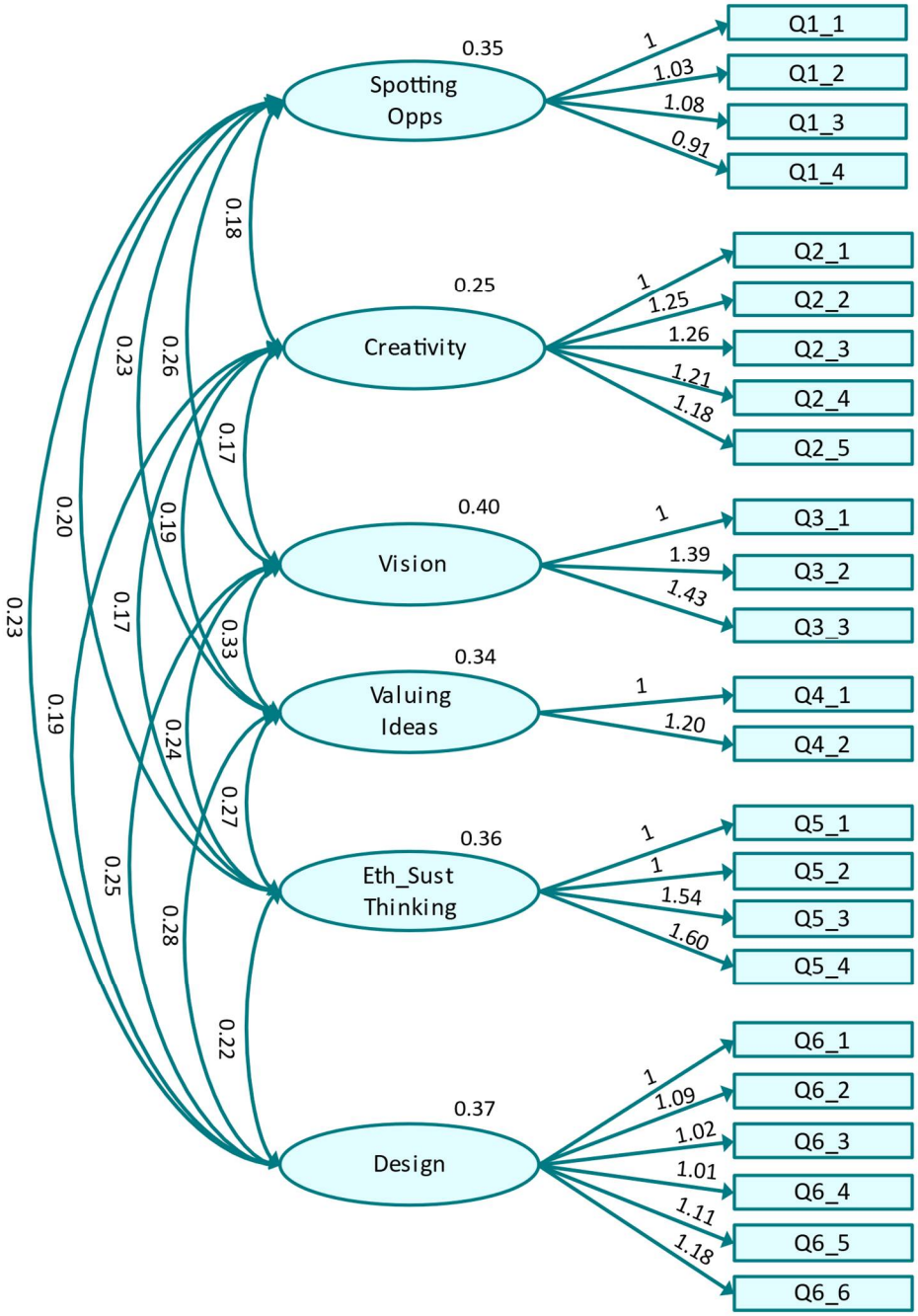

Figure 2. Optimised original path model for domain "Ideas and opportunities".

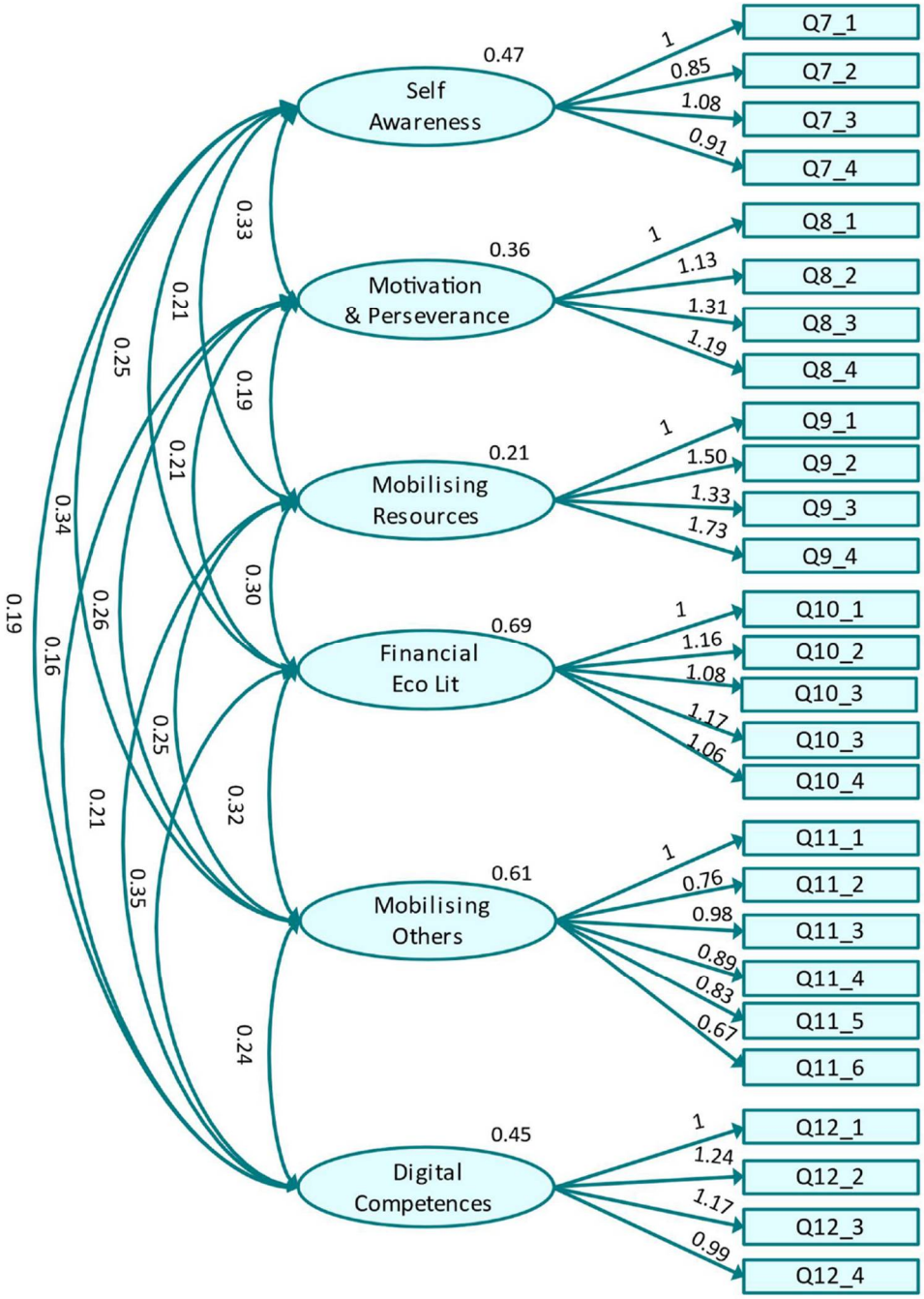

Figure 3. Optimised original path model for domain "Resources".

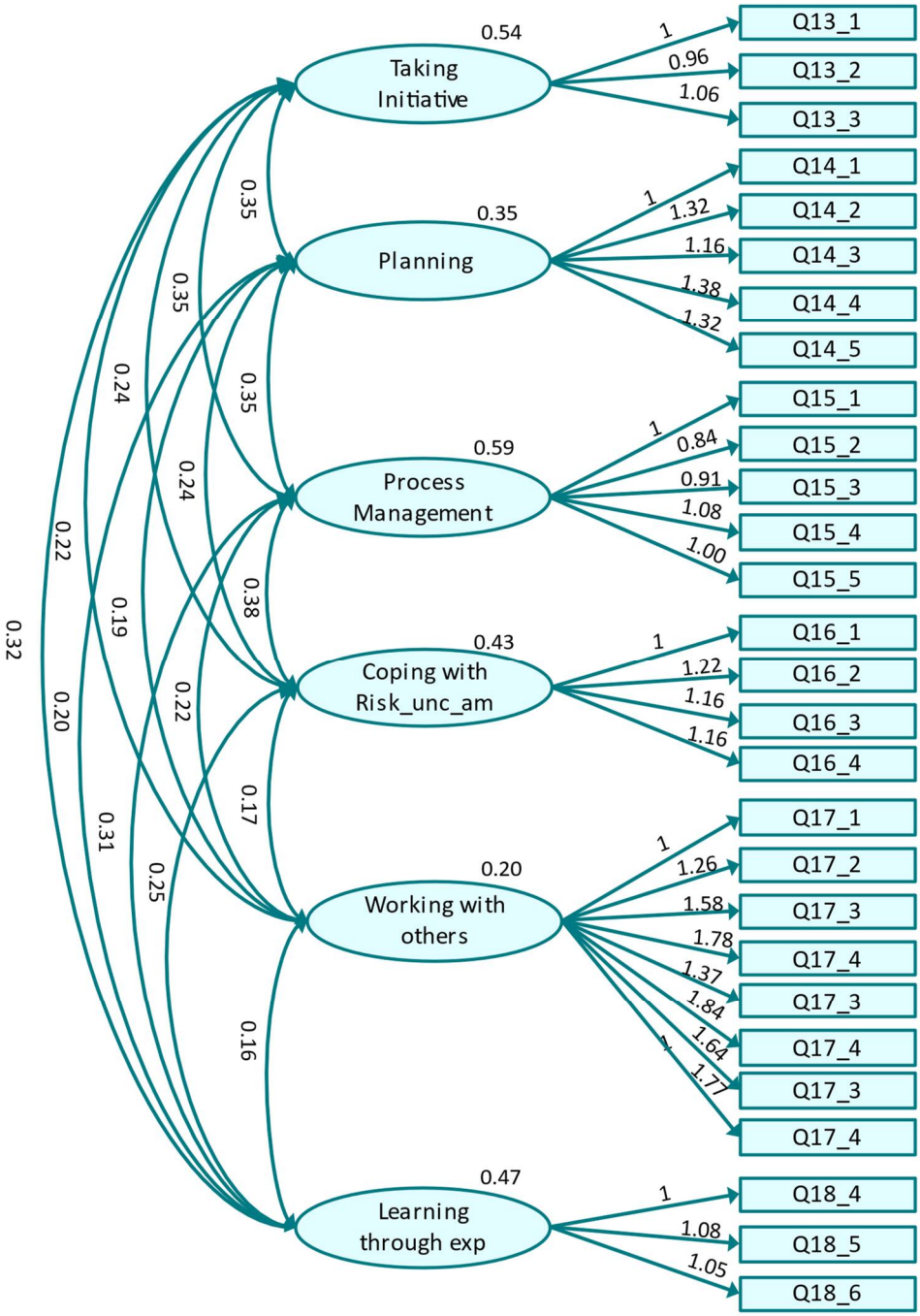

Figure 4. Optimised original path model for domain "Into action".

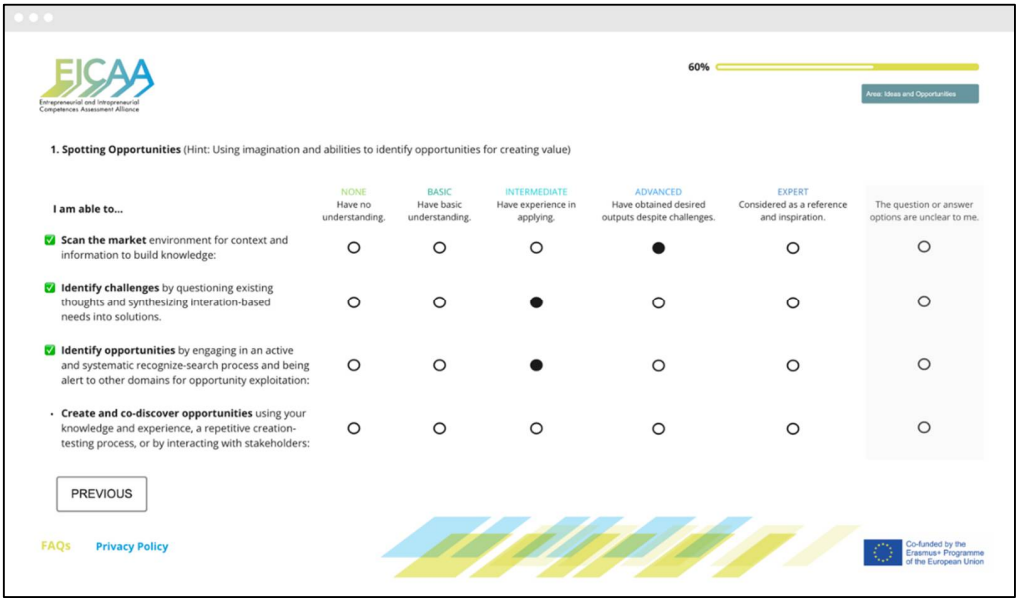

Figure 5. Screenshot of the EICAA Digital Platform with a fragment of the Competence Monitor, as seen by the student/employee.

Figure 6. Screenshot of the EICAA Digital Platform with first pilot tests showing survey performance tracking (see text, Step 1, n.4).

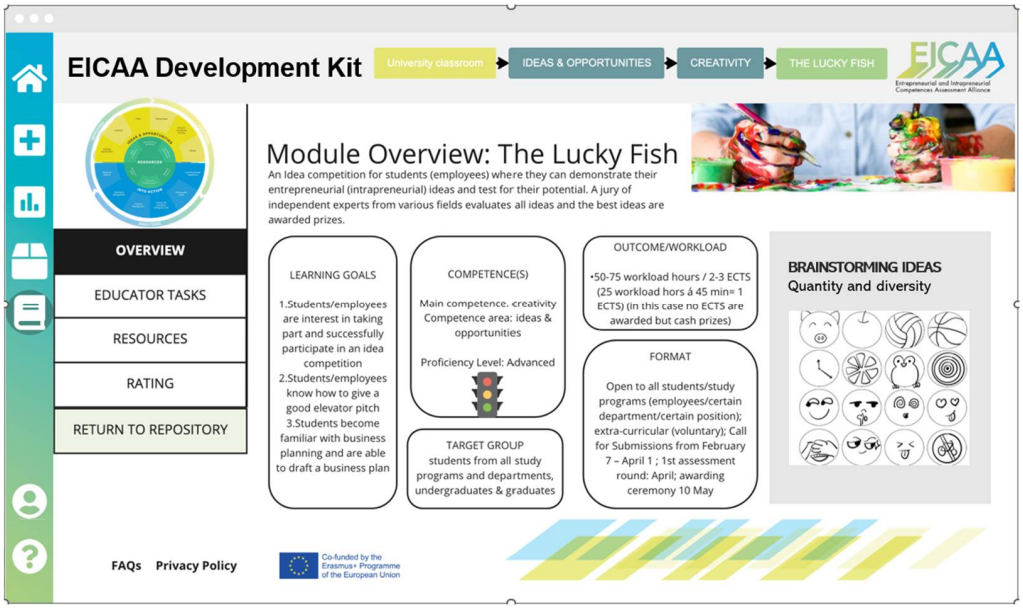

Figure 7. Screenshot of the EICAA Digital Platform depicting the structure of a learning module belonging to competence Creativity (see text, Step 3, n.10).

5. Discussion

The EICAA Digital Platform offers an innovative instrument to facilitate blended entrepreneurship education for higher education teachers as well as those seeking to foster entrepreneurial learning in the corporate sector. By following and carrying out the pathways of EntreComp, it is based on a wide and domain neutral conceptualisation of entrepreneurship. This broad conceptual understanding is also embraced by its two substituent components—the EICAA Competence Monitor and the EICAA Competence Development Kit. Consequently, they have been designed to be applicable to a wide range of disciplines and are beyond the scope of preparing learners to start-up businesses or similar purposes.

The EICAA Digital Platform relies on the identification of the entrepreneurship and intrapreneurship competences collected under the EICAA Competence Framework. The Competence Framework keeps the same structure as EntreComp [21], the reference framework designed by the Joint Research Centre (European Commission), while reducing its complexity to four progression levels, and adding three key competences, namely Design, Digital, and Process management. While the reduction makes the framework more accessible and manageable, the new additions update the framework to the newer trends on entrepreneurship. Particularly, we place a greater emphasis on the current practitioners and teaching practices—a scientific approach to entrepreneurship and agile development—-while keeping the neutrality with respect to any particular entrepreneurship method. EICAA Competence Framework has also been benchmarked with other extant competence frameworks [33–35,43,44], and we ensured that all competences relevant for successful entrepreneurship identified in these frameworks are represented in the EICAA Competence Framework.

The EICAA Competence Framework sets the basis for the definition of a rubric system and, in turn, for the Competence Monitor, a survey for self-assessment of entrepreneurial and intrapreneurship competences. The survey is answered by the individual student/employee and aggregated to the group level and presented to the educator/trainer. Thus, it allows the educator to diagnose the current development of entrepreneurship competences of their group of learners and apply tailored interventions. Adapting teaching interventions to the results of entrepreneurship competence assessment was also reported in a previous case study, although it was restricted to entrepreneurship personality traits and fewer skill dimensions [31]. The EICAA diagnosis tool also allows for enhanced functionalities, such as comparisons of pre–post interventions and/or among different groups.

Furthermore, if we compare it with other cited platforms, we note that EICAA has been set up to enable large-scale applications by allowing the self-assessment of entire organisations (e.g., entire student body of a university), providing a dashboard that delivers an aggregate analysis of all assessment data, and by suggesting suitable education activities to improve entrepreneurial competences.

A potential limitation of the EICAA Competence Framework is its broad approach to entrepreneurship, which consequently results in a broad and general definition of some competences. As an example, one could argue that competence "Ethical and sustainable thinking"—and its translation into the survey items—remains too broad and applicable to any area of life or work. A similar reasoning can be applied to other competences, such as "Motivation and perseverance" (see the Appendix for the detailed list of the survey's statements). The reason behind this approach is to evaluate the competence of the student or learner rather than the entrepreneurial behaviour itself. This, in turn, relies on the conceptualisation of competence as the ability to use knowledge and skills as well as personal, social, and/or methodological abilities in work or study situations and in professional and personal development, as defined by European Qualification Framework (EQF) [41]. Because of this conceptual approach, the EICAA Competence Framework contains competences and competence definitions that are relevant not only to entrepreneurship but also to other areas of life and work. Nonetheless, this might promote a greater acceptance of the Digital Platform in programs and faculties beyond business schools, such as in the humanities. It is also worth noting that the Competence Development Kit is designed with hands-on activities based on the methodological approach of "teaching through entrepreneurship". Thus, despite adhering to a broad conceptual understanding of entrepreneurship in the Competence Framework and in the Competence Monitor, the Competence Development Kit provides opportunities for learners to develop the entrepreneurship competences through experiential learning in real or simulated entrepreneurship scenarios.

The EICAA Competence Development Kit offers a set of stackable learning modules that the educator can use by following the recommendations for the target group or by freely selecting among the set of available modules. Compared with Massive Open Online Courses (MOOCS), the Competence Development Kit provides resources for teachers, educators, and trainers and gives greater flexibility for selection and adaptation to the teaching objectives.

Notwithstanding this, the real benefits that the EICAA Digital Platform may offer can only be evaluated once a series of use cases has been established in different contexts. This is particularly true for applications that are not of large scale and outside the context of higher education. In fact, using the EICAA Digital Platform only for a low number of self-assessments jeopardizes the statistical value of the metrics delivered by the dashboard of the EICAA Competence Monitor as well as of the course/training interventions suggested by it.

To add, the EICAA Digital Platform has been developed as an open educational resource. Its use is cost-free upon prior user registration. It is published under the European Union Public Licence (EUPL 1.2). However, the consortium was not willing to licence the platform entirely as open source, as this would allow the commercialisation of its code by externals. Rather, EICAA makes use of the "commons clause" which serves as a legal wrapper text to EUPL and turns the EICAA Digital Platform into a source-available solution. The prevention of commercialisation of open-source code appears to be an unsolved issue given that there seems to be no ideal licencing model yet strong enough to prevent such a scenario.

Furthermore, the EICAA Digital Platform is GDPR-compliant, which, however, appears to be challenging when trying to collect data of students and/or employees and when the technical infrastructure is not provided by the very organisation running the self-assessment. Apart from the self-assessment of entrepreneurial competences, the EICAA Competence Monitor also asks self-assessment participants a very basic set of demographic questions (e.g., age, gender, and country where university/organisation is located). While large-scale applications are the preferred scenario, use cases that collect only a few self-assessments and, in principle, bear the potential to infringe on the data privacy of

self-assessment participants, cannot be entirely ruled out. Defining a threshold for data volume that prevents such (unlikely) abuse appears to be challenging. Thus, the trade-off relation between guaranteeing data privacy and allowing for a meaningful data analysis is hard to balance when trying to establish a digital instrument such as the EICAA Digital Platform. As a result, innovative digital tools that collect participant data with a good and non-commercial intention behind it are legally challenging to establish. It will need to be reflected whether the current legislation is still sufficiently incentivising the establishment of such digital innovations that are developed as open educational resource.

6. Conclusions

This article presents the EICAA Digital Platform which is aimed at helping educators and trainers develop the entrepreneurial and intrapreneurial competences of their students/employees. It has three main components: the Competence Framework, which sets a taxonomy and a rubric of entre/intrapreneurial competences, the Competence Monitor, a self-assessment survey for learners, and the Competence Development Kit, a set of learning modules for every competence. Within the framework, the user (educator or trainer) can assess the entrepreneurial competences of their group of students/employees, analyse their developmental needs, and apply tailored trainings.

The EICAA Competence Framework and the Competence Monitor have been validated with several samples of students in the five partner universities of the consortium, and it is ready for a massive pilot round of university and business application cases during the winter term 2022/23. This pilot will prove the adequacy of the Competence Monitor and the benefits of the Competence Development Kit in helping educators further develop the entrepreneurship competences of their target group. The pilot will collect feedback from users, which will be synthesized in a public report and will serve to improve the tool and as a case study to inspire other entrepreneurship education programs. Ultimately, the success of this beta round will also serve as an indicator of whether the platform has the potential to substantially grow its user base as well as to keep users using it over time. Following the beta pilot round, the platform will be ready for the open launch and available to any educator or trainer upon free registration.

Beyond all the above-mentioned functionalities, the platform will allow the educators to collect their own data for research purposes. Thus, educators will be able to assess the impact of their own interventions. The EICAA community behind it may also become a valuable point of reference for national and European policy makers, as it offers new data on entrepreneurial competences or learners within and across organisations. As such, the EICAA Digital Platform may also be understood as a proof-of-concept for whether a wider understanding of entrepreneurship is still practical enough to be translated into a clear-cut measurement tool that leads to relevant data about entrepreneurial competences.

The EICAA Digital Platform can become a reference source of entrepreneurship teaching modules that can be enriched with the experiences of the users. Thus, ensuring ways of collecting feedback and suggestions from users will help further improve the platform. Beyond this, future developments of the platform could consider an open collaborative tool where educators and trainers become content creators by including their own teaching designs and resources.

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Appendix A

Table A1 presents the list of items and their match with the competences and threads. The participant needs to answer on a five-point Likert scale where 1 is no proficiency (none) and 5 is the highest proficiency (expert).

Table A1. EICAA Competence Framework and EICAA Competence Monitor (survey items).

Competence Area	Competence	Survey Item
Ideas and opportunities	Spotting opportunities	1. Scanning the environment to obtain relevant information. 2. Identifying challenges by questioning mainstream ideas. 3. Creating opportunities by actively using my knowledge. 4. Discovering opportunities by interacting with others (such as peers, colleagues, mentors, etc.)
	Creativity	5. Challenging the status quo, i.e., questioning the current solutions and ways of operating and providing alternative points of view. 6. Promoting and leading disruptive changes. 7. Solving problems creatively. 8. Generating ideas and developing them. 9. Developing and implementing innovations (product, technology, process, marketing, etc.)
	Vision	10. Developing an inspiring vision for an entrepreneurial idea. 11. Thinking strategically in alignment with my long-term vision. 12. Guiding action by building and implementing an action plan or a to-do list.
	Valuing ideas	13. Developing strategies to assess the value of new ideas. 14. Identifying which stakeholder prefers which value type of a new idea (economic, influence, harmony, etc.) 15. Protecting and sharing intellectual property by using appropriate strategies (such as patents, copyrights, trademarks, agreements, etc.)
	Ethical and sustainable thinking	16. Adopting and promoting ethical behavior when turning an idea into action. 17. Thinking about the sustainable impact of my actions before executing them. 18. Monitoring and assessing the impact of what I do. 19. Ensuring accountability for my actions.
	Design	20. Developing a user-oriented offering. 21. Identifying the needs of relevant target groups 22. Anticipating future needs. 23. Identifying basic functions of a prototype 24. Testing a prototype. 25. Co-creating products, services, or solutions with others.

Table A1. *Cont.*

Competence Area	Competence	Survey Item
Resources	Self-awareness and self-efficacy	26. Following my aspirations by translating them into achievable goals. 27. Identifying my strengths and weaknesses regularly. 28. Implementing a project, even in difficult circumstances. 29. Shaping my future by developing necessary skills.
	Motivation and perseverance	30. Maintaining my focus on long-term tasks. 31. Staying motivated and passionate when realising an entrepreneurial idea. 32. Persevering in the pursuit of my goals, despite difficulties. 33. Showing resilience (staying emotionally well) in the face of adversities.
	Mobilising resources	34. Making the most of limited resources (such as money, people, time, etc.) 35. Acquiring the resources needed to make an entrepreneurial idea successful. 36. Building a network that supports me and my ideas.
	Financial and economic literacy	37. Understanding economic and financial concepts (such as supply and demand, cash flow, and profit and loss). 38. Proactively designing a budget plan 39. Securing funding by raising money from diverse sources. 40. Understanding and complying with the basic mechanisms of taxation. 41. Developing the key processes and actions required to implement an entrepreneurial idea, such as marketing operations, sales, HR, and legal aspects.
	Mobilizing others	42. Seeking inspiration from role models. 43. Inspiring others by maintaining momentum even in adverse circumstances. 44. Persuading others to engage them with an entrepreneurial idea. 45. Developing ethical negotiation strategies 46. Communicating my message clearly and effectively. 47. Developing effective media (social and other) strategies to mobilise others.
	Digital management	48. Knowing when and how to use general digital tools (MS Office, virtual communication, etc.) best suited for my purpose. 49. Employing complex digital tools (CRM, web analytics, etc.) to grow an entrepreneurial idea. 50. Reporting data in meaningful and clear ways like graphs and charts. 51. Ensuring own and others' safety against cybersecurity risks through protective measures (e.g., anti-phishing guidelines, malware protection, etc.)

Table A1. *Cont.*

Competence Area	Competence	Survey Item
Into action	Taking the initiative	52. Taking responsibility while performing tasks. 53. Working independently when required. 54. Initiating action on new ideas and opportunities.
	Planning and management	55. Defining clear and achievable goals. 56. Planning and organizing carefully to make an entrepreneurial idea successful. 57. Defining priorities for tasks, even in uncertain circumstances. 58. Developing a sustainable plan of action for an entrepreneurial idea.
	Process management	59. Monitoring progress by using appropriate metrics. 60. Redirecting my plans when necessary. 61. Being flexible and adaptive to changes. 62. Anticipating team changes and being able to respond to them. 63. Working agilely by planning short-term and achievable goals and adapting my plans according to my results.
	Coping with uncertainty, ambiguity, and risk	64. Coping with uncertainty, ambiguity, and risk. 65. Calculating the risk versus the benefit of an entrepreneurial idea. 66. Developing risk management strategies for an entrepreneurial idea. 67. Testing and refining the key assumptions underlying an entrepreneurial idea.
	Working with others	68. Promoting the diversity in my team by being open to different profiles and points of view. 69. Developing and displaying emotional intelligence. 70. Listening actively to my users and other relevant stakeholders. 71. Building a team with balanced and complementary skills. 72. Working with others structurally and harmoniously. 73. Developing emotionally positive relationships with project partners (including mentors, investors, etc.) 74. Expanding my network proactively.
	Learning through experience	75. Reflecting on and learning from failures and achievements. 76. Actively engaging with opportunities to grow on my strengths and reduce my weaknesses. 77. Learning from my or others' prior experiences.

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Article

Internationalisation of Teaching and Learning through Blended Mobility: Potentials of Joint International Blended Courses and Challenges in Their Implementation

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Abstract: Blended Mobility formats such as joint international blended courses have the potential to enable more students at universities and other HEIs to gain international experiences in the course of their studies. They enhance transnational cooperation in the European Higher Education Area by building bridges at the crossroads of education, research, innovation, serving society and economy. In this article, the authors reflect on their experiences in the conception, planning, organisation and implementation of a joint international blended course between Freie Universität Berlin and Universidad Complutense de Madrid in the field of sustainable development in the summer semester of 2022. The course was offered within the framework of the Erasmus+ KA3 project "Online Pedagogical Resources for European Universities" (OpenU project).

Keywords: blended mobility; international learning; joint international blended courses; sustainable green and digital transitions; OpenU

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1. Introduction

The Erasmus+ KA3 project "Online Pedagogical Resources for European Universities" (Acronym OpenU, Ref. 606692-EPP-I-2018-2-FR-EPPKA3-PI-POLICY) is a consortium of European universities seeking to support international blended learning, mobility and networking in Higher Education Institutions HEIs in Europe. It, therefore, addresses two fundamental aspects that can contribute to strengthen long-term strategic and structural cooperation between European HEIs: innovative solutions for the internationalisation of educational practices, strengthening university alliances and contributing to the transferability of innovative models, and joint agendas for incorporating sustainable development.

Within the OpenU consortium, Freie Universität Berlin (FUB) and Universidad Complutense de Madrid (UCM) have developed a joint experimentation project seeking to expand the internationalisation of teaching practices in both universities and to fill a methodological gap in the inclusion of sustainable development within the internalisation of the teaching agenda of Higher Education. The following lines present the challenges found in the implementation of the project as well as its achievements.

The paper is divided in various sections that present internationalisation policies in FUB and UCM, the context of sustainable development in Europe, the methodology used in the implementation of the international joint blended course, the results achieved, their possible implications for transference to other institutions, as well as some final recommendations and conclusions.

1.1. Internationalisation

As international network universities, FUB and UCM offer all students the opportunity to prepare for a life in a globalised world and workplace, and a chance to experience the

value of transnational cooperation and intercultural encounters. This is mainly reached through the continuing internationalisation of the formal curriculum as well as informal kinds of learning. While FUB and UCM include programmes that involve physical mobility, opportunities are extending to meet the needs of a diverse student population through innovative, participatory, digital scenarios for teaching and study, including virtual and blended mobility [1]. In this regard, both FUB and UCM have a strong strategic interest in further developing digital learning and teaching formats within the framework of the Una Europa alliance in order to offer partners new exchange opportunities and, thus, create new opportunities for internationalisation. The research conducted is intended to make a strategic contribution to the "European Universities" initiative and the internationalisation strategies of both universities.

A large proportion of students are interested in gaining international experience as part of their studies; however, for a variety of reasons, they do not always have the opportunity to participate in long-term physical exchange programmes. Blended Mobility (BM) has the potential to offer all students the opportunity to gain international experience in a flexible, inclusive, and innovative way: it combines joint online teaching and learning phases with periods of short-term physical mobility at one or both partner universities. Through the online exchange with international students and teachers, students who, for instance, do not have time to participate in a physical exchange programme, can still gain international experience. At the same time, they can participate in a physical short-term mobility at their international partner university, which increases the motivation for long-term participation and cooperation. The face-to-face exchange again can be made more sustainable through digital preparation phases and follow-up communication. Brief: BM provides easier, low-threshold access to international encounters through digital exchange and, at the same time, creates incentives for long-term student motivation and participation through physical short-term mobilities. However, the effort required to implement BM formats is not insignificant and there are numerous challenges that need to be addressed at an organisational, technical and policy level, to foster their development and implementation at HEIs.

The experimentation carried out between FUB and UCM aimed first and foremost at identifying challenges for teachers and teaching support services in designing, planning, organising and teaching an international joint blended course. These courses are usually taught by two or more teachers from different partner universities, alternating their teaching or simultaneously teaching in tandem, and involving two or more student groups from the respective universities. Another goal was to determine the motivation of students to participate in a blended international course, as well as the course's potential in enabling students to gain international experiences. Furthermore, the experimentation was to help determine which requirements need to be placed on the joint European digital hub, which is to be developed within the framework of the OpenU project: BLOOM. Possible aspects include joint teaching online tools, access to shared teaching materials, online communication, and collaboration between student groups from different international universities or tools for flexible online communication exchanges. Finally, the experimentation also sought to explore which policies would need to be adapted at HEI and European level in order to foster the development of joint international blended courses. Our findings are of particular value for the development of future blended mobility formats, not only in the context of the Una Europa Alliance but also within the European Higher Education Area as a whole.

1.2. Sustainable Development in the EU Context

In the last decade, Higher Education Institutions were looking for ways of enhancing the connections between curricular activities and sustainable development. On 22 November 2016, the EU presented its response to the United Nations 2030 Agenda [2–4] and adopted a set of priorities for sustainable development [5,6]. Among the decisions adopted, and in line within SDG 4 [7], target 4.7 [8], educational institutions should make sure that:

All learners should have acquired through education the knowledge and skills needed to promote sustainable development, including, among others, sustainable habits and lifestyles, knowledge with regard to the defence of human rights, gender equality, the promotion of a culture of peace and non-violence, an appreciation of cultural diversity and for culture's contribution to sustainable development [8].

However, these reports and indicators recognize that there is an urgent need to strengthen the introduction of sustainability in education across world regions [3,4].

The experimentation presented in this paper defends that the contribution of cultural products to sustainable development needs to bridge STEM and STEAM disciplines (Science, Technology, Engineering, Arts, Mathematics). The main reasons behind this claim are related to the fact that many of the soft skills required in sustainable development come from areas within the Social Sciences and Humanities. A STEAM approach can help students access science concepts from different vantage points, promoting creative thinking, and enhancing commitment and understanding.

Many of the 17 Sustainable Development Goals (SDG) within the United Nations framework cannot be measured only in terms of economic value. Instead, they require opportunities and ideas to be transformed into value for others. The created value can be financial, cultural, or social. This way of measuring value in terms of quality is characteristic of the Social Sciences and Humanities (SSH). The introduction of soft skills [9–11] and responsibility in research and innovation addresses wider social impact challenges on sustainable development [12], marked also by the MoRRI indicators [13], aligned with issues related to social value [14] and Responsible Research and Innovation RRI [15].

Additionally, the UN resolution on Creative Economy for Sustainable Development highlights the sector as an important tool for the attainment of the Sustainable Development Goals (UNCTAD) [16]. According to recent forecasts, the creative economy is one of the most rapidly growing sectors of the world economy; in particular, concerning income generation and job creation [17]. It will represent around 10 percent of global GDP in the years to come [18,19]. Creative economy also generates non-monetary value that contributes significantly to achieving people-centric, inclusive and sustainable development [20]. As noted, this value comes from areas related to SSH education and requires a systemic approach that connects individuals, in this case students in Higher Education Institutions, with endeavours in art, design, culture and heritage, within sustainable development.

2. Methodology: Experimentation Description

The aim of the FUB-UCM experimentation was firstly to gather experience on the practical implementation of joint international blended courses. The authors wanted to answer questions such as: What difficulties can arise in joint planning of a blended course? How can teachers be supported in the planning and implementation? Secondly, the authors wanted to collect data on students' perspectives on joint international blended courses, including the motivation for their participation, the perceived potential of the course to facilitate international learning, perceptions of the course concept, etc. Lastly, the authors wanted to learn more about teachers' perspectives, e.g., what incentives and support do teachers want when creating and designing their joint international blended teaching? What challenges do they see in planning and implementing the course? etc. In order to find answers to these questions and to collect data, the authors gathered experience during the implementation of the joint international blended course and conducted two surveys of the participants at the end of the semester.

2.1. Implementation of the Joint Blended International Course

In order to attract participants to the experimentation, the OpenU project manager/E-Learning consultant from the Services for Teaching and Learning of the University Library of the FUB issued a call for proposals. The call was advertised at various information and networking events, as well as in training courses at the FUB. In the case of UCM, the call was e-mailed directly to all teaching staff by the Vice-Chancellor of Technologies and

Sustainability, who was also responsible for the overall coordination of OpenU at the UCM. In the end, two very motivated and engaged teachers from FUB and UCM were ready to offer a joint blended course in the field of "Sustainable Development" in the summer term 2022: Dr. Berthold Kuhn from FUB and Dr. Asun López-Varela from UCM. Dr Kuhn is a political scientist and works as a private lecturer at the "Otto-Suhr-Institut" and at the "Sustainability & Energy Unit" of FUB. Asun López-Varela is Assoc. Prof. at the Facultad Filología of Universidad Complutense de Madrid.

In July 2021, the requirements for a joint international blended course were discussed between FUB's OpenU E-Learning consultant and the Academic Coordinator for Sustainability (in) Teaching at the "Sustainability & Energy Unit". The number of course places available for FUB students was reduced to 15 instead of 30, in order not to increase the supervision effort due to the additional group of max. 15 students from UCM. It was agreed that access to the course should be as prerequisite-free as possible, as it primarily aimed at undergraduate students. Furthermore, as teaching and learning activities, the course had to include project-based collaboration and work in student groups.

More detailed planning for the course started in October 2021. The Academic Coordinator for Sustainability (in) Teaching and the OpenU E-Learning consultant together with both teachers, elaborated a framework for a possible teaching cooperation in the summer semester 2022, which included, i.a., the following aspects: How many online sessions and how many face-to-face meetings should be organised and when? How to deal with different ECTS requirements at the two universities? Which funds could be applied for in order to finance the physical short-term mobilities? Do the student groups match each other in terms of prior knowledge and fields of study?

The reasons for planning only one face-to-face phase at the FUB were, i.a., the only slightly overlapping lecture/semester times of FUB and UCM, especially in the summer semester: shared lecture period from 25 April to 10 May, including the exam period at UCM until 8 July 2022. In addition, the OpenU E-Learning consultant at FUB was only eligible to apply for funding for the internationalisation of teaching at FUB. In order to cover the travel costs of the FUB students to Madrid, it would have required either a longer period of presence at the UCM of at least 5 days in order to apply for funds for blended mobility, or the initiative of Madrid to apply for funds for the internationalisation of teaching at UCM. Eventually, funding was applied for from the Una Europa Early Career Host Programme to support joint teaching events at the FUB with partner universities of the Una Europa University Alliance [21]. These funds were intended to cover the travel costs to Berlin of a maximum of 15 UCM students and the teacher, Ms López-Varela. The administration of the reimbursement of travel expenses and the extensive communication with the UCM students were taken over by FUB's OpenU E-Learning consultant in cooperation with the Una Europa project coordinator.

Mr. Kuhn and Ms. López-Varela drafted the joint teaching concept, starting in February 2022. With the working title "Global Perspectives in Sustainability Transitions", the seminar sought to introduce the concept of sustainability and the 2030 United Nation Sustainable Development Goals from an interdisciplinary STEAM perspective. Thus, it included different approaches from various academic disciplines in working with sustainability concepts. As mentioned, sustainable development requires an integrated bottom-up approach that looks at the full spectrum of scales, networks, states, and shifts. The students gained knowledge on the UN framework which includes the 17 SDGs with specific sessions focusing on the following three pillars:

- Pillar 1. Social Progress and Health, including SDGs 1 to 7 as well as SDG11 and SDG16.
- Pillar 2. Economic growth and Circular bioeconomy, including SDGs 8 to 10 and SDG12.
- Pillar 3. Climate change, life underwater and life on land, including SDGs13 to 15.

They also learnt how sustainability is being approached by the general public of non-specialists, appearing, for example, in cultural representations that include art and literature.

The learning experience was centered on the students and their individual approach to sustainable development. Therefore, part of the online sessions was conducted in a flipped

classroom format, where students were to explore a topic or activity before class, ranging from UN reports, to videos, books, graphic narratives and cell-phone APPs about particular initiatives to help sustainability [22], and then share their findings with their classmates in an informal way during the online sessions, focusing on each of the pillars discussed.

The international joint blended course was designed on a semiotic basis: sustainability was explored moving upwards to the social level, in relation to initiatives taking place at the students' respective universities, their families, larger communities, regions and countries. Thus, alongside the theoretical introduction to the 17 UN Sustainable Development Goals (SDGs), this systemic approach involved careful attention to students' individual responses to their surrounding environments. It took into consideration the values they attached to things within their physical/perceptual/material realms, the forms in which these things acquired meanings, qualified and quantified, and were made sustainable. Finally, the social concerns that emerged when these aspects were also discussed and considered, both online and face-to-face in joint group interaction during the blended mobility exchange.

At the FUB, the course was offered as a "General Professional Skills Course" at the "Sustainability & Energy Unit". These courses are geared towards the acquisition of practice-related skills. They are part of all Bachelor's degree programmes at FUB: students usually have to acquire 30 ECTS of their undergraduate studies with courses from the General Professional Skills area. FUB students received 5 ECTS according to their learning and workload in the blended course. UCM students took the course complementary to their study programmes. In Complutense, undergraduate students can acquire up to 6 ECTS in extracurricular activities and classes. According to UCM regulations, since the course had a blended learning format, they were entitled to receive 2 ECTS. They did not have to take a final exam in the form of a poster presentation of a sustainability project at the end of the semester like FUB students.

While at the FUB undergraduate students from all disciplines were eligible to attend the course, at UCM, undergraduate students from the Faculty of Philosophy who had already taken a preliminary course with Ms López-Varela could participate. All students were admitted on a "first come, first served" basis and no official proof of English language proficiency was required at either university. A total of 14 FUB students from different degree programmes enrolled in the course. From UCM, 13 students participated, with the majority enrolled in the BA study programme "English Studies". During the course, the number of participants from UCM decreased to 11, due to exam coincidences at the end of the semester.

The course started with an online phase on 25 April 2022, taking place each Monday from 10 to 12 a.m., ending with a face-to-face phase at FUB between 8–9 July 2022. The course included 8 online sessions (total 12 h) and 2 face-to-face sessions (total 12 h), along with Q/A sessions (total 4 h). The online sessions were conducted using the FUB's video conferencing tool, Cisco Webex. UCM students did not need a separate FUB account to participate in the live online sessions but could participate via browser. Moreover, a blackboard course (LMS) was created for the course, which was mainly used for announcements by the teachers. To use Blackboard, UCM students needed their own FUB account. After confirming their accounts, students had to be manually added to the course in the LMS.

2.2. Student and Teacher Survey

The student survey consisted of 22 closed and 10 open question items on the topics "Seminar content", "Media didactics" (e-learning) and "Teaching skills". Under the section "Seminar content" the survey was to determine, i.a., the relevance of the international aspect of the course for the students' motivation and satisfaction. Moreover, the authors wanted to know whether the blended course, from the students' perspective, had the potential to provide international experiences and enable international learning in addition to acquiring subject-specific or methodological knowledge. International learning refers to the further development of intercultural and diversity competences; for instance, by getting to know different academic perspectives and approaches to the same subject, which

may vary from country to country. Furthermore, the survey aimed to determine whether the blended international teaching format could act as a steppingstone to physical mobility. Under the section "Media didactics" the survey should identify the students' perspective on the design of the blended course with questions about the blended course concept, the perceived balance of online and face-to-face as well as synchronous (i.e., live online sessions) and asynchronous (i.e., self-study, self-organisation) phases, and about the cooperation and communication with the students from the partner university during and outside the online sessions. Under the section "Teaching skills", the survey was intended to identify how students viewed the teaching concept and methods to determine what forms of facilitation and support the students would have liked from the teachers. All the individual questions of the survey and the students' answers can be found in the Supplementary Materials.

In order to achieve the highest possible response rate, the evaluation was scheduled in the last face-to-face meeting. The students received a PDF with a QR code and token (password) as well as a link to the online evaluation form. They were asked to take 10 min to answer the questionnaire and to consider the open questions as constructively as possible, i.e., clearly formulated, appreciative and with concrete alternative suggestions if something was critically assessed. The absent students received the evaluation by e-mail. They had until 31 July 2022 to complete it.

The quantitative part of the questionnaire was analysed and processed by the "Sustainability & Energy Unit" at FUB with the programme "Unizensus", the central evaluation software of FUB for teaching and course evaluations (see Supplementary Materials). The qualitative part was analysed and summarised by the authors. The student survey had a response rate of almost 100% (24 out of 25 students); the usual average response rate of students in FUB's elective courses is 30%.

The student data collected in the survey with Unizensus were not personal. It is, therefore, not possible to draw conclusions about specific survey participants from the collected data. All participants were informed that anonymity is assured and that their answers help to ensure or further develop the quality of teaching and study at FUB. Their participation was voluntary and there were no consequences for those who did not answer. In compliance with the European Regulation, specifically the General Data Protection Regulation (GDPR) applied to research in humanities and social sciences, the survey was conducted anonymously. This was guaranteed by various measures, e.g., the allocation of tokens (passwords or access to the online evaluation) or the anonymisation of handwritten comments in printed questionnaires.

To better identify the needs of the teachers regarding the planning and implementation of the course, they were asked to answer a qualitative questionnaire in the end of the semester with ten open questions on the topics of "planning and designing of the course", "blended course concept" and "student participation" via the ARS/evaluation tool Votingo. The focus was on perceived barriers to planning and teaching a joint international blended course, incentives that would facilitate the implementation of such courses, digital tools and support services that teachers would like to have for the implementation and a reflective engagement with their own course concept and teaching methods. The survey was analysed and summarised by the authors. It had a response rate of 100%.

3. Results and Discussion

3.1. Challenges in the Joint Planning of the Blended International Course

A major challenge in the planning was to find teachers who would be interested in a blended teaching cooperation in the Una Europa University Alliance and who would be willing to invest time in designing and planning a joint course. This may have been concerned with a certain 'digital fatigue' among the teachers who, after four semesters of mainly teaching online courses because of COVID-19, wanted to get back to campus and teach face-to-face again. The only slight overlap in lecture times between the FUB and other Una Europa universities, especially in the summer semester, also made it difficult to hold joint courses. Finally, the considerable extra effort required to plan a joint international

blended course should be mentioned as a possible reason for the lack of interested parties in the experimentation: Especially without prior contact and experience in tandem teaching, the design of a joint course or course requires more time to discuss learning objectives, create a syllabus, apply shared teaching methods, etc.

Ideally, the extra coordination and communication effort required for the joint planning of an international blended course should be balanced by less synchronous teaching/lecturing time and/or moderation time due to the second teacher. However, in this experimentation, more planning and coordination effort was necessary. The effort for supervising and examining students remained more or less the same as for regular courses, as each teacher was only responsible for his/her own group of students.

It is advisable to discuss the framework conditions and basic requirements for an international blended course with the course planner and the head of the respective department before planning a course to include course requirements, specifics of the subject area, strategic goals, etc. Strategically, it also makes sense to talk to the department heads about their interests and needs for digital, international teaching cooperation right from the start. The heads have better contact with the teachers, which can significantly increase the likelihood of feedback.

Planning a joint international blended course requires increased effort and the need for structured preparation (more than regular seminar planning). Early consultation with partners is, therefore, important: ideally, this occurs at least half a year before the planned start of the course, one year before is even better. A joint communication medium must be found for the planning: it is a good idea to create a shared document or wiki for the teaching concept, which the actors involved (teachers, teaching planning, e-learning, etc.) can access in order to always find information in one central place. Regular contact and communication between the teachers are indispensable for the planning process. If the teachers do not know each other from previous contexts, it may be advisable at the beginning of the cooperation to initiate and moderate the meetings from the project/teaching planning side. Factors in planning a joint blended course include:

- Financial framework: Identification and calculation of available funds and funds to be raised, application for funding
- Available time frame: Determine the start and end of the project, consider possible constraints through fixed dates such as the course of a semester, draw up a milestone plan with buffer zones and deadlines.
- Personnel capacities: Clarify responsibilities and division of tasks with the teaching partner; if applicable, include student assistants or research assistants
- Support from services for teaching and learning should be asked for at the beginning of the planning process and at important points during the project
- Technical aspects: Clarify the technical and E-Learning infrastructure at own and partner university and decide early on which systems you want to use

When designing a joint course, it is important to first discuss the content, objectives and learning goals together with the partner teacher. The content of one's own course should be expanded with the help of the other teacher's offerings and jointly developed beyond the original course content. In doing so, a certain openness to new orientations of one's own course should be demonstrated. The following questions can help in the beginning of the designing phase:

- Which (learning) tasks are suitable to support learners in acquiring competences through self-organised and cooperative forms of learning?
- Which forms of assignments and examination are best suited for working on these tasks?
- What information must be made available to the learners so that they can work on the tasks?
- Which information should they work out themselves and, if necessary, also make available to other course participants?
- Which learning tasks and information should be combined into learning units?

- What organisational and procedural plan, i.e., what learning scenario does this combination of learning tasks and forms of work suggest?

Next, the structure of the course must be determined together: The overall sequence of the course and the sequence of the learning units must be determined, as well as the alternation of asynchronous and synchronous learning phases: successful digital learning requires asynchronous collaboration on assignments as well as synchronous communication for exchange with teachers and peers. Synchronous meetings/presentations are useful at the beginning of the course to clarify the objectives and to reduce fear of contact between students. Expectations and requirements of students should be defined and aligned. The preferred social form should be international group work, i.e., self-organised, mixed international learning groups working cooperatively on selected learning assignments and seminar topics to enable international learning. Attention should be paid to a fair distribution of work between students, and a realistic amount of time should be considered for processing. Teachers should not rely on communication between students running by itself. There should always be occasions for communication. Jointly established rules for communication can prevent misunderstandings.

Teachers should also be comfortable with the technical resources needed to implement their learning scenario. Likewise, media that are widely used among students should be used whenever possible. Finally, the examinations must be determined: In joint international blended courses, the final examination can take place at the respective university.

3.2. Student Survey

3.2.1. "Seminar Content": Internationalisation

In addition to the professional introduction to the topic of sustainability development and SDGs, for most students, the exchange with an international group of students was the main motivation for their participation in the course. As expected, the UCM students additionally indicated the physical short-term mobility in Berlin as a major reason.

> I joined the curse [sic!] for two reasons: first, to continue participating in inter-university projects, and second, to have a chance to travel to Germany. My expectations were fully met since I was looking forward to a project that would emphasise teamwork (as well as individual participation and investigation) in relation to sustainability. Of course, the prospect of a trip was highly motivating and made me work even harder than if there had not been a "reward" of some sort.
>
> (Supplementary Materials, p. 2)

However, many FUB students, though not travelling to Madrid, also gave the exchange with UCM students as a reason for their interest in the course. Comparative studies would be necessary to determine whether the physical short-term mobility at the partner university is the main reason for students to participate, or whether international exchange is the main focus, i.e., whether pure online courses with an international partner would have a similar appeal. Some students stated that they had taken part in the course to practise their English language skills. The international exchange with the students of the partner university was also mentioned as the most positive aspect of the seminar, closely followed by the simulation game, which was conducted on-site at the FUB campus.

In order to determine whether the course facilitated international learning, the students were asked whether they had been able to get to know different cultural or national perspectives on the topic of sustainability: 75% of students claimed that this statement fully applies and 20% said that it applies. Students should also indicate, how they had or had not benefited from the participation of an international group of students and from being taught by two international teachers. The main advantage of having a group of students from an international partner university in the course was said to be the different experiences, perspectives and backgrounds of the participants, which often led to interesting discussions.

> Treating with people from different countries is, I feel, essential to understand that we are not that different after all and that it simply requires more time to understand another point of view that may even challenge ours, but it always leads to growth.
>
> (Supplementary Materials, p. 4)

As a benefit of an international teaching tandem, the students mentioned above all the different subject perspectives and academic cultures, in addition to the different teaching methods. No disadvantages were mentioned here. More comprehensive quantitative studies would, of course, be needed to determine the extent to which certain blended international courses could increase intercultural and diversity competences.

About half of the participating students had not participated in a physical exchange before the course. A total of 90% of all students claimed that the statement "After attending the course, I am more in favour of participating in a physical exchange program." fully applies, while the remaining 10% stated that this statement applies. In particular, students can imagine participating in a physical exchange programme at UCM or FUB: 85% said that this fully applies, 15% answered that this applies. This shows that blended international courses can contribute to students being more likely to consider a physical exchange.

3.2.2. "Media Didactics": Blended Learning

Most students liked the blended format, which they would prefer to purely online formats in the future. A total of 25% of the students would prefer hybrid formats for future international teaching collaborations, i.e., part of the teaching is on-site, part is digitally connected. As expected, the majority of students would have preferred a second face-to-face phase at the UCM, so that FUB students could also have a physical short-term mobility. This critique is particularly important because an imbalance in the physical mobility flow in a blended course could lead to a motivation gap among students, i.e., students who are allowed to travel to the partner university have an additional incentive for high participation and investment of work, which is lacking in the other student group. Some students would have liked to have a longer face-to-face phase at the FUB, because the participation of all students was higher and communication among each other as well as cooperation was better on-site. In addition, the students would have liked to have more time to get to know each other personally or to run more simulation games.

Most students liked the balance of synchronous (weekly online sessions) and asynchronous (i.e., self-study, self-organisation) phases during the online cooperation phase. There were no digital tools that were missing for the students, i.e., the learning management system of the FUB, Blackboard, and the video conferencing tool, Cisco Webex, were perceived as sufficient for teaching, learning and communication. However, it was critically mentioned that there had been no joint digital platform, so that the UCM students had to be manually entered into the LMS by the support of the FUB and students had to confirm manually.

The cooperation and communication with the students from the partner university during the online sessions was perceived as unbalanced: the majority of students stated that student participation in discussions varied greatly and that only a few students, especially from UCM, participated in joint discussions during the online sessions. At the same time, all students confirmed that the teachers encouraged the communication and collaboration between the students (Supplementary Materials). The reasons for the lower participation of FUB students, therefore, could lie in the aforementioned motivation gap due to the lack of the incentive of a physical short-term mobility in Madrid. The Academic Coordinator for Sustainability (in) Teaching of the "Sustainability & Energy Unit" saw the fact that the course at the FUB was offered as a "General Professional Skills Course" for undergraduate students as a further reason for the partly lower motivation of the German students. Commitment and participation would usually be lower in these courses compared to the regular study programme.

3.2.3. "Teaching Skills": Teaching Concept and Methods

Most students found that the learning objectives were clearly formulated at the beginning of the course (85%) and consistently implemented throughout the semester (80%). A total of 90% of the students claim that the teachers explained in an understandable way. Students liked that the seminar was interactive, participative and that students could work together in groups.

Several students expressed the wish for clearer instructions and work assignments, as well as more guidance from the teachers during the work phases. Some students would have liked more structured lectures and fewer student presentations. Others wished for more organisation and clearer expectations for the course and its requirements. In order to increase student participation, it was suggested, for instance, to have group work during the online sessions, with teachers facilitating and giving input during the work phases.

3.3. Teacher Survey

To determine the reasons for teachers' engagement and participation in the project, they were asked about their perceived potentials of international online and blended teaching:

1. Diverse online and face-to-face inputs from different disciplines and from different countries and regions would increase motivation and competencies of the students
2. Joint international online teaching would meet the requirements of the EU Commission Council Recommendation on building bridges for effective European higher education cooperation [23,24]
3. Joint international online teaching would meet the EU target that, by 2030, at least 45% of 25–34-year-olds obtain tertiary level attainment [25]
4. Universities would have a unique position at the crossroads of education, research, innovation, serving society and economy [26].
5. Joint international online would have the potential to strengthen the flow of knowledge also in research and innovation, enhancing transnational cooperation, creating a more inclusive and connected Higher Education, and helping build resilience and global competitiveness of European higher education system [27].
6. There would also be opportunities to maximise Europe's global influence when it comes to values, education, research, industry and societal impact, helping universities become lighthouses of the European way of life and reinforcing universities as drivers of the EU's global role and leadership.
7. Joint international online teaching could empower universities as actors of change in the twin green and digital transitions.

Moreover, the survey was to identify possible explanations for the few applications for international digital teaching collaborations. The following were cited as challenges in implementation of joint international online and blended teaching formats:

1. alignment of policy priorities and investments at EU, national, regional and institutional levels
2. the elimination of legal and administrative obstacles to international strategic institutional partnerships
3. structural and operational issues that include
    a. possible incompatible requirements
    b. diverse temporal frameworks
    c. different syllabuses that prevent the execution of programmes as well as the award of joint evaluations
    d. admission and enrolment criteria of students and lifelong learners
    e. defining the languages of instruction
    f. inclusion of flexible learning pathways
4. new instruments and legal frameworks for alliances
5. funding of universities is often insufficient to fulfil their growing societal mission. Additional funding is needed to help in fostering synergies [28].

6. significant disparities in digital skills across the EU must be overcome
7. quality assurance procedures, impact assessment European Quality Assurance and Recognition System needed.
8. similar infrastructures (e.g., in digital tools) should be in place

Teachers were also asked to identify possible incentives that they felt were needed at the departmental and/or university level to enable more joint digital, international teaching-learning formats to be offered in the future:

1. adequate compensation for extra time needed to engage in communication and exchanges with university administrations at different levels
2. recognise in their career assessment the time spent by academics in the development of new innovative pedagogies through transnational cooperation
3. adequate financial support
4. economically valorise a teacher's time in these activities, or else recognise them as part of their teaching workload
5. support online as well as face-to-face interactions, including short mobility exchanges.
6. ensure flexibility in funding programmes to allow for interdisciplinarity
7. administrative and tech support from higher education institutions
8. joint digital strategies and shared interoperable IT infrastructure
9. training and support services
10. seamless access to findable, accessible, interoperable and reusable (FAIR) data and other interoperable services
11. support capacity building for strong and effective leadership in implementing joint ventures

When asked what they think were the biggest challenges in the joint planning and designing of the course (before the semester), Mr. Kuhn indicated the different academic calendars between the international partners. In his opinion, this could be improved via communication and flexibility of students and administration. Another challenge was making teaching frameworks compatible in participant institutions and design common evaluation proposals for students. In both cases, higher management structures were involved, which made the process more complicated.

The teachers were also asked to indicate what they enjoyed about teaching together with their international partner and what challenges they encountered during the semester. Ms. López-Varela expressed, that it was interesting to learn how things occurred in the partner university, and that the major challenge was concerned with the timing of activities in the course. Mr. Kuhn stated that the different subject perspective of the partner teacher was very enriching, but that communication and administrative issues had taken up a lot of time.

Both teachers stated that they did not need any further digital tools for the joint curriculum/course planning or for the online teaching activities, implying that the available e-learning infrastructure of the FUB, specifically the LMS Blackboard and the videoconferencing tool Webex, were sufficient for their purposes. Mr. Kuhn though would have preferred the use of a shared digital/e-learning infrastructure in order to avoid an extra effort for getting a group of students used to the digital infrastructure of the partner university.

According to the teachers, there was also no particular need for support from the different support services at the university regarding the planning and the teaching of the course. However, it should be noted that the Academic Coordinator for Sustainability (in) Teaching at the "Sustainability & Energy Unit" as well as the OpenU E-Learning consultant of the FUB intensively supported the teachers in planning the course, especially in working out the framework conditions of a joint international course. In addition, the Una Europa project coordinator of the FUB supported the management of the physical short-term mobilities of the UCM students.

The teachers did not use specific teaching methods, concepts and/or formats to enable international learning. Cooperation among students was principally facilitated through mixed group work, whereby the students were largely given a free hand in group composition and working together. Ms. López-Varela stated that she would have used

inverted/flipped classroom methods. With more time, she would have liked to introduce problem-solving activities using Design Thinking methodologies, for she thinks this is the future of higher education.

The teachers were asked how they rated the participation and motivation of students in the course and, if applicable, what reasons they saw for lower participation/motivation of specific students: The participation and motivation of the Spanish students was in general perceived to be higher. A possible reason for this mentioned was the incentive for the Spanish students to be able to travel to Berlin as part of the attendance phase of the course, with their travel costs being covered. In addition, UCM students were made aware that the physical short-term mobility in Berlin would require their active participation during the online sessions. Therefore, both teachers recommended having two attendance phases for future blended teaching cooperation: one at the beginning of the cooperation at one university, the second at the end of the cooperation at the partner university. Students would be more motivated to collaborate and communicate when they have met in presence. In Mr Kuhn's opinion, ECTS and certificates would provide the best incentives for students to actively participate in a course.

4. Conclusions

The following is a summary of some of the main findings and conclusions from the experimentation between the FUB and the UCM.

4.1. Opportunities of Joint International Blended Courses

Blended mobility formats have the potential to significantly increase student mobility at universities and other HEIs by providing a higher number of students with the opportunity to have an international experience without the need to participate in long physical exchange programmes. They combine the advantages of virtual and physical mobility: the digital cooperation phase makes BM formats to be scheduled more flexibly into students' study programmes and daily lives. Blended mobility is, therefore, more inclusive, offering international experiences especially to those who are limited in their ability to participate in longer physical mobility due to family, financial or other reasons. At the same time, the included face-to-face phase makes blended mobility formats more attractive for students than pure online courses.

Our student survey showed that students choose certain courses not only because of the course content but also because of the participation of an international student group and teacher from a partner university. Internationalisation of teaching and learning with BM formats can, therefore, make study programmes more attractive for students. International blended courses can enable international learning, if teachers encourage communication and collaboration between student groups through the course structure, meaningful assignments, provision of appropriate digital tools and motivational encouragement. Blended mobility can also become a steppingstone for students to physical exchange programmes, as it provides a low-threshold insight into the teaching programme, teaching methods, student life, etc., at an international partner university.

Students would like to attend blended teaching-learning formats that are as interactive and participative as possible, with clearly formulated assignments and requirements and a high proportion of group work, to promote the participation of all students in joint discussions and collaborations. Accordingly, students should be able to become as active as possible during the online sessions, be it through discussions, presentations, group work or similar. Cooperation between the international student groups should be promoted through meaningful tasks and methods, communicated as clearly as possible, e.g., working together on long-term tasks in mixed groups.

Joint international blended courses could be integrated into the existing curriculum of a study programme, if blended learning is recognized in the respective study and teaching regulations, and the overall students' work and learning efforts remain the same compared to the usual face-to-face course. When implementing a joint international course, both

groups of students should receive the same number of ECTS credits for taking the course within the framework of their respective study programmes and regulations. Otherwise, students would have to work different hours, which could make it difficult to work together and cooperate. Teachers would have to be prepared to open their curricula and teaching methods, and to design a joint course curriculum in exchange with the partner teacher. Students would not necessarily have to be enrolled at the partner university as part of their mobility, since they would not have to take (e-)examinations at the partner university but could be examined at the end of a semester by their own teacher at their own university as usual.

4.2. Challenges in the Implementation

A major challenge in the implementation of international blended courses is to find teachers who would be interested in a blended teaching cooperation and who would be willing to invest time in designing and planning a joint course. Experience shows that it is easiest if the teachers already know each other from research collaboration or other academic contexts. In this case, the motivation for a teaching cooperation is usually high enough so that no further incentives are needed. In the case of new cooperation, however, incentives are necessary for the teachers, be it intensive support in the planning and implementation of the course by the support services for teaching and learning, and for the organisation of the physical short-term mobilities also by the International Office, be it crediting of the extra effort to the teaching load or be it funding. One approach to recruit interested teachers for international blended teaching collaborations is to first seek dialogue with the department's heads and management, to convince them of the benefits of international blended teaching and learning scenarios (international experience for *all* students), include their needs and perspectives on the internationalisation of teaching, and eventually to agree on specific targets for offering blended courses. Teaching staff could then be invited to express their interest in offering international blended courses.

Another challenge lies in convincing the relevant stakeholders at the departments and faculties to reduce the course places in a joint blended course that are available to their own students (compared to a regular face-to-face course). For example, a course that usually has 30 places for FUB students will only have 15 places in a joint international format, as the others are taken by students from the partner university. Theoretically, it would be possible to increase the number of total course places, but despite a second participating teacher from the partner university, this would significantly increase the supervision effort. Even if the teachers share the moderation of the sessions, the supervision of group work or the evaluation of the students' performance, certain teaching-learning activities, such as joint discussions or student presentations, are not feasible with too many participating students.

When designing international blended learning courses, it is important to conduct a face-to-face phase at each participating university so that no student group feels disadvantaged, and the motivation and participation of all participants is equally high. Ideally, an attendance phase is carried out at the beginning of the cooperation so that the students can get to know each other personally and, thus, create a good basis and high motivation for the collaboration during the online phase. A presence phase at the end of the course at the other partner university could then be used for a discussion of the joint work and for final presentations. If there is only a slight overlap in the lecture times of the universities, it makes sense to use these for the online cooperation and to schedule the attendance phase as a kind of summer school during the lecture-free period. The incentive of financed short-term physical mobility increases the likelihood that students will also attend courses outside the lecture period. Of course, this in turn requires flexibility on the part of the students as well as the teaching staff, administration and teaching support.

Travels to the partner universities should ideally occur via train/sustainable travel options within Europe. Therefore, longer attendance phases should be organised, so that students and teachers can travel by sustainable means of transport and the travel time and travel costs are at the same time in a reasonable proportion to the length of stay. We

recommend the consideration of climate concerns in the implementation of joint blended courses at Una Europa universities and advocate for the inclusion of sustainability criteria in the funding criteria of Una Europa funding.

4.3. Requirements for the Joint Digital Platform (BLOOM)

The establishment of digital and cross-location infrastructures is in most cases the first step towards the development of joint digital teaching-learning offerings cf. [29] (p. 148). In order to address the important challenges of internationalisation and sustainable development, the OpenU consortium is creating a European digital hub, called BLOOM, that is intended to provide a joint digital infrastructure, which should support the design and implementation of joint teaching, cooperation and mobility formats in Una Europa and the European Higher Education Area.

Future international blended international courses could be hosted and implemented via BLOOM. One big advantage would be that participating students could use the account from their home university to access the offered courses via eduGAIN, without the need of having received a second university account at the host university for gaining access to all digital platforms and resources. The providers of the platform would then have to decide which attributes of the students are needed and must be transferred from the home university of the student. This procedure would require at least a suitable master data record to be created at the host institution, to which, e.g., course bookings or examination results could be linked.

The implementation of a course catalogue on the hub with all available international blended courses for Una Europa students would be useful, as international BM formats cannot yet be flagged in the Campus Management/Student Life Cyle Management Systems of the FUB or UCM.

An eTwinning tool should be integrated on the joint platform so that interested teachers can submit search queries for potential cooperation partners and teaching tandems can be found more efficiently. Until now, teachers either had to already know each other or the project coordinators had to undertake a lot of communication and advertising at the different partner universities to find potential partner teachers.

A sustainable support concept and corresponding personnel resources are needed to answer the requests of teachers and students regarding the platform and to support them in the design/concept of digital teaching and learning scenarios as well as implementation of and participation in the blended courses.

It would be preferable if the blended courses could be offered via the HEI specific e-learning infrastructure. Teachers prefer to use the e-learning systems and digital tools they are accustomed to and often do not have the capacity to familiarise themselves with new LMS, video conferencing software, etc. This is strongly regarded as an obstacle to teacher motivation in offering BM concepts in their own teaching. Therefore, BLOOM should be able to integrate the HEI specific e-learning infrastructures.

4.4. Policy Implications

In general, motivated early adopters and bottom-up drivers among teachers, departments, and service center staff are essential for the introduction of blended mobility formats at HEIs. For a long-term implementation of BM formats, commitment and investment from decision-makers at the middle (department head, dean of study) and higher institutional levels (university board, management of the International Offices or centers for international cooperation) are equally important cf. [30] (p. 11).

On the departmental level of a university/HEI, target agreements could be negotiated between the department heads and the university management to allow for a certain quota of international blended and/or online courses. To enable teachers to offer blended courses, it is advisable to adapt the study regulations accordingly, i.e., inclusion of blended teaching in "teaching and learning format" regulations and include the blended mobility format in the "study abroad regulations".

On the university/HEI level, the implementation of BM formats could be included with further details in the HEI's internationalisation strategy [1] (p. 13).

Furthermore, the university management, together with HEI policy on the federal state level, could decide on a regulation that integrates international blended teaching hours/preparation workload to "count" towards the fulfilment of teaching obligations under certain conditions.

On the federal state level in Germany, BM formats should be included in higher education contracts with the federal states (in Berlin 2023–2026) under the section "Internationalisation of Berlin's higher education institutions (internationalisation of teaching)" [31] (Berlin uses the instrument of higher education contracts to guarantee Berlin's HEIs planning and continuity in funding. It makes the amount of its subsidy dependent on the fulfilment of specific targets that are negotiated with the universities).

On the national level, government initiatives should continue to offer additional funding programmes for HEIs to support European University Networks and support programmes to enable the use of digital learning technologies and methods. The German Rectors' Conference (HRK) could negotiate and formulate jointly accepted standards and procedures for implementing BM formats at HEIs.

On the EU level, the further development of a joint European platform for digital education (e.g., BLOOM) should, of course, be promoted within the framework of the Digital Education Action Plan. Furthermore, the Digital Education Action Plan or the ERASMUS Charta could promote BM formats as inclusive, equivalent to physical exchange in order to motivate wider student participation.

A particularly important measure at EU level would be to further develop the Blended Intensive Programmes (BIP). BIPs are a great innovation in the current Erasmus+ programme generation 2021–2027 to foster the development of BM formats in teaching. They are intended to encourage the development of short, intensive and joint curricula and activities to provide students and university staff with the opportunity to participate in a short physical group mobility (5–30 days) combined with a digital phase. A minimum of 15 learners (students and/or staff) must participate. The funded students should be able to achieve at least 3 ECTS and at least 3 ECHE universities (Erasmus Charter for Higher Education) from 3 different programme countries are required for the conceptual development [32] (p. 9).

One main concern of the authors is that no requirements are formulated for the design of the digital cooperation phase in BIPs. Only a "virtual component description" is required, and innovative teaching methods are to be used, e.g., research-based learning or challenge-based approaches [32] (p. 7), though the latter could also only be used in the presence phase. However, this could lead to the online phase remaining under-complex, e.g., by only providing materials such as PDFs for reading preparation in an LMS or for short "get to know each other" meetings. This can be all the more significant because the relationship between online and face-to-face phases is not clarified either, e.g., whether they have to be related to each other in a didactically meaningful way. For the area of individual blended mobilities, at least some examples of the design of the virtual phases are given: "The objective [of blended mobility] is to facilitate collaborative online learning exchange and teamwork. For example, the virtual component can bring learners from different countries and study fields together online to follow online courses or work collectively and simultaneously on assignments that are recognised as part of their degree." [32] (p. 4) In the author's opinion, the requirements for BIP applications also need to be supplemented with criteria on how to design an effective virtual phase so that the blended mobility scenario can enable international learning or teaching skills, e.g., students have to watch learning videos and solve matching tasks, or students have to work on long-term tasks in mixed groups. The concept development of the BIP consequently would require not only "the cooperation between the international office and the faculties/departments, where a person will be assigned as blended intensive programme coordinator" [32] (p. 11), but also the e-learning support services of the HEI. Another need for change is the number of face-to-face phases:

within the framework of a BIP, only one attendance phase at one of the participating HEIs is allowed, but as our experimentation shows, both students and teachers expect short-term physical mobility to take place at all universities involved in a blended course or BIP. If there is only one attendance phase at a university, this can lead to motivational gaps among students who feel unfairly treated.

Finally, the implementation of a BIP as "enhancement of an existing [study] programme" [32] (p. 7) seems difficult to the authors. Since most study programmes at ordinary universities are predominantly face-to-face, the short-term physical mobility of at least five days taking place in the context of a BIP leads at least to the obligation for students to stay away from other courses, which is not ideal. Therefore, the implementation of BIPs as supplement to the regular study programme in non-lecture periods or as part of a joint degree programme seems more feasible. Shorter mobilities than 5 days, as in our project, are difficult to imagine for reasons of sustainability, since for such short-term mobilities it usually only makes sense to travel by air.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci12110810/s1. Data from the student survey.

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Article

Gamification Tools in Higher Education: Creation and Implementation of an Escape Room Methodology in the Pharmacy Classroom

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Abstract: Educational escape rooms have emerged as an excellent active learning tool to improve student learning, motivation, and engagement. In this work, a methodology to design and develop escape rooms in the classroom has been established and implemented within the general pharmacology, biopharmacy and pharmacokinetics, and pharmaceutical technology disciplines for pharmacy students. Each escape room consisted of three sequential challenges that the students had to solve, and we divided the students into groups of 3–6 participants to complete a mission containing educational questions related to the curriculum of each module. The escape rooms were successfully implemented in all these disciplines, and the activity was positively evaluated by the students (>95% satisfaction). They allowed the students to apply the theoretical learning outcomes of each subject. Moreover, escape rooms promoted teamwork and improved the problem-solving skills of the students. For an escape room to be successful and meet the established learning outcomes, challenges must be adapted to the target students, the time should be precisely set, the tasks of the game master should be well-defined, and final feedback should be included in the session.

Keywords: active learning; escape rooms; game-based learning; gamification tools; health sciences; integral formation in higher education; pharmacy degree; student engagement

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1. Introduction

Teaching methodologies in higher education have undergone a major shift moving from teacher-centred techniques in which students played a completely passive role acting as "mere listeners" of the lessons to active methodologies that imply greater student participation and student involvement in the classroom [1,2]. Many studies have highlighted that the use of blended learning methodologies is a very beneficial tool for student engagement [3]. Implementation of active educational techniques increases motivation, engagement, and student classroom attendance. Additionally, blended learning techniques allow the improvement of students' soft skills, such as critical thinking, problem-solving capacity, creativity, and collaborative competencies among others. All these results translate not only into better academic performance but also into an improvement in the personal life and future employability of the students [4,5].

Gamification is the application of game elements to non-game environments and is one of many blended learning strategies that has been implemented in higher education [6]. Educational staff in higher education are adopting this teaching methodology and incorporating it in different elements of games, such as badges, leaderboards, giftings, quests, points, and ranks, among others, during their lessons [7]. In recent years, a step forward has been taken, and educators have begun to turn classes into "immersive games", developing escape rooms for educational purposes.

The escape rooms are team-based live-action games in which players are challenged to resolve a mission consisting of several enigmas in a specific time. These types of games were first developed in Japan in 2007, but they rapidly spread to other countries and became popular leisure activities in many cities [8,9]. The players, usually 3–6 people per escape room, must collaborate to resolve the challenges. Therefore, these activities promote teamwork and leadership abilities [10]. Escape rooms are used in many companies to facilitate "team building" [11]. Moreover, the enigmas are usually based on cognitive puzzles that include ciphers, encoded messages, and combination locks among others [12], potentiating the logic, creativity, critical thinking, communication skills, and problem-solving capacity of the players. It should be noted that there is always a "game master" that supervises the successful development of the escape room and that provides clues to the players when requested [13]. All this makes escape rooms an excellent teaching tool in higher education to improve student learning [14,15].

However, the successful implementation of educational escape rooms in higher education is complex, and several aspects must be considered before starting. Firstly, it must be clear that unlike the objective of commercial escape rooms is "to have fun", educational escape rooms are focused on student learning. For this, it is necessary to cover a set of learning outcomes to the challenges proposed to the students being aligned to the curricula as well as combining them with fun elements. Secondly, it is key to take into account the target audience of the activity [16]. The audience of commercial escape rooms is broad. However, educational escape rooms are designed for a very specific target group, usually the students of a certain subject [14], and enigmas must be adapted to them. Therefore, for the escape room to be effective, it is essential to have extensive knowledge of the target students, their skills, and their attitudes [17]. Based on these considerations, the implementation of an escape room in the classroom should take place when an important part of the curriculum of the subject has been delivered to the students to enable them to actively apply themselves in the resolution of the challenges [18]. The number of students that will participate in the activity is also essential as it will dictate the number of game masters that will participate during the activity. Third, the available time is also an important aspect as it will determine the number and the complexity of the proposed challenges. The duration of educational escape rooms is limited to the academic timetable and usually lasts between 45 to 90 min. Finally, other aspects being considered are the available space to run the activity, limited to the size of the classroom [14], and the available resources. All of this determines the proposed game environment and challenges [19].

The main objective of this work was to design and develop a methodology for the implementation of educational escape rooms as a teaching strategy to improve student learning and engagement within health science-related disciplines, in particular pharmacy. Escape room games were designed and implemented in three different subjects, (i) biopharmacy and pharmacokinetics, (ii) general pharmacology, and (iii) pharmaceutical technology of the pharmacy degree at the University Complutense of Madrid (Madrid, Spain). Basic considerations to bear in mind during development and implementation were analysed, and student satisfaction was evaluated. Finally, the implemented methodology will be used with a different group of educators in different institutions to evaluate the degree of satisfaction with the training received.

2. Materials and Methods

2.1. Design, Development, and Implementation of Escape Rooms

In this work, educational escape rooms were developed for three different subjects in the pharmacy degree at the Universidad Complutense de Madrid (Spain): biopharmacy and pharmacokinetics, general pharmacology, and pharmaceutical technology.

2.1.1. Knowing the Target Audience

Before starting to design an escape room, it is important to know the target students that will participate. Therefore, it is advisable to implement the escape room either at the

end of the course or when the content of the course is relatively advanced so that students can apply their knowledge and skills during the activity. All the escape rooms developed in this work were carried out on the last day of class of the term, so the students had extensive knowledge of each discipline, enabling them to apply the knowledge and learn during the process.

As a first step, the application of an empathy map is a very useful tool to deepen the knowledge of the participants, which in turn will be reflected in the type of challenges proposed. The empathy maps used in this work were obtained from the tractionwise website (https://www.tractionwise.com/en/magazine/what-customers-want/ (accessed on 20 August 2022)), and the questions used were the following:

1. What do the students think and feel? (e.g., students' aspirations)
2. What do the students hear? (e.g., what do influential people say?)
3. What do the students see in their environment?
4. What do the students say and do? How do the students behave? (e.g., poorly or highly engaged with the subject)
5. What efforts do the students make, and what barriers do they encounter? (e.g., low, medium, or high difficulty challenges)
6. What results do the students seek? (e.g., knowledge, skills, or aptitudes that the students want or need to achieve)

Educators should consult these items before creating a new teaching methodology and, in particular, an escape room. For this reason, it is more convenient to implement an escape room at least after a few hours of contact between students and the educator, so the educator understands the essence of what the students are looking for and expecting from such an activity. Knowing the target group will facilitate the setup of the game.

2.1.2. Learning Outcomes

Other aspects that must be considered before designing educational escape rooms are the learning outcomes to be achieved that must be aligned with the curriculum of each discipline.

In the general pharmacology escape room, six key learning outcomes were covered:

1. To understand basic terminology in pharmacology.
2. To understand how drug databases are managed.
3. To understand the mechanism of action of drugs at the molecular level and the main characteristics of the structure and function of receptors.
4. To understand the processes of absorption, distribution, metabolism, and excretion of drugs.
5. To identify and assess different types of adverse reactions associated with pharmacological treatments.
6. To be able to determine the site of absorption of a drug based on the Henderson–Hasselbalch equation.

In the biopharmacy and pharmacokinetic escape room, three key learning outcomes were established:

1. The concept of the plasma drug half-life.
2. The concept of the drug volume of distribution in the body.
3. The concept of relative and absolute drug bioavailability.

In the pharmaceutical technology module, a discipline focused on the design and manufacturing of medicines, the escape room covered three key learning outcomes:

1. The selection of the most suitable administration route for a specific indication.
2. The selection of the most suitable pharmaceutical dosage form for a specific indication.
3. The identification of the properties and characteristics of a drug that can limit its clinical efficacy and safety.

2.1.3. Escape Room Narrative and Challenge Design

Once the objectives of the escape room have been established, it is important to frame the learning objectives within a relevant narrative or story to establish a suitable game environment that can engage the interest of the students. In this work, each escape room consisted of three different sequential enigmas that the students must resolve to complete the mission. The flow chart used during the escape room is illustrated in Figure 1.

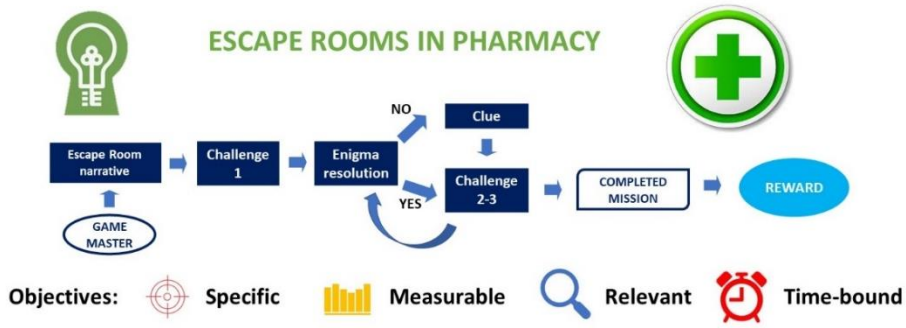

Figure 1. Flowchart used in the escape rooms implemented.

The pharmacology escape room focused on a 2-year-old patient admitted to a paediatric intensive care unit (ICU) with suspected poisoning. In this scenario, the patient accidentally ingested a specific drug to relieve the symptoms of allergies. The students had to solve three challenges based on pictograms, a crossword puzzle, and short answer-based questions to find the drug responsible for this intoxication and the antidote necessary to save the patient.

In the biopharmacy and pharmacokinetic escape room, the narrative consisted of an anthrax outbreak. At the beginning of the game, students received a letter warning them about them being potentially intoxicated with anthrax spores. Students had to solve three numerical challenges to decipher the half-life of the contaminant in the body, the dose of antidote requested, and the relative bioavailability of the antidote in the body.

In the pharmaceutical technology escape room, an outbreak produced by a toxin was contextualised. The story was focused on a highly lethal toxin spread throughout Europe, and the researcher in charge had disappeared before finding the cure. The students had to find and prepare the antidote against the toxin by deciphering a set of pictograms, crossword puzzles, and short answer-based questions.

2.1.4. Playing the Escape Rooms

All the escape rooms took place in the usual classrooms where each module was usually taught. Before each game, the educator responsible for each module acted as the "game-master" and prepared the room accordingly, setting all of the clues (lockers and puzzles) at their corresponding positions. The students then entered the room and were distributed into groups of 3–6 students. Students were studying pharmacy degrees at the Complutense University of Madrid during the academic year 2020–2021. In Table 1, the main characteristics of the three games are summarised.

Table 1. Main characteristics of the escape rooms implemented in this work.

Characteristics	Pharmacology	Biopharmacy and Pharmacokinetics	Pharmaceutical Technology
Number of Participants	16	27	13
Number of Groups/game	4	6	4
Number of challenges	3	3	3
Duration	45 min	45 min	45 min

Once the students were organised into groups and distributed throughout the class, the "game-master" explained the rules necessary to perform each escape room (e.g., all the clues have only one use and are distributed in the classroom at the player's fingertips) and the narrative and mission of each activity. Then, the students had 45 min to resolve all three challenges proposed to complete the mission. It should be noted that the educators were in the classroom during all the games to provide support to the students and provide them with the necessary clues. In Figure 2, several examples of the enigmas and clues proposed during the escape room are illustrated.

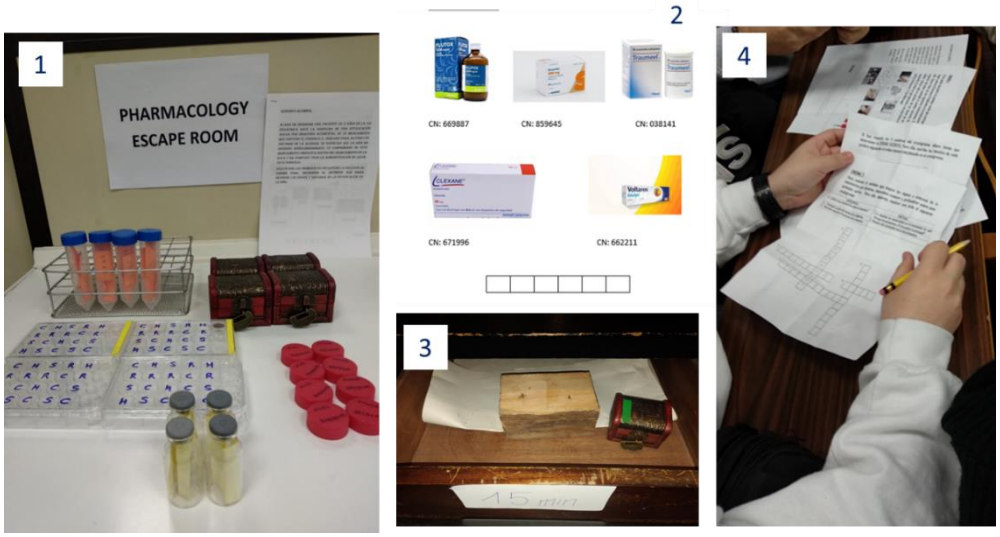

Figure 2. Examples of the challenges and game elements used in the escape rooms: (**1**) Game base elements used in the pharmacology escape room. (**2**) Pictogram used in one of the enigmas of the pharmaceutical technology escape room. (**3**) A chest used in the biopharmacy and pharmacokinetic escape room. (**4**) Students solving one of the enigmas of the pharmacology escape room.

All the escape rooms lasted 60 min. The following scheme was followed: 5 min for the organisation of the students in groups and the explanation of the rules and narrative of the activity, 45 min for the students to solve all the challenges and complete the mission, and 10 min to summarise the activity.

2.1.5. Questionnaire

After each escape room, students filled out an online questionnaire using "google forms" to measure their degree of satisfaction and learning engagement with the activities. The questions were based on a questionnaire used in a previous study [20]:

1. Do you think gamification activities should be implemented in the classroom to improve student learning?
2. Do you think you have learned while playing escape room?
3. What did you like most about the escape room?
4. What did you like the least about the escape room?

Questions 1 and 2 were multiple choice with the following possible answers: "No", "Yes—a little bit", or "Yes—a lot", while questions 3 and 4 were written answer questions to collect as much information as possible about the student's perceptions.

2.2. Training Other Educators to Develop Escape Rooms in Other Disciplines

"Master Class" sessions were developed to share the knowledge acquired with educators from other institutions, such as the Lithuanian University of Health Sciences. This Master Class was delivered online using the google meet platform for over 45 min, followed by a 15 min discussion. An online questionnaire consisting of 4 multiple-choice questions (yes or no) was sent to the attendees to find out their feedback on the activity and their

willingness to create and implement their own escape rooms. Google forms were used. The following questions were evaluated:

(1) Do you consider that the implementation of game-based learning approaches in the classroom has benefits for students?
(2) Have you ever implemented game-based learning approaches in the classroom? If yes, what approaches have you implemented?
(3) Do you consider that the development of escape rooms in the classroom may have benefits for students?
(4) Do you consider that a similar training as the one received has helped you in implementing escape rooms?

2.3. Ethical Considerations

Participation in the escape rooms developed for this project was voluntary. The answers collected from the questionnaires were anonymous.

3. Results

3.1. Data Collected from Escape Rooms

As shown in Figure 3, a total of 56 students participated in the escape rooms: 16 in the pharmacology escape room, 27 in the biopharmacy and pharmacokinetic escape room, and 13 in the pharmaceutical technology escape room. The questionnaire was completed by 36 participants, representing a response rate of 62.5%. It is interesting to note that 35 questionnaire respondents (97%) considered the use of gamification tools in the classroom as a way of improving student learning. Thirteen students (36.1%) showed positive feedback for the game, indicating that it enhanced their learning process, while twenty-two students (61.1%) considered that the game significantly allowed them to improve their learning process. One student (2.8%) did not show positive learning satisfaction with the game.

In the open question, "What did you like the most?", most students considered that the escape rooms allowed them to learn in a fun way and improve their problem-solving skills. Some students highlighted the importance of team building to solve most challenges, considering that the escape room promotes teamwork. In contrast, in the question "What did you like the least?", a great majority of the students considered that the escape rooms were too short in time and the number of challenges proposed was too small. Table 2 shows all student responses to these questions. Data were organised into categories, and the number of answers in each category was quantified.

Table 2. The most and least likeable items of the escape rooms pointed out by the students.

What Did You Like the Most? (*n* = Number of Answers in Each Category)	What Did You Like the Least? (*n* = Number of Answers in Each Category)
You can learn in a fun way (*n* = 13)	Short-lived activity (*n* = 11)
You can apply the theoretical concepts learned in the classroom (*n* = 6)	The number of enigmas to solve was too little (*n* = 10)
Dynamic activity (*n* = 9)	Nothing (*n* = 11)
Teamwork (*n* = 8)	Few participants (*n* = 4)

3.2. Data Collected from Master Class

A total of 18 professors from the Lithuanian University of Health Sciences attended the Master class. The questionnaire was completed by eight participants. All of them answered that they have never developed gamification activities in the classroom but have considered that its implementation (including escape rooms) is beneficial for student learning. In total, 75% of the educators considered that escape rooms have great potential for higher education. Regarding the feasibility of implementing and developing escape rooms in the classroom, most participants agree (75%) that it is feasible, while the remaining showed some concerns regarding their implementation, especially lack of time in the curriculum. All participants

agree that training, such as the one received, is required and very useful to help in the implementation of this type of gamification technique in higher education. All participants highlighted the need to receive further training (Figure 4).

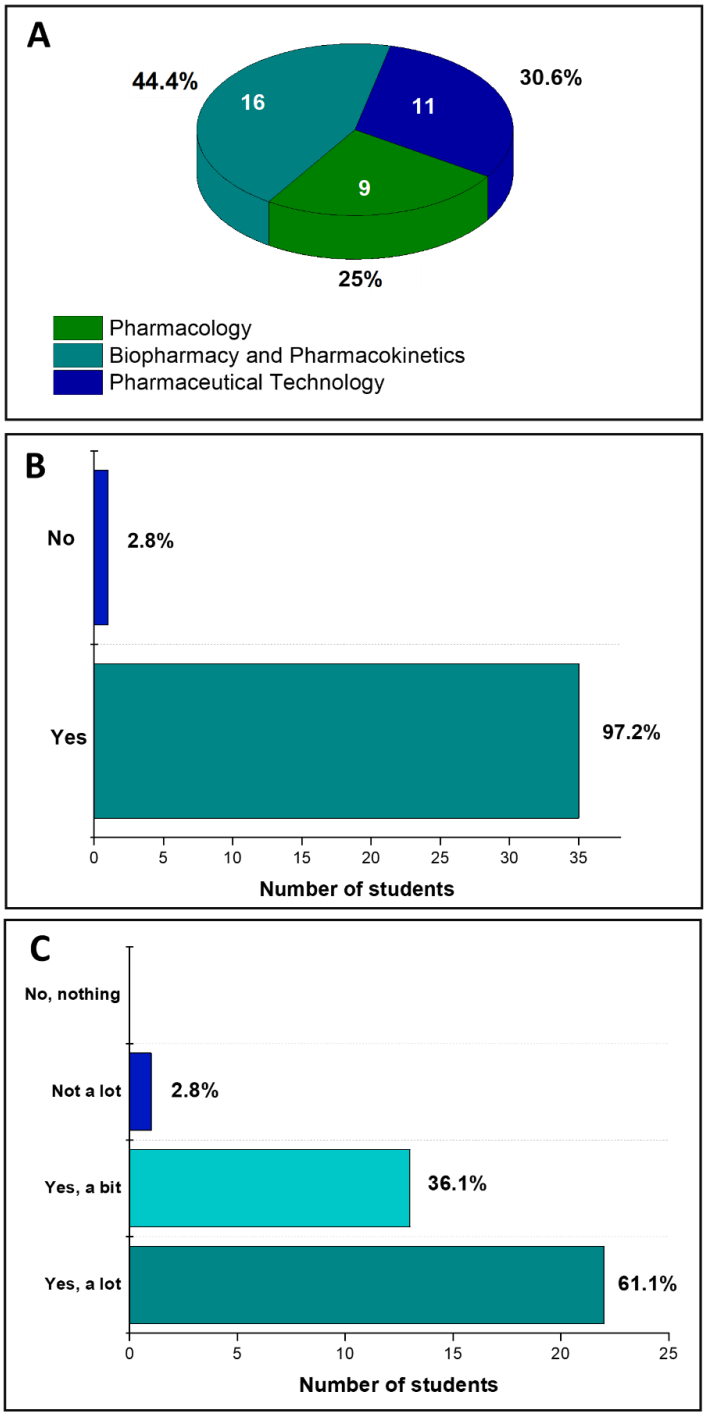

Figure 3. Student responses to the escape game questionnaire. (**A**) Distribution of the total students that completed the questionnaire in the different escape rooms. (**B**) Recorded answers to the questions "Do you think gamification activities should be implemented in the classroom to improve student learning?" and (**C**) "Do you think you have learned while playing Escape Room?".

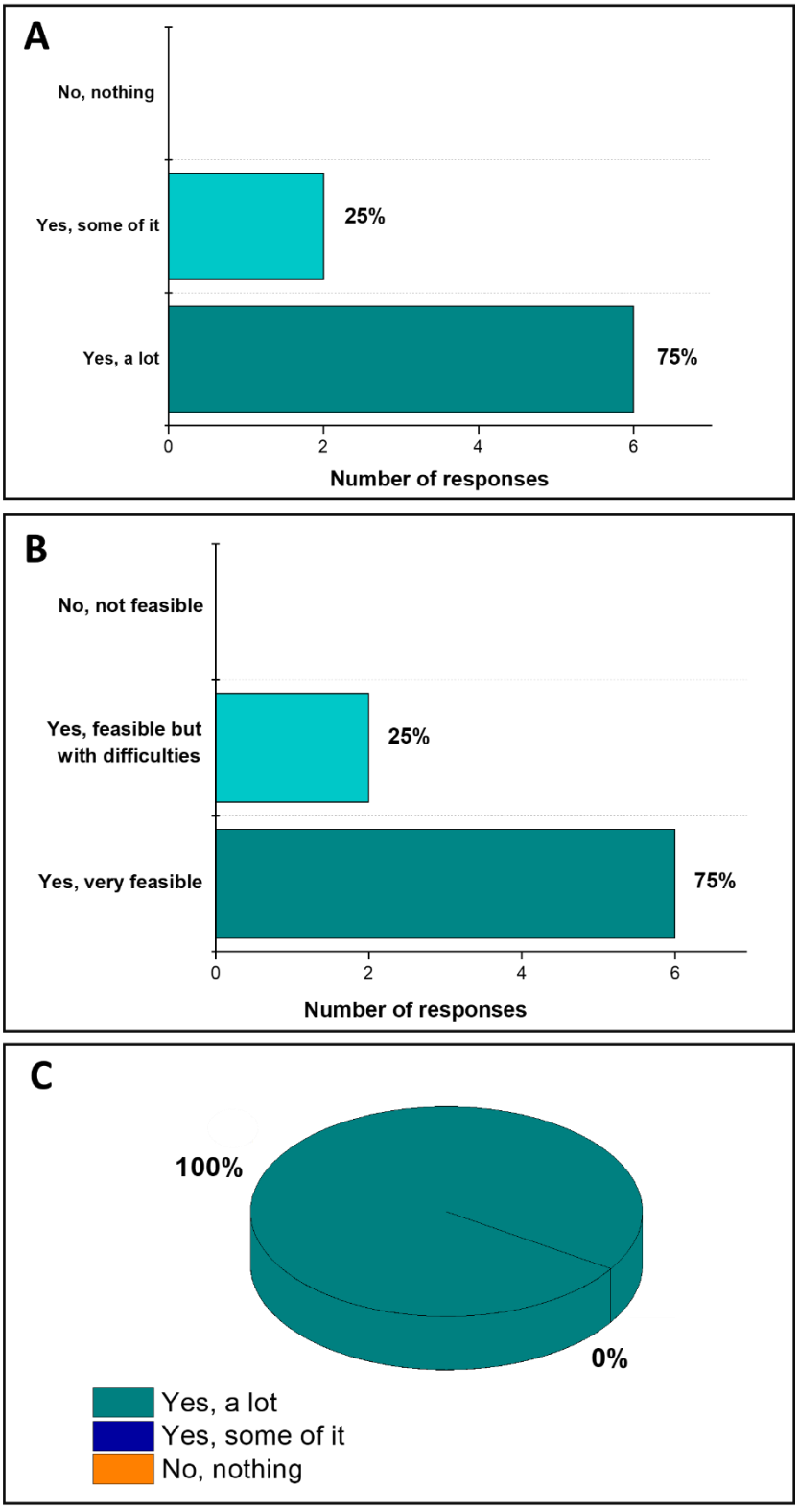

Figure 4. Student responses to the escape game questionnaire. (**A**) Distribution of the total students that completed the questionnaire in the different escape rooms implemented. (**B**) Recorded answers to the questions "Do you think gamification activities should be implemented in the classroom to improve student learning?" and (**C**) "Do you think you have learned while playing Escape Room?".

4. Discussion

In recent years, escape rooms have emerged as an attractive, active teaching methodology to improve student learning and engagement in higher education [21]. It should be noted that Health Science education represents one of the areas where more escape rooms have been implemented, especially in nursing but also medicine, dentistry, and pharmacy. The development of this activity allows students to better reproduce situations that they may find in their future professional life, allowing them to apply theoretical concepts in practice [22]. The objective of this work was to design and develop a methodology for the implementation of educational escape rooms as a teaching methodology to improve the learning and engagement of students in health science-related disciplines, in particular, pharmacy.

It should be noted that escape rooms are generally very well accepted by students. Very positive feedback (97% student satisfaction) was obtained in all three escape rooms, considering that the development of this kind of activity in the classroom is beneficial for the students as it allows them to learn in a fun way. This methodology contributes to promoting student motivation and engagement [23]. The implementation of escape rooms in health sciences-related disciplines allows the application of the theoretical concepts learned in the classroom to real scenarios that the students will find in their professional future [22]. This is highly beneficial for their professional development. In fact, it has been perceived by most of the students as one of the most positive aspects of the escape rooms implemented in this work.

Another positive point highlighted by many of our students is that escape rooms promote teamwork. Students are organised into different groups and must collaborate to resolve the challenges and complete the mission allowing them to increase their social and communicative skills, as well as offering the opportunity to train their leadership skills. In fact, Baker and collaborators found that pharmacy students who participated in an escape room considered that this activity strengthened their leadership capacity [24], which is essential for their professional careers.

Concerning the negative aspects perceived by the participants, it should be noted that many students indicated that the escape rooms had a short duration. Precisely, one of the main limitations when developing and implementing this type of activity is that the duration is limited to the academic timetable. For this reason, escape rooms were designed according to the time allocated for each module (60 min). In fact, most of the escape games designed in pharmacy-related disciplines had a similar duration of 30–45 min [12,17,18]. Another aspect perceived negatively by the students was the low number of challenges to solve. In comparison to the escape games designed by other authors, who usually designed four to five challenges in each game, the number of enigmas in our study was three [12,25]. However, it should be noted that in the biopharmacy and pharmacokinetic game, the enigmas were problem-based challenges, and the students needed more time to solve them. Except for one group, the rest of the groups completed the mission satisfactorily within the 45 min allocated to the game, which indicated that the proposed difficulty and number of challenges were adequate for the duration of the escape rooms designed.

The design and implementation of escape rooms in the classroom, although feasible, is complex, and several aspects are especially critical for their success. First, it is critical to know the student profile that will participate in the activity, their degree of knowledge about the module, their skills, and their attitudes to adapt to the difficulty and duration of escape room challenges. Secondly, it is essential to establish learning outcomes aligned with the curriculum. The escape room implemented in this work took place at the end of the semester, but they can be implemented at different times, according to educator perception and needs. Thirdly, it is important to adapt the type and number of the enigmas to the escape room duration, place, and type of students. The students should have enough time to solve all of them but within the time limit allocated for the activity. Finally, it is essential that the educator, who acts as the game master, is available throughout the activity, verifying its correct progress and providing clues and support to the students when needed.

Based on the escape rooms implemented in this work, we suggest the escape rooms should run with one educator per 15 students. For larger groups, the presence of a second educator is highly recommended to ensure students receive appropriate support in a timely manner.

Most of the escape rooms developed in higher education focused on a certain discipline. However, several authors have reported the benefits of implementing interprofessional collaborative escape rooms in health sciences (nursing, pharmacy, medicine, and physical therapy) [26–28]. These activities promote interprofessional socialisation and collaborative skills of the students and may have a positive impact on their professional future as the escape rooms can reproduce situations that the student of all these disciplines will face collaboratively in their future careers. For this reason, the next step planned in this project will be to design, implement, and develop collaborative virtual escape rooms among students from different institutions.

5. Conclusions

The implementation of gamification tools in the classroom is an excellent strategy to improve student learning, motivation, and engagement, with an escape room being an exceptional tool. However, the lack of training in how to implement this methodology in higher education results in a poor number of cases of escape room implementation at this level. Educators in higher education should receive suitable training discussing the key points to bear in mind for a successful design and to mitigate the risk of failure. In this work, we demonstrated that the escape room methodology can be applied successfully to health science-related disciplines, especially pharmacy, with minimal cost. Student satisfaction was 97%, indicating that this methodology is likeable for the students and enhances student awareness and learning as well as team building. These activities allowed the application of theoretical aspects learned in each discipline to real case scenarios.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data that supported the findings of this study can be available from the corresponding author.

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Article

Barriers to Digital Higher Education Teaching and How to Overcome Them—Lessons Learned during the COVID-19 Pandemic

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Abstract: The COVID-19 pandemic forced a transition to digital teaching in higher education institutions (HEIs) as itwas the only safe method for higher education (HE) teaching during the pandemic. However, this crisis emphasized the barriers students face worldwide. For digital HE teaching to survive in the future, these barriers should be overcome. The present paper aimed to systematically identify these barriers and present recommendations to overcome them. For this purpose, a quantitative survey (n = 369) was conducted with students in three countries, and qualitative student statements were analyzed. Possible countermeasures for corresponding barriers are described, and related stakeholders are identified. Thus, the study provided an overview of recommendations for stakeholders to overcome the barriers. The recommendations to resolve most barriers entail offering hybrid formats, adjusting lecture design, and ensuring proper communication.

Keywords: digital teaching; barriers; higher education institutions; COVID-19 pandemic; recommendations

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1. Introduction

Even before the impact of the COVID-19 pandemic, higher education institutions (HEI) had to support, engage, and graduate stressed students [1]. The stresses students faced were further emphasized by the challenges induced by the COVID-19 pandemic, when face-to-face interactions had to be avoided, and digital teaching was adopted exclusively within a short time. Original teaching methods had to be discarded, leading to a significant transformation into emergency response teaching (ERT) for teachers without proper planning, implementation, or quality assurance [2]. As a result, ERT was assumed to be just a substitution according to the substitution augmentation modification redefinition (SAMR) model [3]. Students had to adapt their learning, too. Although digitization attempts in higher education (HE) teaching were discussed before the pandemic, full scale digital teaching and learning were never adopted due to various factors [4], which the current paper refers to barriers. When digital teaching became inevitable due to the pandemic, the need for research insights into barriers to digital HE increased. The increased digital teaching provided an opportunity to analyze and understand these barriers. As previous research on the methods to overcome these barriers was quite limited, the most common institutional reaction to a barrier is avoidance or the adoption of ad hoc countermeasures [5].

The pandemic will probably permanently change HE, making a return to old habits increasingly unlikely [6]. Therefore, in the aftermath of the pandemic, more structured and strategic studies are required to overcome barriers. Even if ERT is different from online learning [2], lessons learned from the pandemic may help to develop methods and ways to overcome certain barriers. In addition, an evaluation of possibilities for overcoming barriers in an ERT situation, in which most physical activities were converted into an

online substitution, will help reach a higher level within the SAMR model [3]. In general, the presence of barriers requires various stakeholders to perceive and resolve them. To overcome the barriers, several studies have focused on approaches adopted by certain HEIs and governments [7], while others were simply case studies [8]. However, research that included recommendations to overcome the barriers via a systematic analysis based on a large cross-country sample is still quite limited. HEIs should use the pandemic experience to improve future digital teaching approaches. Therefore, empirical recommendations are significant for the development of HEI strategies. Students have a significant stake in the development of these recommendations. The shift in HEIs to "student-as-consumer" and the increasing competition for students among HEIs [9] necessitate the inclusion of the students' views in the feedback process [10].

Thus, the following research question (RQ) was determined:

RQ: According to students, how can the barriers to adopting digital higher education teaching, which evolved during the COVID-19 pandemic, be overcome?

To answer the RQ, we first present an overview of the barriers that were identified in a previous literature review [11]. The study methodology is discussed in Section 3. We adopted a four-phase approach to consolidate insights available in the literature based on empirical data. The findings are presented in Section 4 and discussed in Section 5. The final section includes conclusions and implications, where the limitations of the study and the outlook are discussed.

2. Background

Our research drew on two areas of research. The first area gives a general background on HE and experiences from COVID-19. The second area contains the specific literature on barriers to digital HE teaching, which we used during our analysis.

2.1. Experiences from COVID-19 and Research on Barriers

Researchers generally use the technological, pedagogical, content knowledge (TPACK) model to discuss how to use technology in the classroom. The essential idea behind the model is integrating the three components into seamless units of course elements [12]. With ERT, we can argue that the integration was disrupted due to the focus on getting the technology to work. Currently, the literature is evolving, taking experiences from the recent pandemic into account and giving an outlook on future needs. Researchers and opinion leaders claim that digital HE teaching will have an accelerated future after COVID-19 as it has the potential to deliver courses effectively. Still, future development needs to focus on the quality of online offers [13,14]. Quality needs to be seen from the perspective of the learners to come to conclusions about which digital course designs foster or hinder teaching. In addition, the teachers need to be supported to be able to deliver quality content, meaning teachers need to be taught [15]. Other conclusions address the general education of health-related courses in the general curriculum and digitally extending mental health and medical services for students [16]. Further studies see the need for better internet connections and better socio-economic development as prerequisites for digital teaching [17]. The creation of enhanced resilience in HE is another consideration. A framework incorporating the phases of responding, recovering, and reimagining can guide future work [18]. Students and teachers have different perceptions of the situation. While teachers have struggled to produce additional teaching materials, students have wished for more activities to keep up with the topics being taught. Interestingly, when problems occurred, both groups were flexible in adapting to different technologies [19]. Research on information systems (IS) can help this domain in several ways. It can help implement direct measurements in the case of crises on an operational level and can support research on digital HE transformation on a strategic level [20].

Studies on barriers and advancement can be classified into different streams. One stream of studies centers on researching the impact of technology on students' individual learning results [21] and tolerance of digital systems [22]. Following the concepts of drivers

and barriers [23], these studies often encompass suggestions for the instructional design of blended learning courses and their acceptance [24]. Another smaller stream of research emphasizes challenges facing faculties or departments within the organization [25,26]. Organizational challenges often originate from the resistance to change within organizational units [27]. Therefore, faculty support in institutions is missing [26,27]. Insufficient resource allocation resulting in a lack of time and technical equipment is another organizational challenge for teachers. Usually, the digitalization of teaching leads to adaptations to curricula, which teachers often see as critical [28]. In addition, external barriers impact the digital transformation of HE. Political and economic pressure to adapt to global requirements exists. However, HEIs are regularly incapable of keeping up with the speed imposed by these external pressures [28].

In the field of HE research, barriers are repeatedly connected to specific teaching scenarios, which limit the generalizability of study results. Systematic research offering guidance for the identification of barriers and recommendations for overcoming them is still in a nascent state.

2.2. Stakeholder and Barrier Model

Faculty, students, and academic institutions are stakeholder groups that play various roles in addressing different challenges in HEIs [29]. Our first stakeholder group is teachers, which refers to faculty members instructing classes in HEIs in the current study. These individuals include tutors, student assistants, and professors. The second stakeholder group includes students, who are referred to as learners in HEIs. The third stakeholder group is the HEI itself, represented by its academic institutions. This group includes the management, administration, and support units. As an HEI is part of the local community, we follow the author Bozkurt [30], who added a fourth stakeholder group, the industry. To broaden the perspective, we aggregated industry and the government (I&G) [31]. Both stakeholders strive for high-quality education and employable graduates. "The inclusion of student voice in efforts toward educational reform" [32] is emphasized in much of the scientific literature [33]. Following this call, the authors of the current study identified the barriers students experience from a survey conducted in a previous study [11]. These barriers are discussed in eight categories: *technical resources, interaction, skills, didactics, workload, health, personal readiness, and framework conditions.* Each category has at least two coded subcategories. An overview of this classification is presented in Table 1.

Table 1. Barriers to digital higher education teaching during the COVID-19 pandemic. [34].

Category	Subcategory (Code)	Number of Mentions
Technical resources	Lack of technical resources (TR1)	102
	Insufficient internet connection (TR2)	119
Interaction	Lack of social interaction (I1)	192
	Lack of discussion and participation (I2)	56
	Invisible reactions (I3)	48
	Miscommunication (I4)	62
	Low possibility to ask and get help (I5)	65
Skills	Lack of digital competencies (S1)	36
	Lack of self-management (S2)	10
Didactics	Limited possibilities for lecture design (D1)	29
	Lack of practical exercises (D2) Lack of skill	13
	transfer (D3)	3
	Lack of knowledge transfer (D4)	11
Workload	Higher workload (W1)	7
	Laborious group work (W2)	30

Table 1. *Cont.*

Category	Subcategory (Code)	Number of Mentions
Health	Higher stress level (H1)	4
	Isolation (H2)	19
	Bodily discomfort (H3)	11
	Concentration problems (H4)	66
Personal Readiness	Lack of flexibility (PR1)	15
	Lack of trust (PR2)	5
	Lack of motivation (PR3)	130
	Fear of change (PR4)	7
Framework Conditions	Insufficient institutional framework (FC1)	46
	Insufficient learning environment (FC2)	27

Technical Resources are conceived by students as a barrier when technical resources and/or internet connections are inadequate. Students considered that *interaction* was seriously disrupted in digital HE teaching during the COVID-19 pandemic, as they articulated in various subcategories, such as the lack of social interaction, discussion, and participation, invisible reactions, miscommunication, and the low possibility to ask and obtain help. Digital HE teaching requires that both teachers and students have certain *skills*. For example, problems associated with the lack of digital competencies were observed and, students noted the lack of self-management strongly required by digital teaching. Digital HE also requires specific *didactics*. The current didactic concepts in conventional teaching could not be transferred during the pandemic, but they should be adapted for the use in novel conditions. Students considered this to be a barrier due to the limited possibilities for lecture design and the lack of practical activities as well asskill and knowledge transfer. Students' *workload* was altered by the COVID-19 pandemic [7,35,36]. Digital HE led to a higher workload [37], and digital teaching increased the students' assignment workload. Frequently, students were required to participate in group work; thus, this barrier was included in the laborious group work subcategory. Students' *health* was negatively affected by digital HE teaching during the pandemic due to higher stress levels. Social distancing restrictions forced students to study and work at home during the pandemic [8]. Therefore, this group was socially isolated. Staying at home often also led to bodily discomfort, according to students. Furthermore, students experienced concentration problems. Digital teaching was introduced immediately during the pandemic, and students did not have time to adjust. This fact was included in the *personal readiness* barrier, which included the lack of flexibility, trust, motivation, and the fear of change subcategories. External conditions could also act as a barrier to digital HE teaching; this factor was included in *framework conditions*, which includes insufficient institutional framework and insufficient learning environment as subcategories.

Barrier models, such as the one already described herein, open up the possibility for stakeholders to identify barriers more systematically and efficiently. However, identifying barriers is only one side of the coin. To offer successful digital HE teaching, barriers must also be overcome. Therefore, our current study built on the barrier model and proposed recommendations for action.

3. Method

During the course of this study, we addressed the RQ regarding recommendations to overcome barriers to the adoption of digital HE teaching by conducting an exploratory qualitative study. An exploratory study "addresses a question, a problem, or an area of concern that has previously been unresearched or under-researched" [38]. As a common overcoming framework is missing, our study aimed to develop an understanding of how these barriers can be overcome. To this end, our research design was divided into four sequential phases.

In the **first phase,** we collected qualitative data using an online survey instrument. The survey focused on students' perceptions of digital HE teaching and consisted of multiple parts. The survey included questions on socio-demographic variables, perceived barriers to digital HE teaching, and how these barriers could be overcome from students' points of view. All student participants were asked the same open-ended questions: "In your opinion, what are the 3 strongest barriers to digital teaching?" and "How could each of these barriers be resolved?".

In our research, we focused on the population of students who experienced digital HE teaching during the COVID-19 pandemic. To gain insights from the population, we opted for non-probability sampling—more specifically, a convenience sample. Compared to probability sampling, non-probability is more susceptible to bias. However, it is capable of exploring a field [39]. We surveyed students who attended one of three HEIs in Sweden, Türkiye, or Germany during the pandemic. In all three HEIs, digital higher education ERT was adopted to sustain instructions during the pandemic. We included HEIs from different countries to ensure a diverse and cross-country sample. For digital teaching, the overall digital readiness of the country is important. Thus, the countries represent different groups within the Digital Readiness Index (DRI) [40] to avoid a readiness bias. On the DRI, Sweden is in the top 10, Germany in the top 20, and Türkiye in the top 60 of 141 countries. The survey was conducted with undergraduate and graduate students during various terms. Thus, the sample included students who studied in the related HEI before the COVID-19 pandemic and those who started their studies during the pandemic. We aimed to diversify the sample because, according to Yin, diversification allows us to extract the most insights [41]. However, all surveyed students attended elective courses in business programs associated with IS. These courses were instructed on digital media and conducted entirely online during the COVID-19 pandemic. All voluntary and anonymous participants responded to the same online survey questions. In total, 396 students participated in the survey between January 2021 and January 2022. The sample included 40% male and 56% female participants, while 4% of the participants did not indicate their gender. Most participants (84%) were in their 20s.

After finishing the data collection, we analyzed the first open-ended question regarding the perceived barriers to digital teaching in the **second phase**. First, we went through all of the statements to "make sense of the whole set of data" [42]. In sum, we obtained 1190 different statements about barriers through the survey. However, not all statements could be used for the subsequent analysis because the statement was not understandable or some of the participants stated that they did not know of a barrier.. Therefore, 77 statements were excluded. The final statements contained between one and 114 words. The median length of the statements was eight words. Using a digital teaching barrier model [34], we coded the statements deductively [43]. The model we utilized for coding is a model on the barriers to digital HE teaching from the perspective of teachers. Although we did not expect student and teacher experiences to be the same, we viewed the model as a good starting point for the coding process. Adopting the teachers' model would also allow for a comparison of perspectives, although such acomparison is beyond the scope of the current study and, therefore, it is part of a different study [34]. As we could only match 382 statements to the existing barrier model during the deductive coding process, we adapted and extended the model. To do so, we proceeded with the 808 remaining statements using an inductive coding approach [42]. These codes were discussed and categorized during several revisions to ensure inter-coder agreement. Categorization aggregates coded data to set up homogenous constructs, which are heterogenous to other aggregated constructs. Categories are an intermediary step on the way to identifying patterns running through the categories [44]. In our research, these patterns were recommendations and are identified in phase four. Our categorization process resulted in a model of the barriers to digital HE teaching from students' perspectives, containing 25 different barriers divided into eight categories, as presented in Section 2.

In the current research, we extended this research to link the barriers to recommendations for overcoming them. To this end, we analyzed the answers from the second open-ended question in the **third phase** regarding students' recommendations. Existing scientific literature in the field of digital HE teaching lacks a comprehensive model of recommendations to overcome barriers; thus, we coded the statements about recommendations inductively by applying an open coding content analysis technique [42]. As in the second phase, we first went through the statements to obtain an overall impression. From the data, we were able to isolate 987 statements about recommendations. From all these statements, we had to remove statements that were not evaluable. This was the case with statements such as "I do not know" (QS), "none" (QS), "I have no answer on that" (QS), "Not sure there is anything to do with this" (QS), "I don't really think you can change this, it's probably something we have to get used to..." (QS), "I don't think it's possible" (QS), or "Unsure" (QS). In addition, some respondents provided only one keyword, making it impossible to derive a clear recommendation. Excluding these cases, 683 recommendations for action could be utilized. The final statements vary in length from one to 110 words, with a median length of nine words. Due to the open coding of the statements, we derived a list of characterizing codes for each statement. The different codes were aggregated if similar and thematically categorized. In several revisions of the categorization we ensured inter-coder agreement. Following this procedure, 26 different categories representing different recommendations were ultimately identified. Furthermore, our data indicated the responsibility for the execution of the recommendations to specific stakeholders. Thus, we allocated the responsible stakeholder (teachers, students, HEIs, industry and government; see Section 2) to each recommendation. To group the recommendations for action in terms of content and to create a common thread, we oriented towards a classification of socio-cultural digital learning elements [45].

In the **fourth and final phase**, we integrated the coded barrier and recommendation findings from the second and third phases. The barriers and recommendations were surveyed using a single data collection (cf. first phase) and the linkage between both was always preserved; therefore, we could analyze the relationships between both. The relationship among the original statements, coded barriers, and coded recommendations were aggregated into a matrix. The y-axis displays barriers, and the x-axis displays recommendations. Consequently, each cell in the matrix indicates whether a relationship exists between a single barrier and a single recommendation.

4. Findings

The current study revealed 26 recommendations to overcome the barriers in digital HE teaching during the COVID-19 pandemic. Each recommendation was assigned to one of the following socio-cultural digital teaching elements: **technologies, interaction, content, or participants** [45]. An overview of the recommendations and the involved stakeholders is presented in Table 2. Proposed recommendations are discussed below.

Digital HE teaching could not be conducted without **technological facilities**. However, the COVID-19 pandemic emphasized the lack of adequate technological infrastructure in HEIs, complicating the implementation of digital teaching. To overcome these barriers, seven recommendations are presented in the current study. First, *the availability of internet connections should be ensured.* For this purpose, a general expansion of internet availability is needed. During the pandemic, the inadequacy of internet connections became obvious. Better infrastructure could rectify the connection problems in HEI buildings. Furthermore, students' internet access should be facilitated by offering special internet pricing or free internet access. The questioned students (QS) were also aware of the inequality in technical equipment among the students. Thus, it is important to *ensure the availability of technical resources for all users*. This could include free individual or shared technical equipment in HEIs, technical equipment loans for students, financial support for low-income students, and the provision of software or apps. *The use of mobile devices* was also recommended by the survey participants. When all other technical facilities fail, mobile devices can

provide a remedy. In addition, simpler assignments, such as quizzes, can be completed on smartphones. For these emergencies during digital lectures, an IT expert team should "jump in if something is not working" (QS). Thus, every HEI should *provide IT support* for teachers and students. Alternatively, or in addition, *providing manuals* could be helpful, whether in the form of instructions or tutorials on various systems or software.

Table 2. Recommendations.

Element	Recommendation (Code)	Number of Mentions	Stakeholder Involved
Technologies	Ensure internet access (T1)	48	HEI, I&G
	Ensure the availability of technical resources (TR2)	63	HEI, I&G
	Use mobile devices (T3)	3	Students
	Provide IT support (T4)	5	HEI
	Provide manuals (T5)	5	HEI
	Employ technological facilities in lectures (T6)	10	Teachers
	Keep systems up to date (T7)	10	HEI
Interaction Processes	Enable interpersonal exchange (IP1)	82	Teachers
	Offer counseling for student concerns (IP2)	54	Teachers
	Foster groupwork in lectures (IP3)	18	Teachers
	Organize student learning groups (IP4)	15	Teachers, Students
	Foster interactivity in lectures (IP5)	49	Teachers
	Adjust lecture conditions (IP6)	33	Teachers, HEI
	Implement mandatory attendance (IP7)	7	Teachers, HEI
	Set communication guidelines (IP8)	47	Teachers, HEI
Content	Adjust the lecture design (C1)	41	Teachers
	Offer hybrid formats (C2)	34	Teachers
	Apply the learned knowledge (C3)	2	Teachers, Students
	Establish and communicate a clear lecture structure (C4)	31	Teachers
	Set examination policy (C5)	10	Teachers, HEI
Participants	Change the mindset (P1)	20	Teachers, Students
	Have mutual understanding (P2)	14	Teachers
	Offer training (P3)	37	HEI
	Monitor student progress and performance (P4)	6	Teachers
	Create a clear daily structure (P5)	18	Students
	Ensure an appropriate work space (P6)	21	Students

Such manuals would allow access for both teachers and students freely whenever they need (QS). Current technologies and systems provide various methods to conduct digital teaching that are not fully exploited based on the views of the surveyed students. Several participants emphasized the *employment of technological facilities* in lectures. They mentioned the employment of videoconferencing rooms, the digital presentation of materials via screen sharing, and the development of virtual reality environments. For these accomplishments, *keeping systems up-to-date* is crucial. HEIs should permanently review the "features and quality of various applications employed by students and teachers" (QS) as they might require upgrades or replacements. According to the students, it was the external providers' duty to optimize systemic functions continuously.

The next set of eight recommendations refers to the element of **interaction processes**. During digital teaching, personal interaction decreases between teachers and students, making it even more important to *enable interpersonal exchanges*. The surveyed students observed various possibilities, such as social events, real-life meetings, chat groups, or networking portals. The participants also mentioned *counseling opportunities for students*

concerns, employing various methods. Several participants mentioned Q&A sessions as an additional facility beyond the lectures. Consultation hours, which could allow one-on-one conversations between instructors and students, could also add value by providing teachers with additional insights into the students' mental state. Furthermore, students missed being able to ask teachers direct questions after class. Although easier to do in face-to-face instruction, it is also possible if the lecturers were available after online lectures. Finally, better e-mail interaction between the teachers and the students and prompt teacher responses could be sufficient as well.

To promote further interaction among the students, *group work should be fostered in lectures*. The free selection of group members was especially important for the students (QS), as they could then maintain social contacts beyond group work. In addition, students considered the *organization of student learning groups* to be necessary and helpful: "Lecturer or students could organize study circles where students could talk and discuss" (QS). Furthermore, *fostering interactivity in lectures* was considered a key factor for successful digital teaching. This could be achieved by introducing interactive elements such as "more engaging exercises during class [. . .]" (QS) and active discussion moderation by the teacher. However, students' openness to participate in discussions is also crucial. Consequently, it could be necessary to *adjust the conditions of the lectures*. The reduction of the class size was especially strongly argued by the students as smaller class sizes would facilitate digital teaching.

Furthermore, students believed that both regular breaks and the reduction of class hours were important. Mandatory attendance could also increase participation in digital lectures, although such a policy should be determined by HEI policymakers. To guarantee good communication during digital lectures, teachers should *set communication guidelines*. Participants frequently suggested keeping cameras on at all timesduring the lectures (QS). Videoconferencing system functions, such as the hand sign symbol or chat, should also be employed to coordinate communications.

The participants mentioned five recommendations related to the **content** element. The present lectures were only conditionally fit for the digital HE teaching format: "Since we left the classroom environment, [the] way of teaching should also change, online classes like a physical classroom is not very useful [. . .]" (QS). Students realized the need to *adjust the lecture design* and stated that the courses could be changed to fit online learning (QS). This was also the case for educational tasks and assignments, which should be adapted to the virtual world for the students to complete them. The students considered a combination of physical and digital lectures as desirable. This could be achieved by *offering hybrid formats*. Such an approach would lead to "a balance between the conventional and new [lecture formats]" (QS). For example, a combination of face-to-face student presentations and theoretical knowledge instruction with recorded lectures was considered adequate.

Students recommended the *application of the learned knowledge*, which would be possible via "more practical courses [. . .]" (QS) or "internship[s] in corporations [...]" (QS). Independent of the method of transfer of the lecture to the virtual space, *establishing and communicating a clear lecture structure* became more important. As it is necessary to ensure that every student is aware of the instructional approach, communication efforts in classes should be improved. Additionally, all information should be included in learning management systems. The successful completion of a course usually entails an exam. Students believed that online exams were immature, and they recommended the determination of exam policies. The "exam methodology should be based on online practice" (QS). This could lead to alternative exam methods that employ technical facilities to supervise the exams. However, when this is not possible, the students recommended face-to-face exams.

The **participants** in digital teaching were considered the final element. Six recommendations were proposed by the students. Digital HE learning became a challenge for all involved and led to various prejudices that should be eliminated. The participants recommended a *change in mindset* to be "[. . .] open to change" (QS). Furthermore, a *mutual understanding* of the situation was considered important. Teachers and students should be

aware of each other's conditions and be more understanding "by not placing too much [of a] burden [. . .]" (QS) on one another. All participants should be aware of connection problems and/or the lack of equipment. However, how to conduct digital lectures or digital discussions could be learned. Therefore, students recommended *training opportunities*. For teachers, the training should achieve a "deeper understanding of digital interaction" (QS) and entail the availability of a higher "number of digital experts" (QS). For students, "digital courses on IT" (QS) and learn-to-learn courses were considered necessary. Furthermore, *monitoring student progress and performance* was recommended, even if it was considered an "obviously hard task" (QS). Evaluations regularly soliciting student feedback on learning could be used for this purpose. The rapid conversion to digital teaching disrupted all previous routines of the participants. Thus, it is important to *create clear-cut daily structures* by developing new routines and study schedules. A basic need for study in both virtual environments and HEIs is the physical space. The students need to have adequate study spaces. For this purpose, certain rooms could be made available in the HEIs, such as "specific single individual study pods in libraries" (QS), to avoid other public spaces such as cafes, lobbies, or trains. At home, it is important to avoid all distractions.

The current and previous study findings were combined in the last phase to recommend certain actions to eliminate the barriers to digital HE teaching during the COVID-19 pandemic. The matrix that assigned the recommendations (x-axis) to respective barriers (y-axis) is presented in Table 3. The row and column labelled "N" represent the number of mentions of the respective barrier or recommended action. These figures are also shown in Tables 1 and 2. New in this table are the numbers within the matrix. Each matrix cell with a number indicates a relationship between a barrier and a recommendation. The numbers are absolute numbers indicating how many times a certain relationship was observed in the data. The numbers range from 58 to 1. For example, the participants in our study named "Enable interpersonal exchange (IP1)" 58 times to overcome the barrier "Lack of social interaction (I1)". In contrast, for the barrier "Lack of self-management (S2)", "Create a clear daily structure (P5)" was mentioned only once. The matrix can be viewed from different directions. If the matrix is read from left to right, it shows which recommended actions can be taken to overcome a given barrier. If, on the other hand, the matrix is read from top to bottom, it shows which barriers are influenced by a given recommendation for action according to the student's point of view. The matrix indicates that various recommendations suggested by the participants could help overcome barriers. A blank cell in the matrix, however, means that the barrier and recommendation were not mentioned in combination.

Table 3. Matrix: Relationships between barriers and recommendations.

			Recommendation																								
			T1	T2	T3	T4	T5	T6	T7	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8	C1	C2	C3	C4	C5	P1	P2	P3	P4	P5	P6
		N	48	63	3	5	5	10	10	82	54	18	15	49	33	7	47	41	34	2	31	10	20	14	37	6	18	21
Barrier	TR1	102		49	2	5			1										3					3				
	TR2	119	48	8	1			1							2				11					4				
	I1	192						1	2	58	15	12	6	5	6		8	3	1		1				2			
	I2	56		2				1	2	3		1		11	4		9	4	1							3		
	I3	48							1	1				4			13		3							1		
	I4	62							2	7	10		1		2		2				11				1			
	I5	65							1		24			6	1		7							1		1		
	S1	36					5																		21			
	S2	10								1										1	4						1	
	D1	29						3						1	2			14	1						1			
	D2	13						1										1	2	1	1							
	D3	3																	1						1			
	D4	11											1					1	1		4							
	W1	7																4						2				
	W2	30		1				1		4	2	2	1				1	5								1	1	
	H1	4													1													1
	H2	19								5			1											2			1	1
	H3	11		1											3				3									
	H4	66												11	9		2	4	2		1			1	2		4	5
	PR1	15																					7		4		1	
	PR2	5																					4		1			
	PR3	130						2		3	3	3	5	11	3	7	3	5	5				5	1	3		10	7
	PR4	7																					3		1			
	FC1	46		1					1												9	10	1					
	FC2	27		2													2											7

5. Discussion

The present study analyzed the methods to overcome the barriers to digital HE teaching that were identified by students during the COVID-19 pandemic. A survey allowed for the elaboration of the actions to overcome certain barriers at once. Each recommended action addressed one or more stakeholder groups in digital HE teaching. Previous studies have revealed that each stakeholder had different demands regarding digital teaching and views on its impact on education [30]. Certain recommendations proposed in the literature went so far as to recommend compensation for teachers who made course content available online or to determine short- and long-term goals for the HEI. I&G requires quality assurance for education, whether on campus or online [30]. Furthermore, they could provide resources to solve barriers such as equipment. In our study, it was evident that certain recommendations could only be realized by the teachers or the students, such as mutual understanding about the lack of technical equipment. Others could not be influenced by these stakeholder groups and were rather associated with HEIs or I&G. However, all stakeholder groups should work in collaboration to overcome barriers to digital HE teaching to ensure high-quality education.

To provide a methodical overview of the recommendations, we categorized them based on sociocultural digital teaching elements (technologies, interaction processes, content, and participants). Most recommendations were associated with interaction processes, followed by technologies, participants, and content. The barriers analyzed in our previous study revealed that interaction was a significant issue for students. The most frequently mentioned issue in the survey conducted with the students was related to the *Interaction* barrier category [11]. This issue, which was strongly perceived as a barrier, was also addressed in various recommendations for action. The most prominent relationship in our data existed between lack of social interaction (I1) and enabled interpersonal exchange (IP1). Other recommendations that could be helpful in overcoming barrier I1 stem from the same group of interaction processes. Other studies have highlighted that many students complained about the deterioration in communication and interactions between students and teachers during the pandemic [46]. Even before the pandemic, interaction and connection with peers and teachers were considered a strong driver of academic success [47] and student engagement [48]. Our research adds to recommendations on the four dimensions of student engagement, which are emotional, behavioral, cognitive, and social [48]. Recommendations on interaction processes in particular foster the social dimension. In addition, the role of teachers has significantly changed in recent decades [49] and changed even further due to online teaching, as students today expect greater availability and one-on-one communication from teachers. This paves the way for a more facilitator-oriented role, which HEIs should embrace in capacity planning. Pedagogical concepts such as flipped classrooms [50] could also support changes to teacher roles, as students take a more active part in developing educational material before meeting the facilitator.

The present study findings emphasized the relationships between barriers and recommendations. Table 3 could be read in two ways. When read from the perspective of the barriers, more than one recommendation was associated with each barrier. In addition, several actions can be adopted to overcome certain barriers. The largest number of recommendations proposed that teaching had positive effects on learning motivation when compared to conventional set-ups [51]. However, in the current study, the survey conducted with the students during the pandemic revealed a different picture. An analysis of the quantitative parts of the survey data revealed that students who started online during the pandemic feared less study success than peers who started on campus [52]. This result shows how easily digital learning can be perceived as engaging or disengaging, which aligns with research on student engagement depicting a complex interaction between the two [48]. The transition to digital teaching and the pandemic-specific factors, such as social distancing and working from home, decreased motivation, leading to another barrier. Certain studies proposed improving student resilience, especially in times of crisis, to eliminate this barrier [53]. Various factors could generally be considered motivators

in HE. However, sources of motivation could be quite different for each individual [54]. Thus, various actions could be effective in overcoming the motivational barrier. The action leading to the desired effect depends on the respective circumstances. In contrast, the recommendation to offer hybrid teaching methods could eliminate several barriers [55]. Even before the pandemic, hybrid formats that combined digital and face-to-face teaching were popular as they reportedly exploited the benefits of both online and face-to-face courses [56]. The barriers that could be eliminated or mitigated with hybrid formats are presented in Table 3. However, this would only be possible once the pandemic regulations are relaxed and face-to-face teaching is again possible. Hybrid formats are not a solution during lockdowns. Nevertheless, the students' strong interest in this method demonstrated that they recognized the advantages of digital teaching but still desired face-to-face interaction alongside digital teaching. Although other reports draft lower physical class attendance and engagement post-COVID [57], HEIs should ensure face-to-face learning, for which students considered mandatory attendance a solution.

As education is conducted online, more data are available, which even the students proposed as a recommendation. Learning analytics could provide the tools to monitor student progress and performance. Thus, HEIs should implement such analytics along with an adequate learning management system [58].

The recommendation for the availability of Internet access was associated with inadequate Internet connections. Technical barriers and recommendations score high in Table 3. However, this issue could be considered a basic prerequisite for digital teaching. The pandemic emphasized global connectivity issues. The future of digital learning depends on students calling upon governments and industries to adopt a sustainable approach.

6. Conclusions and Implications

During the COVID-19 pandemic, digital HE teaching changed radically and stakeholders experienced various barriers. While embracing the positive impact of digital teaching [59], these barriers should be eliminated in the future to ensure that negative experiences are replaced with positive practices. The present paper significantly contributed to the literature by identifying the relationships between barriers and recommendations for the elimination of these barriers. Concerning the TPACK model [12], we found barriers and solutions mostly for the areas of technology and pedagogy. Further exploration of how to address conceptual knowledge is needed. Otherwise, students will experience a mismatch among the three domains. According to the SAMR framework [3], a real transformation must address the creation of new tasks through technology. These new tasks might address pedagogy or content knowledge.

The qualitative data collected from 396 students provided insights into the barriers to digital HE teaching during the COVID-19 pandemic and how these could be eliminated. The analysis of the findings led to the development of a matrix that presented the relationship between 28 barrier subcategories and 26 recommendations to eliminate these barriers. Thus, our overview went further than a mere classification of barriers; it included a systematic analysis of the recommendations for action.

Although the data were collected during the COVID-19 pandemic, the findings are valuable for the post-pandemic era, especially for online courses or online degree programs [60]. The matrix in Table 3 provides three different possible applications for this purpose [61]. In the first application, decision-makers can identify barriers in a current online course and determine recommendations for action based on these barriers to improve teaching. In the second application, past actions to eliminate barriers can be critically reviewed based on the matrix. The third application can be put to use even before the implementation of a course design, and the actions recommended by various stakeholders could be adopted proactively to prevent potential barriers. The matrix also provides a solid foundation for researchers to identify different types of barriers and recommendations and directions for future research. Although the matrix displays adequate recommendations for respective barriers, the effectiveness of various recommendations is not clear. For example,

can these relationships be converted into hypotheses? Future studies could measure the relationships between recommended measures and barriers and, thus, provide statistically reliable data on the actual relationships.

As current research on barriers to digital HE teaching has discussed the possible elimination methods, albeit with limited systematic analyses, this paper fills a significant gap in the literature. However, the proposed outcomes are based on student experiences, which is a limitation of the study findings. As the matrix is based on student assumptions, subsequent quantitative studies should verify whether the relationships between barriers and recommendations for action presented in this study are statistically significant and, if so, how strong each relationship is. At this stage, the relationships are provisional and can be used to formulate hypotheses, especially in conjunction with other studies on student engagement. Furthermore, it can be assumed that the matrix would be improved with the consideration of other stakeholders, such as teacher barriers and recommendations. Thus, further research on other stakeholder views is required. The inclusion of other stakeholders, namely including HEIs and I&G, could also improve the study's findings and the matrix. Further research could also investigate each stakeholder's power to influence the barriers.

Nevertheless, the elected methodological approach and broad data collection allowed an overview of the relationships between barriers to digital HE teaching and recommendations for their elimination. The current study's findings could raise awareness about the potential barriers and the necessary countermeasures across the HEIs. After all, only adequate action following the pandemic experience can improve digital HE teaching in the future and cannot remain a solution for a particular crisis.

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User-Oriented Policies in European HEIs: Triggering a Participative Process in Today's Digital Turn—An OpenU Experimentation in the University of Paris 1 Panthéon-Sorbonne

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Abstract: As European higher education institutions (HEIs) increasingly grapple with new challenges, the importance and difficulty of massification, democratization, and inclusion have been reinforced by the recent pandemic crisis and the simultaneous need for pedagogical continuity. Meeting these challenges not only implies a profound change in organization and teaching practices, which need to focus on user-centered quality learning, but also raises questions about financing, management, and governance. Using results from two participative experiments conducted in the French University of Paris 1 Panthéon-Sorbonne in the framework of the OpenU (Online Pedagogical Resources in European Universities) project, the authors present ethical and practical issues that currently face inclusive and user-oriented policies in the European higher education area. Through this paper, we argue that creating an imaginative and inclusive participative process is as essential today in the spirit of evidence-based policies supporting digital education as it is partial. We furthermore present emerging results on current needs, as well as incentives to increase participation. Such results ultimately allow us to draw conclusions and recommendations for institutional and national policymakers to further improve user-oriented policies.

Keywords: inclusion; user-oriented approach; pedagogical relation; participative process; social distributed learning; reflexive approach; students; peripheral learning; policy experimentation; university leadership; legitimate peripheral participation

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1. Introduction

In the last decades, social sciences fields such as sociology, political science, planning, and even architecture, have seen a rise in the popularity of experiments. The capacity to foster experimentation is argued to be one of the key characteristics of both behavioral economics and innovation policy mixes [1]. By viewing experimentation as continuous growth, the process of iterative adaptation to new circumstances and experiences is believed to pragmatically entail a certain idea of progress and improvement [2].

Perhaps one of the best known defenders of experimentation in policy sciences, Donald T. Campbell considered experiments, and more particularly randomization, to be the main pathway for scientific research and even an ideal for a better governance and Utopian society [3].

Policy experimentation can be defined as "a purposeful and coordinated activity geared to producing novel policy options that are injected into official policymaking and then replicated on a larger scale, or even formally incorporated into national law" [4]. Experimentalist governance is based on deliberation and generation of evidence, which was developed in response to command-and-control regulations. These were argued not to work in a contemporary world that experiences fast-paced changes and problems of

implementing fixed rules on the ground [5]. In contrast, experimentalist governance is increasingly considered an important driver for desirable societal transformation, and in the particular field of education, a catalyzer of innovation [6].

More importantly, though, policy experimentation is an attempt to fill a gap in our knowledge of what works and what does not. As early as in the 1960s, Harold Lasswell asserted that experiments were an effective way to improve policy making practices, generate scientific knowledge, and build capacity to implement novel ways of doing policy. These purposes imply a certain level of learning and a subsequent translation into policy practices [7]. In order for educational experimentation to work, education systems must adopt an attitude of constructive skepticism that acknowledges the risk inherent in any reform or experiment and allows them to transparently govern this process [8,9]. In this framework, HEIs represent what James Mahoney and Kathleen Thelen describe as "compromises or relatively durable though still contested settlements based on specific coalitional dynamics" [10]. They are thus not only inscribed in the political and social structure, but are themselves not strictly independent of socio-political changes.

Digitalization cannot be studied while neglecting the context. In the French public higher education area, competition between institutions has been furthermore accentuated by international rankings and the establishment of evaluation agencies (e.g., the French Agency for the Evaluation of Research and Higher Education [AERES], the High Council for the Evaluation of Research and Higher Education [Hcéres], and EQUIS) [11]. Higher education institutions have been urged to stand out by demonstrating their ability to innovate in both research and teaching. In particular, digital strategies appear to be a decisive lever for competitiveness available to higher education institutions. Whether it is to adapt training to the diversity of student populations, to increase the visibility of research and teaching activities, or to provide effective management tools, digital technology is bringing about profound changes in university policies. Thus, in such a competitive higher education system, it seems that institutions have no choice but to innovate.

Because the dominant conception of experiments in the policy sciences is that they are mainly a research method, the matter of governance and leadership have not garnered enough attention and have remained limited. Yet, such deep changes raise questions on the management process within a public French higher education institution, the current principles of which are still mostly based on the unity of time and place. When considering improvement, Gilbert developed the Behavior Engineering Model with the belief that the greatest barrier to worthy performance comes from a lack of information and support by management rather than an individual's lack of desire to perform well.

Gilbert's model focuses on two distinct factors of performance—the environment and the individual's behaviors—which can be viewed from three perspectives—information, instrumentation, and motivation. Based on his understanding of technological improvement, Gilbert's Behavior Engineering Model consists of three Leisurely Theorems that:

1. Distinguish between accomplishment and behavior to define worthy performance: worthy performance is characterized by a person's behavior and accomplishments;
2. Identify methods for determining the potential for improvement (PIP), amounting to the ratio between typical performance and exemplary performance;
3. Describe six components of behavior that can be manipulated to change performance, among which are environmental components (data, resources, and incentives), as well as knowledge, capacity, and motives [12].

Thus, the aim of this paper is to focus on motivations, participation incentives, and the ethical issues at hand during the institutional management of the technological and digital improvement process in the University of Paris 1 Panthéon-Sorbonne. This objective relies on the following observations that have been made.

First, studies show that emerging attention has been directed at the link between public governance aspects [13] and user perspective [14] since 2018. In the management, marketing, and IT fields, this focus on users through "customer-centric", "human-centered", "user-oriented" approaches has been expounded earlier by researchers (e.g., [15,16]) and prac-

titioners alike [17]. In these fields, user-centered design is often branded as a means to create highly usable and accessible products through an iterative design process in which users and their needs are involved in each phase of the design process. In user-centered design, designers use a mixture of investigative methods and tools (e.g., surveys and interviews) and generative ones (e.g., brainstorming) to develop an understanding of user needs. This allows a product to reach the standard of "external integrity" [18], which refers to the match between the product and the intended user and involves managing knowledge.

Similarly, the operational success of an experiment implies that all stakeholders (school staff and parents, local and central authorities, communities, and of course the students themselves) play their parts at all the steps, including the evaluation, which should be performed with respect to criteria decided a priori [8], whether it be "relieving [users] of frustration, of confusion, of a sense of helplessness [, making] them feel in control and empowered" [15], or to human factors, user experience, or "usability" [17].

The challenge of developing successful products, here effective policies and infrastructures that enhance the user's learning experience and improves it, requires an interrelational approach across all the key disciplines, thus leading to a higher level of "collective creativity" [19]. This aims to generate more creative solutions than those generated by less user-oriented approaches.

Second, only a few studies have been conducted on digitalization in universities. In 2021, a survey was conducted in Paris and its surrounding areas on the use of digital technology in universities and training centers. The objective of this exploratory study was to identify pre-existing digital uses in higher education institutions before the health crisis, then to analyze the solutions implemented during the lockdown and measure their impacts on students and teachers. A survey was also carried out on the sustainability of the changes once the crisis was over and the issues that were highlighted within the higher education community. A second phase of complementary qualitative interviews involved 40 teachers and students from different institutions and levels of training in order to gather their experience of distance learning. Overall, studies showed that while the health crisis has forced institutions to accelerate their transition, French higher education institutions had to rely on a massive and unprecedented deployment and use of digital technology [20]. Six universities proposed actions related to digital or distance learning through international cooperation (Paris 1 Panthéon-Sorbonne, Sorbonne Nouvelle, and Sciences Po), geographic dispersion of sites (Paris-Saclay), professional platforms (Ensam), and educational digital third parties (Evry).

In the particular case of Paris 1, although increasing attention has been given politically to digitalization in the last two years, data on Paris 1 members' perception of digitalization remain relatively lacking. Only one examination of digital use in Paris 1, which remains internal, has compared the first lockdown and the second one, showing that the student experience was not similar to that of the teachers. An explosion of use by teachers can be observed at the beginning of March 2020, while students do not follow the same acceleration curve at all.

These studies also lacked data on the particular populations of students. The aforementioned study conducted in the Parisian region only included eight student experiences, among which there was only one student of Université Paris 1 Panthéon-Sorbonne. When an informal exchange forum was conducted in Paris 1, only two students came forward, reporting the same general sentiment that was reported in other institutions. On an institutional level, surveys conducted by the ORIVE of Paris 1 only concerned three questions related to digitalization prior to the health crisis: first, student perspectives on teachers' available equipment (50% satisfied or very satisfied), second, the desire to have online or blended courses (around 40% a categoric "no"), and third, the format used to transcribe classes (more than 60% digital format) (ORIVE, 2018–2019 data, Survey on Study conditions for bachelor and master student). In 2021, a thematic survey was conducted with all the students enrolled in a Master 2 during the academic year 2020–2021, which was marked by the generalized use of distance learning. This excluded distance learning, off-site training

abroad, mobilities, online law school, Administration institutes, and preparatory classes. A total of 27% of the students responded to the survey.

However, as the survey took place in March–April 2021, the questions only covered assessments that took place before April 2021. By this date, 89% of students reported taking distance assessments during the academic year. Furthermore, the survey focused on one certain population and a certain time.

In a particular context where this institution was not accustomed to distance learning, all levels of the university were overwhelmed and had to make do with the means at hand. However, while the health crisis has made it possible to reexamine the teaching and pedagogy provided by teachers in France [20], the digital transformation was not necessarily inscribed in strategic policies. Difficulties experienced in achieving a complete and sustainable transformation have not yet been resolved, mostly and undoubtedly due to the lack of a global policy for digital transformation in certain institutions, with very different situations from one university to another.

The situation of urgency and uncertainty that characterized the COVID-19 pandemic was therefore not necessarily compatible with the implementation of real innovative projects [21]. The renewal of pedagogical practices often remains at the stage of reflection for the moment in spite of a few experiments by teachers. The adaptation of courses most often resulted in a simple transposition of the courses given in class to digital media. The COVID-19 pandemic has, for many students, reinforced a precariousness with multiple origins (cultural, economic, family, social), increasing the vulnerability of some of them.

Therefore, looking at the future of higher education from an adaptive perspective requires a better understanding of where and how students learn, since some learning activities may take place off campus. This also fits with the Vantage Points model developed by MGTaylor Corporation, which acts as a "slice of reality" serving to diagnose possible influences on behavior and identify strategies for performance improvement. Through glyphs, a certain spatial arrangement, and connections through different components, the Vantage Points models assert that "you can never understand the philosophy of a system or enterprise until you are immersed in the tasks that comprise its daily functions. The task provides a mental elevation from which the whole essence of the system can be contemplated."

Third, there is much to be learnt from the process in itself. It is no coincidence that such surveys and studies have seen a rise in number since the COVID-19 pandemic [22]. Previous literature suggests that "institutional settings define the degree and form of experimentation that is deemed legitimate" [23], implying that experiments are bound by institutional rules. In other terms, "experiments are infused with political ideas and [. . .] often confirm existing ideas rather than challenge them [24]. An 'informal' policy experiment [2] can be derived from that, exceeding formal evaluation-based learning, and creating an informal cognitive and normative learning that can influence further institutional changes [25]. Since learning occurs through trial and error, Popper emphasises the importance of being able to identify the causes of success or failure of a change.

Our study builds on those observations and refers to the outputs emerging from two participative experiments conducted in the French University of Paris 1 Panthéon-Sorbonne in the framework of the OpenU project. The processes explored in this paper fall into the gradual reforms approach, i.e., the necessity of small changes in order to more clearly identify the effects of the intervention and bring stakeholders on board.

In this paper, we report the results of those two rounds of experiments investigating the extent to which the knowledge generated in the higher education community can succeed in being pertinent when aiming to orient policies in said field. In each of the two experiments, which were conducted in spring 2022, members of the academic community of Paris 1 Panthéon-Sorbonne did not update their beliefs on digitalization when presented with the opportunity to run counter to their predispositions.

2. Materials and Methods

All figures and data used in this study stem from two participative experiments conducted with members of the University of Paris 1 Panthéon-Sorbonne University between January 2022 and September 2022.

2.1. Specification of Context, Population, and Field of Study

Both authors are themselves members of the University of Paris 1 Panthéon-Sorbonne, which facilitated their access to the field and allowed them to make full use of the necessary internal services and actors. The University of Paris 1 Panthéon-Sorbonne is also one the academic partners of the OpenU project within the framework of which lies this research. The choice of this university appeared to be particularly pertinent in the context of the stated policy experimentation process.

Paris 1 Panthéon-Sorbonne is neither the only French university in the project nor the largest one. However, it is relatively representative of public universities in the French higher education system. The university gathers around 45,000 students and 2500 professional members. It reflects the LMD system, which most European countries have adopted in an effort to promote coherence across borders, but also reflects the antagonistic nature between public entities and more selective ones ("Grandes écoles") [26]. In the year 2021–2022, around 2950 students were parallelly enrolled in an external two-year preparatory course (cours préparatoires or prépas). Those students do not attend classes in the university but remain registered as a "back-up plan" should they not be admitted into more competitive institutions.

At the same time, Paris 1 Panthéon-Sorbonne is a social-sciences-only university revolving around three disciplines—Economics and Management, Arts and Humanities, and Law and Political Sciences—and as such is one of the largest universities of humanities and social sciences in France. This exclusive nature is particularly interesting here as this paper's discussions include the acceptance, adoption, and use of technologies [27], which lies at the heart of the expertise of the university.

Its campus, which is famously based in the capital city, is characterized by its scattered nature. The University of Paris 1 Panthéon-Sorbonne is located on 25 sites in Paris and the Ile-de-France region, with more than 1500 students being enrolled in non-LMD (capacités, university diplomas, DAEU, etc.). Its research departments are structured around three major disciplinary poles with 36 research teams, including 23 UMRs under joint supervision with the CNRS or IRD and 13 host teams, as well as 10 doctoral schools.

The university also lies at the heart of a network of international relations covering five continents. More than 670 foreign students were registered in the university in the academic year 2021–2022. This is facilitated by the University of Paris 1 Panthéon-Sorbonne's choice since 2020 to continue applying the same registration fees to French and foreign students, whether they are of intra- or extra-European origin. Beyond mobility, more than 1100 students are enrolled in off-campus courses in nine countries abroad, while 800 students are either in joint degrees or in double degrees [28].

This large, yet exclusively humanities-oriented panel, therefore provides an appropriate field in which to conduct qualitative and reflexive experimentation on the role of community members in policy making.

In the process, we address the following questions:

Research Question 1. (RQ1)—*What are the current barriers to the digital turn, as seen by non-strategic members of the community?*
Research Question 2. (RQ2)—*How to implement an inclusive user-oriented participative approach in the digitalization of university, i.e., how to ensure participation, and adherence?*
Research Question 3 (RQ3)—*Which ethical issues are at play when building policies based on such approaches?*

Specifically, we have six principal hypotheses about how the effectiveness of policy experimentation will vary. The assumptions guiding the paper were as follows:

H1. *There is a lack of information leading towards a lack of acceptance.*

H2. *The aforementioned varies in accordance with social factors, including marginalization.*

H3. *A more participative process is requested by concerned parties.*

H4. *When existent, participative processes remain quite lethargic due to a lack of incentive.*

H5. *Participative processes only concern and include those who are favourable to the topic of digital education.*

H6. *Participative processes only concern and include those who are interested in the topic of digital education.*

In order to bypass possible bias stemming from such a close relationship, the choice was made to use different sampling techniques when addressing the target groups.

Non-probability sampling techniques were useful in this exploratory and qualitative phase of the study, as the aim was not to test a hypothesis about a broad population, but to develop an initial understanding of a small population. After a limited voluntary response (discussed below), a more judgemental sampling was implemented to consume less time and select a committed and diverse sample for conducting the focus group. Such diversity did not only concern different bodies (students, administrative body, and teachers) but also clusters such as gender, nationality, associative engagement, and interest/position vis-à-vis digital technologies. Encapsulating such a diversity required an extensive knowledge of those involved to select a sample that is most useful to the purposes of the research and gather a varied range of data on their experiences.

The second experimentation phase first built on this sampling, combining a voluntary response (in which already existing students were free to volunteer or not, while a call for contribution was also disseminated) together with a snowball sampling where students recruited other potential participants with similar characteristics. However, and in order to extend the representativity of the study, the second part of this phase, which consisted of a survey, relied on a voluntary response. The survey was sent out to all 45,000 students. Sampling here was therefore random. All the same, it is still not possible to speak of a probabilistic sample, as some respondents were at least somewhat inherently more likely to volunteer than others, whether it be due to their availability, to their interest, or to their acceptance of using online technologies to respond. Such circumstances were taken into consideration, and are further discussed in this paper.

2.2. Data Collection in Two Phases

2.2.1. First Experimentation Phase

The first experiment (hereafter Phase 1) lasted between January 2022 and April 2022.

The purpose of this phase was to examine the expectations of users of the EU universities in digital times and report on outputs stemming from the creation of an engaging and inclusive imaginative process for members of the community where ideas are received, deepened, and put into use. This process aimed at wholly involving diverse university members and thus strengthening their perception of themselves as key players in their universities. At the same time, it aimed to extend the network of the OpenU project within the university while engaging members in marginal discussions that would feed into the institutional level and current interrogations within policy spheres and EUAs. While working on expectations and imagination, mediation was used to lead the collective work toward the definition of changes in digital policies necessary to meet and satisfy the expectations and hopes.

To that end, a series of focus group working sessions were held between members of the Paris 1 community, as shown in Figure 1. The primary aim of the focus group working sessions was to assess and identify expectations of users of the EU universities in digital times. Collective work was led to define changes in digital policies necessary to meet and

satisfy the expectations and hopes. A certified professional facilitator was recruited to chair the meetings, train the trainers, and ensure impartiality.

Such sessions heavily relied on the philosophy of focusing on the real needs of users. It also built on inclusion and the necessity of leaving room for plurality, as it intends to sensibly welcome differences (of means, perspectives, priorities, etc.) between the present/future of some and the present/future of others. The focus groups were based on an adapted Design Sprint process in that it worked on the basis of a rapid approach, allowing participants to understand, analyse, decide, imagine, and test thanks to having user feedback within an imposed time constraint and in the absence of iterations. While the process did not limit itself to five consecutive days in order to adapt to the community's calendar, its priority remained to limit the risks and uncertainties linked to innovation. Beyond reaching an immediate result, it moreover stimulated creativity, improved the credibility, engaged diverse views, and generated a strong motivation and a training of the concerned sample.

This process proved to be well adapted to the process as it clearly explained who does what, when, how, and with whom, yet without interfering in the collaborative multidisciplinary innovation method that is at the heart of the focus group.

Through a call for participation, 12 members were identified from the three bodies of the academic community within the university (students, teachers, administrative staff). This group was diverse as it included both members familiar and unfamiliar with digital tools, teachers who are skeptical of them, foreign students, undergraduate students, PhD candidates, alumni, administrative staff, and involved members in Una Europa. Participants were to live the experience of a deep sharing in the thinking process, which is necessary to foster a belonging feeling in participants and trigger deep involvement. They should be able to share hopes, expectations, and dreams about the digital university and the capacity of change of the university that would allow for better experiences as students, teachers, and administrative staff.

The steering group monitored and approved the quality and ethics of the expected project results against the progress indicators and the key question it sets at the beginning of the project.

By the end of this project, it was expected that participants would have engaged in an imaginative process that they found relevant to the OpenU project, but also that they would feel their contributions had been received with openness and had contributed to the final outcome and that their results can feed into the downstream discussions and steps within OpenU.

Personal data was limited to what was necessary for the purposes of processing the data: name, status in the university, and discipline.

However, a privacy statement was drawn up concerning the personal data, which was all the more necessary considering the trust environment that was built. For this reason, the confidentiality of all participants' information shared in this focus group was respected.

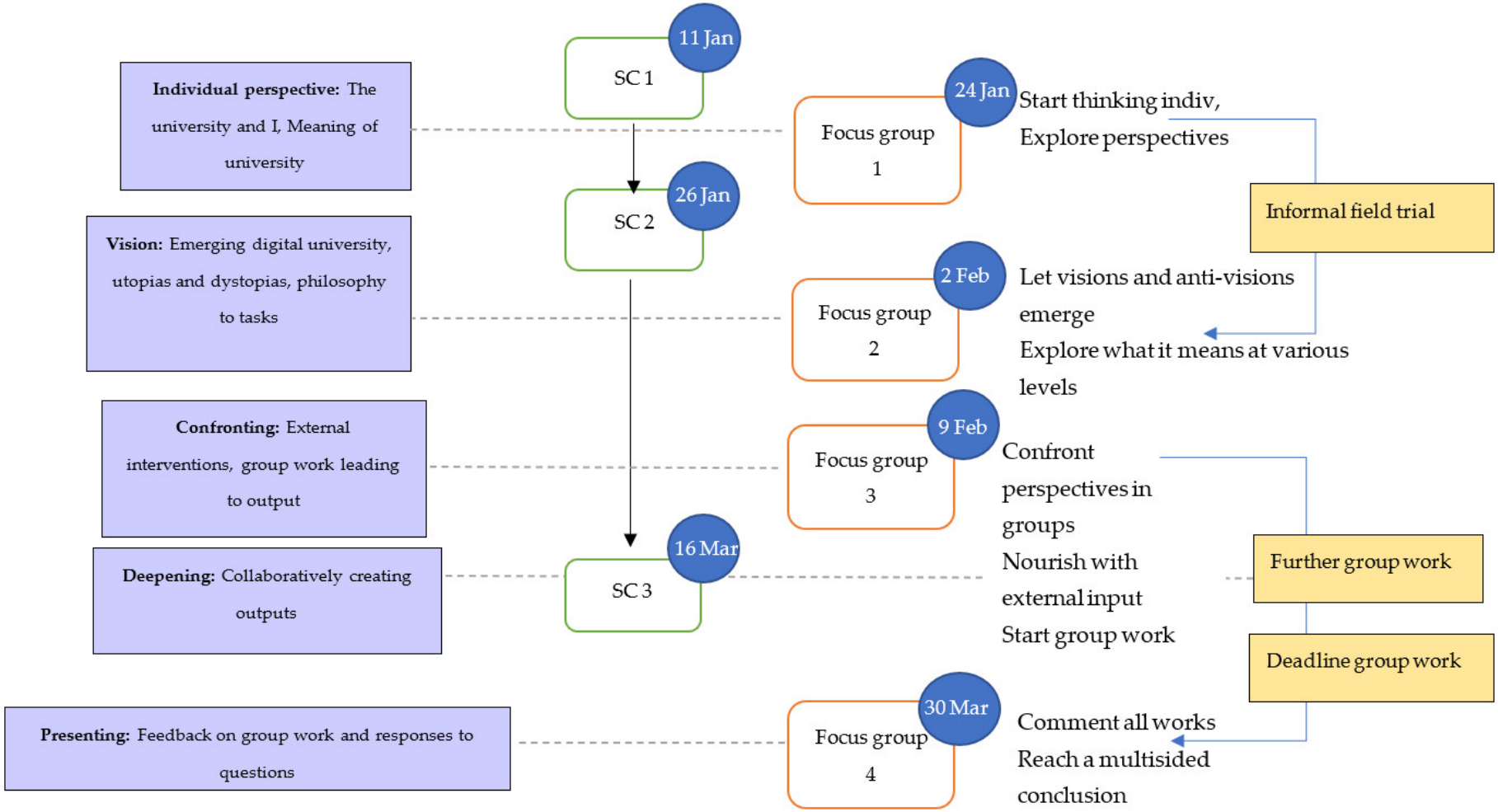


Figure 1. Structure of the Experimentation Phase 1 (designed by © Kumquat).

Two overarching questions were designed by participants in the experiment and guided the experimentation: How are we to consider the digital university and what does it look like? What are its challenges and limits? What are the hopes, fears, and priorities regarding the use of digital technology in order to ensure an optimal implementation of education, research, and study?

Such a qualitative method made it possible to give control to the participant, within well-defined limits, while giving them a certain liberty in the used discourse. The participants take a direct part in the production of knowledge, exercise immediate control over the work and conclusions of the researchers, and directly link the analyses to a social praxis that is quite different in nature from scientific experimentation as it is conventionally conceived. It is important to note that this is not contradictory to the research register because it is still a matter of taking the initiative, ensuring the methodological conduct, and assuming responsibility for the conclusions.

The role of iteration here allows "a loop-like pattern of multiple rounds of revisiting the data as additional questions emerge, new connections are unearthed, and more complex formulations develop along with a deepening understanding of the material" [29]. It is less a question of asking good questions than of asking good questions of oneself, so that they emerge naturally in the course of the interview, which is conceived as a true interlocution [30]. Such a question is therefore to be linked to a deeply reflexive process, the key to sparking insight, developing meaning, and progressively leading to refined focus and understandings.

It is also noteworthy that these two questions themselves stem from a number of diverse questions that came out of a collective discussion, such as:

- What does the ideal digital university look like?
- How does digital use correspond or diverge from the missions of the university?
- How does the digital university raise concerns?
- How does digitalization of the university have an impact on your daily life and work?
- What are your expectations with regards to security and privacy of digital universities (and why?)
- Where to start?
- Does digitalization improve pedagogical content?
- How does fragmentation and interoperability of digital services affect your work?
- What did you learn from your experiences with the digital university during the pandemic? (positives and negatives, necessary/desirable/unwanted things)
- Is digitalization necessary? It is inevitable?
- Can links be established between the digital university and society at large?
- What institutional guarantees would you like for the digital university? (diploma, ECTS, transferable credits to your home university)
- How to overcome the language barrier?
- How can digital functionalities support mobility?
- Which changes would be necessary for the coordination and delivery of this new pedagogy?

Objectives were therefore to sufficiently engage members of the experimentation collectively so that they would provide a reply to those questions.

2.2.2. Second Experimentation Phase

The second experiment (hereafter Phase 2) started in May 2022 and ended in September 2022. One of the main targets of this phase was to build and conduct a survey in the student population of the university on digitalization. The main principle guiding this phase was the inclusion of students from the beginning of the experimentation as main actors in the EU HEIs, which implies a high level of inclusion for students in the HEI's teams. Students were involved in the project from the beginning and were called to lead and conduct the experimentation, and at the same time policy making, inside the project. Students were also naturally targeted by the questionnaire and were involved in the analysis of the study.

Students took up the question of digital pedagogies in order to design a survey that reflected their needs, fears, and expectations. Special attention was given to the diversity of participants. The steering committee was made up of six students from different fields (informatics, arts, economy, history), different levels (bachelor, master, doctorate), and different profiles (CPGE before university, foreign, L1 to L3 at university, reorientation during the course, etc.). The steering committee was involved in (1) the survey design, (2) the launch of the questionnaire, (3) joint meetings with JU students, (4) the interpretation of the results, and (5) the communication of the results.

The objectives of the survey, as decided by the students participating in the Steering Committee, were to be informed of students' needs and expectations (both in times of crisis and outside of these periods) to facilitate the current reflections. The survey was therefore a way to become actors of change, and to actively participate in the evolution of our university, and to potentially be heard. In particular, the survey aimed to examine the strength and opportunities of digital in the university, to gather feedback on past experiences with digital in the university, and to entertain possible prospects for improvement of the digital system.

It was decided that there would be no limit to the number of students. The exclusion of courses outside the Learning and Research Units (IAE, ISST, EDS-IED, CIPCEA, DEVE-PSC) or Erasmus courses, exchange programs, delocalized courses, CPGE, etc., was perceived as a potential limit to the diversity of responses. The steering group felt that all students enrolled at Paris 1 would be concerned and that those involved in mobility and exchange programs could have interesting opinions, even if it was admitted that there was a strong chance that they would not respond. The survey therefore concerned all 47,318 students with a first question concerning the profile of the respondent in order to identify particular sources and contexts.

The questionnaire consisted of thirty-two questions, including four open-ended questions, covering five different aspects:

- Identification of the respondent.
- Distance learning conditions.
- Students' experiences with digital technology at the university.
- Preferences of the student for improvement of the digital system currently in place.
- Students' preferences with respect to communicative and informative measures in the digital university.

Respondents to the survey were informed of the context and purpose of data collection. The information collected in this survey was processed by computer, and the data concerning students were used in a strictly anonymous way. The recipient of the data collected is the University of Paris 1 Panthéon-Sorbonne which will establish indicators.

The survey was launched online on the BLOOM platform using the LimeSurvey tool on 17 June 2022 (LimeSurvey Community Edition Version 5.2.14+220214, LimeSurvey GmbH, Hamburg, Germany) An email reminder was sent on 28 June 2022 and the survey was closed on 7 July 2022. A total of 304 students responded. The survey was optional and anonymous, and the data collected were used strictly anonymously. In accordance with the French Data Protection Act of 6 January 1978 and the RGPD, students had the right to access and rectify data concerning them.

In both of these phases, the aim of such narrow but well-identified experiments was not to replicate the current disposition but rather to challenge it. Here, policy experimentation is designed as a means to possibly reach out to actors who have normally been excluded from public governance processes. Therefore, the valuing of innovation would not be specific to that publicly expressed by the education system, but would be directly linked to social representations of innovation [31].

Notably, both the two phases put forward a participatory approach, designed to actively involve the target population, i.e., students. While participatory evaluation processes are sometimes deemed less "scientific" and "objective" than more traditional processes, they allow stakeholders to take ownership of the results of their actions and to make them evolve according to the conclusions they have reached. This is all the more necessary as

evaluation means projecting a system of values (a frame of reference) and expressing a particular point of view on the action, so it is important to encourage the expression of a diversity of points of view on public action so that the social legitimacy of the evaluation is as broad as possible [32].

Participatory evaluation was deemed to offer greater external validity to the evaluation exercise, because it is discussed by concerned stakeholders, encouraging the expression of a diversity of viewpoints. The evaluative judgment is thus constructed from a multiplicity of informed opinions. The participation of stakeholders in the evaluation exercise is then seen as a guarantee that societal concerns will be better considered in the objectives of future projects, which gives these projects greater external legitimacy [33]. By organizing the exchange of points of view, participatory evaluation allows the evaluation process to be an exercise in the co-construction of public action. The confrontation of one's point of view with that of others, the better understanding of the motivations of the other stakeholders, and the identification of points of convergence and areas of irreducible disagreement between actors will enable progress to be made in the collective construction of the decision-making problem. In a way, it is a question of betting on collective intelligence and mobilizing the energy resulting from differences to channel it towards the creation of something that has never been created before.

This evaluation, by seeking to give voice to those traditionally excluded from public debate—particularly the most disadvantaged groups—aims to broaden and enrich public debate. There is here an emancipatory purpose expected of participatory evaluation [32]. If the citizen is involved, this breaks down his or her feeling of apathy, isolation, and powerlessness.

One of the longer-term aims was that results of the evaluation will have all the more chance of being used if the students have participated in the different stages of the evaluation process and they therefore better assimilated the analyses and results of the evaluation. In addition, the more they have contributed to the evaluation process, the more likely it is that they will agree with the evaluation findings. It is therefore hoped that the recommendations will be easier to implement and that there will be fewer obstacles to the solutions adopted [34].

Among the participatory evaluation methods, the choice was made to resort to the accompanied self-evaluation. This was viewed as being one of the most complete in that context because (1) all the participants in the implementation of the project are the actors of the evaluation, from the definition of the objectives to the conclusions, and (2) the methodological and institutional support is provided by an external facilitator, either the ORIVE or the IAF, who brings their competence and the necessary distance from the project to learn and evolve. Accompanied self-evaluation allows the actors to retrace together the path they have taken and to have a long-term vision of what they want to pursue: to find the major stages of the project, to see how the objectives have been implemented, how they have evolved and why, and to identify the obstacles and the resources of which they were not necessarily aware This is an exercise that requires a special kind of perspective and questioning. Moreover, the evaluation can lead to questioning that is difficult for the group to assume if there is no one to regulate this process.

2.3. Data Analysis

Ultimately, by September 2022, material used for the analysis presented in this paper consisted of the following material milestones and outputs:

(1) Results of benchmark evaluations as collected at the start of the first phase from participants of focus groups and steering committee meetings.
(2) Material outputs stemming from working sessions of the first phase—here, written recommendations intended for strategic, institutional, and political levels, as well as a tool kit for facilitating interactive and inclusive pedagogies and decision processes.
(3) The final survey resulting from exchanges and meetings with the Student Steering Committee during the second phase.
(4) Data collected through the survey from 304 students of the University Paris 1 Panthéon-Sorbonne.

(5) Participatory rapid appraisals and observations emerging from working sessions and meetings of both phases, and collected using a collaborative and overarching log book.

Each of the two experiments used both qualitative and quantitative methods to analyze its data.

In Phase 1, data was collected during focus groups and during pre- and post-session surveys.

Through participant observation, text analysis was implemented in order to gather sentiment information. This technique allows the intentions and emotions of discourse to be understood and monitored, whether it is positive, negative, or neutral, and to be analyzed depending on certain factors. In order to maximize realism, classifications were only identified through participative observation, rather than being purposely triggered. Special attention was given to discourse-generated model practices and argumentative and/or legitimating elements.

Furthermore, analyzing the argumentative, dramatizing, and evaluative statements, causal relations (cause–effect), and their link to responsibilities, problem dimensions, value implications, moral and aesthetic judgments, consequences, possible courses of action, and others, allowed building a case towards action generating schemes and frames, which were reflected by further outputs.

Given the focus on discourse analysis, it was crucial to use qualitative methods, in order to yield findings that reflected the participants' perspectives, experiences, and emotions on a topic that, although daily, remains related to the private spheres.

This was also complemented with a regression analysis using historical data (pre- vs. post-) to understand how a dependent variable's value is affected. This analysis method was used in analyzing the survey's responses. The same questions were asked both in an initial questionnaire before the project started and in an evaluation questionnaire after the project had taken place, concerning knowledge of digital university services, opportunities to access and assess digital services, satisfaction and participation, and perspective on participative process and channels. Following this, the results from both questionnaires were evaluated to demonstrate the evolution in opinions over the course of the project. A comparison diagram shows the results from the initial questionnaire and the results from the evaluation questionnaire on the right. This data was also cross-referenced with outputs stemming from the aforementioned text analysis, in order to monitor changes that occurred throughout the project.

Similarly, Phase 2 required both a qualitative participant observation and a more quantitative analysis. By joining and participating in student discussions, we simultaneously observed and documented interactions while noting invaluable information on the topics which subjects would be reluctant to talk about during interviews, because they are considered as obvious until discordance arises. Thus, thematic analysis was conducted. This involved noting the shared data before identifying and reviewing five main themes: perception of digital tools, perception of digital practices, perception of digital use, perception of institution, and perception of students. Each theme was examined to gain an understanding of participants' perceptions and motivations.

For students who had already participated in Phase 1, inference served to examine whether there were significant differences between the two phases. The main effects of each phase were identified, and comparisons or contrasts were established to determine between which conditions a difference was observed.

Additionally, analysis of the survey was also conducted by a student in line with the overall phase's structure. Before quantitative analysis, the gathered data were prepared. The dataset was checked for missing data and outliers. The responses obtained in the 28 questions were entered into the computer and started with a presentation of the data, a "flat sort". This was done in the form of a table (all the data were included, which is appropriate in the case of small numbers), or in the form of a graph, to give a synthetic view of the data, a general trend.

After the simple presentation of the data, the hypotheses for analyzing and understanding the responses were discussed together with the ORIVE and the research team,

question by question or criterion by criterion. This involved comparing the data with each other (from questionnaires and interviews) or with the existing review of literature. Some questions were cross-referenced to identify links. These cross-references and cross-sortings were presented in the form of a graph with the mention of a possible statistical link if the data were representative. A breakdown of the results by field of study was carried out in order to extract potential similarities between the fields of study, in accordance with the one predefined by Université Paris 1 Panthéon-Sorbonne. Five sheets grouping the students by discipline were produced: Art; Law–Political Science; Economics–Business–Mathematics; Geography–History–Art–Philosophy; and Institutes (IAES-IDUP-IEDES-IREST). This breakdown implied that students enrolled in a double degree program in two different fields of study were considered in each field.

Overall, the results were expressed as percentages in the graphs, and as numbers and percentages in the tables, except for the sheet concerning art students, where they were only expressed in headcount due to the small number of students (seven students). As the number of respondents was small, the results must be interpreted with caution and the percentages are given as an indication. In addition, due to rounding, some totals may be less than or greater than 100%.

For the multiple-choice questions, the results were presented in a similar way to the single choice questions.

As for open-ended questions, a content analysis was carried out where description and data analysis are presented together. An initial analysis of each question was carried out, reviewing consistency of responses, possible contradictions, and statements that directly or indirectly identify the respondent. This was followed by a cross-sectional analysis question by question. The report classically presents a question-by-question analysis, or more frequently a criterion-by-criterion analysis of all the interviews, illustrated by excerpts (with anonymity of the respondents). The aim is to identify the homogeneity or, on the contrary, the diversity of points of view.

The target's perception of each organizing dimension was measured. The variables whose factor loadings were concentrated on the same factor were grouped. This also served to uncover variables, which allowed streamlining specific segments.

Since data analysis and interpretation can be influenced by the personality and culture of the evaluator, having unbiased data collected in a neutral and fair manner ensures validity and reliability.

In both phases, neutrality and impartiality were considered while constituting an evaluation team that would overcome biases in data collection, and also in the analysis of the results obtained for better objectivity in scaling up or replication in another context. While in the first phase an impartial facilitator was recruited, in the second phase the student was assigned by the ORIVE service due to their reliability. This, therefore, guaranteed administrative and political independence.

In parallel, and due to the mixed-methods situation, exclusively relying on a neutral and impartial team would lead to a situation of non-in-depth or superficial analysis of cases or phenomena during the process. Both independent entities were supervised by institutional components in the shape of the International Affairs Department and the ORIVE. The ORIVE furthermore declared the survey to the data protection officer, as it was not implemented through internal services but through the OpenU project and its platform. Most importantly, the information collection stage required use of prior knowledge and expertise in the field to better understand the responses and collect information. The interpretation therefore relied on regular and open peer-discussions with analysts and was finalized by the authors.

3. Results

3.1. Remarks on the Perception of Digital(ized) Universities

3.1.1. Digital University: Definition

In both experiments, a considerable amount of time was granted to student and staff views on their outlook for the digital university, which required first to specify the meaning of "digitalization" and "digital university".

One of the main questions to be answered in the first phase indeed related to the way the digital university was envisioned.

Qualitatively, an implicit association test was conducted at the start of Phase 1. Not only was this research method seen as varied and playful, but it also studied automatic, often unconscious, associations of ideas present in the memory, and it revealed associations and preferences that would not be captured by an explicit method, or would be captured incorrectly, because the target group is often not aware of them themselves.

The first exercise recalled infinitely possible images that were associated with the term "digital university". Table 1 below shows the intuitive associations that were recorded during this first session.

Table 1. Words associated with the terms "digital university".

Participant	Function	Words Associated with Chosen Image
1	Admin.	Perspective, discord, realities, diversity
2	Admin.	Tools, functioning, collaboration, wheels
3	Admin.	Outside, window, exchange, open
4	Student	Web, fragile, solidity, domesticity, fear
5	Student	Skidding, slope, slippery, jump
6	Student	Collaboration, human touch, interaction, difficulties
7	Student	Future, English, language, international
8	Researcher	Temporality, snail, slow, residence, domesticity, privacy
9	Researcher	Commotion, argument, calmness
10	Researcher	Computer, antiquated, old, equipment, multitude
12	Researcher	Share, exchange, international

It is thus possible to classify these answers in several categories relating to:

- Means: equipment, tools, computer, functioning, wheels, slope, skidding.
- Interaction: collaboration, exchange, open, argument, commotion, discord, argument, share, diversity, jump, multitude.
- Environment: calmness, residence, domesticity, privacy, international, fragile, outside, window, fragile, fear, slope, language.
- Time frame: future, old, slow, antiquated, temporality.

At the completion of this first phase, the focus group provided a definition of a university that would be digital, as stated below (Figure 2a). However, perhaps more explicit is the definition that was agreed upon by students in Phase 2.

Figure 2 below showcases specifications that were used to clarify the meaning of digital university in both phases.

In both definitions, it is notable that digitalization is placed at a distance from university rather than in juxtaposition with it. A question that was raised during both phases was indeed the contradiction existing in the term "digital university".

During Phase 1, it was noted that by the end of the focus group sessions, the question regarding the digital university was often adapted by discussions to become "how do we envision the university in the face of the digital," "how do we envision the digitalized university," or "how do we envision a university where digital has its place?"

More explicitly, an exercise interrogated the participants' perception of the university through a creative writing exercise. Participants were asked to write a letter to the university (theirs or in general). Letters were compiled into a word cloud, which is shown in Figure 3.

"The digital university of the future is open and accessible to all, free of charge, fair and promotes knowledge sharing. It must be opposed in all respects to the massive casualization and fragmentation that digital practices unfortunately tend to exacerbate. Its objective is not to transform its teachings into online courses. The university must take stock of all its subjects and disciplines to enable teachers and students to make the most of the use of technology for teaching and research.

The digital university does not mean an online university; it means that each instructor should be free to agree with students on the institutional tools and/or platform that they decide to use in addition to the course (exercises, course materials, media, etc.).

The digital university also refers to a set of tools and political prerogatives that frame for students, faculty and administrative staff, both permanent and external. These policy frameworks must be respected. […]

General remarks

- The digital university must be concerned with the well-being of its community by finding alternatives to the destruction of the social link that digital tools can generate.
- It must advocate a reasoned and optimized use of technologies.
- Digital technology is never a default solution: it must be complementary to face-to-face courses.
- The university must encourage the implementation of numerous training programs for digital tools (platforms, software, etc.).
- It must respond to the need for training in tools, platforms, etc., by encouraging more collaborative practices."

(**a**)

"For us, the digital university is not just a switch to distance learning but a real readjustment of pedagogies.

This includes tools and practices, distance learning courses, courses between European universities, interactive courses, international mobilities done online or in a hybrid way, among others"

(**b**)

Figure 2. Excerpts of Policy Note (Phase 1) and Questionnaire (Phase 2). (**a**) Description of the digital university at the outcome of Phase 1; (**b**) Definition of digitalization in the second phase.

Figure 3. Word cloud associated with the creative writing on the term "university" (Phase 1, © Kumquat).

Answers here were mostly classified into the categories below:

- Participants: students, teacher, together, student, people, professors, users.
- Timeframe: years, after, already, schedule, moment, then, time.
- Variation: change, develop, become, new, can, project, transition, turning point, chance.
- Means: tools, equipment.
- Well-being: confidence, concern, request, division, justice, fear, wish.
- Environment: life, experience, facing, have to, place, institution, opportunity, power, political, politics.
- Interaction: open, share, talk, meet, alone.
- Educational content: content, classes, knowledge, practices, know, work.

Table 2 below summarizes the aforementioned word associations by comparing categories used when talking about the university on one hand and when talking about the digital university on the other hand.

Table 2. Categories associated with the term "university" and "digital university".

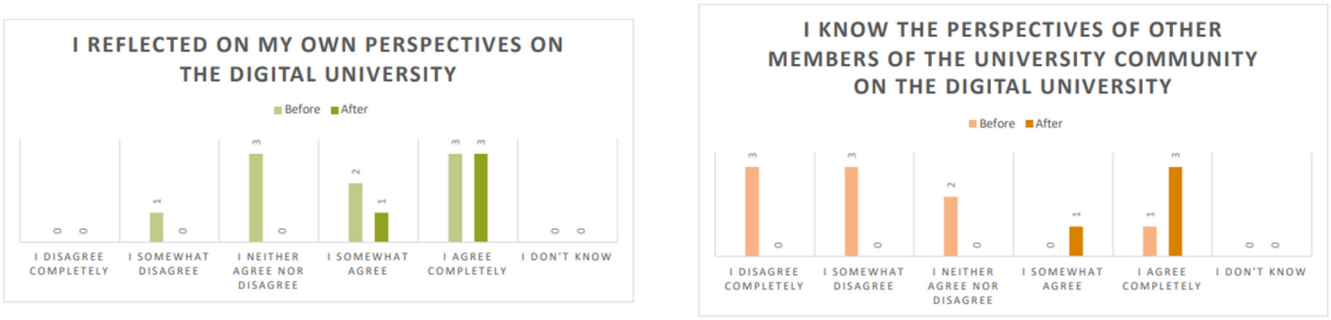
Category	University	Digital University
Means	Tools, equipment	Equipment, tools, computer, functioning, wheels, slope, skidding
Interaction	Open, share, talk, meet, alone	Collaboration, exchange, open, argument, commotion, discord, argument, share, diversity, jump, multitude
Environment	Life, experience, facing, have to, place, institution, opportunity, power, political, politics	Calmness, residence, domesticity, privacy, international, fragile, outside, window, fragile, fear, slope, language
Timeframe	Years, after, already, schedule, moment, then, time	Future, old, slow, antiquated, temporality
Variation	Change, develop, become, new, can, project, transition, turning point, chance	-
Participants	Students, teacher, together, student, people, professors, users	-
Well-being	Confidence, concern, request, division, justice, fear, wish	-
Educational content	Content, classes, knowledge, practices, know, work	-

3.1.2. Existing Information on the Digital University

Based on the aforementioned categories, it was possible to directly collect data on the knowledge and information levels of respondents with regards to the components of the digital university.

- Interactions

In Phase 1, each respondent was presented with two statements related to interaction in the digital university: "I reflected on my own perspectives on the digital university" (statement 1, Figure 4a), "I know the perspectives of other members of the university community on the digital university" (statement 2, Figure 4b).



(**a**) (**b**)

Figure 4. Answers regarding knowledge of interactions, exchanges, and perspectives on digital university during Phase 1 (graphs produced by © Kumquat). (**a**) Statement 1; (**b**) Statement 2.

Before this first phase was undertaken, there was a wide range of answers given by respondents when asked about whether they have thought about their own perspectives on a digital university, with 4 in 9 respondents saying they had not really thought about this before. After the project, the range of responses was much narrower, with 100% of respondents in agreement.

In the same way, respondents to the initial questionnaire demonstrated a wide range of responses to the second statement, with the majority (8 out of 9) unable to agree with it. On the evaluation questionnaire, it was clear that the range of responses had narrowed, with 100% of respondents in agreement to some level with the statement.

- Means

Means, tools, and services appeared to be at the top of the collective imagination when discussing the digital university in Phase 1 (Figure 5).

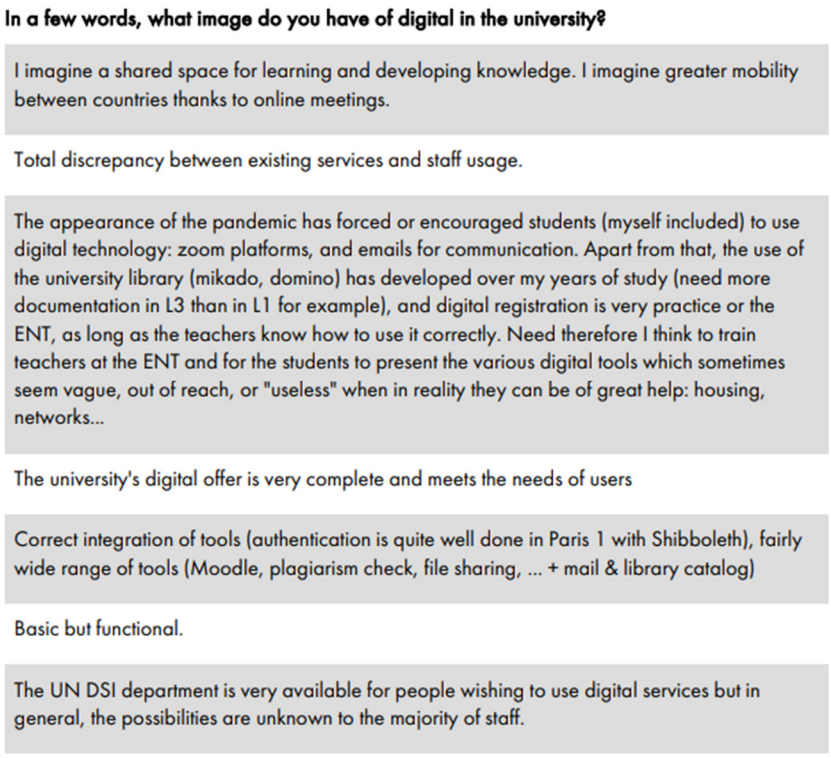


Figure 5. Words associated with digital in the university (Phase 1, © Kumquat).

Indeed, 80% of the respondents in the initial questionnaire of Phase 1 answered that they already knew services. In the final questionnaire, the range of responses had narrowed, with 100% of respondents in agreement with the statement.

However, complementary answers showed that those responses were only associated with certain tools (Figure 6).

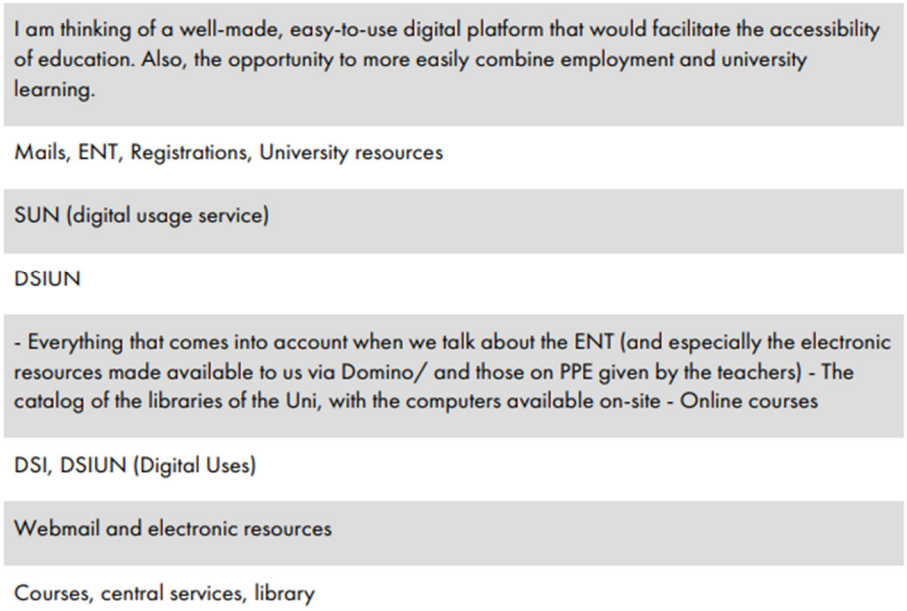


Figure 6. Knowledge of services in the university (Phase 1, © Kumquat).

In the same way, during Phase 2, students were asked whether they felt they needed to be informed or trained for digital use, to which many answered "no" (Figure 7).

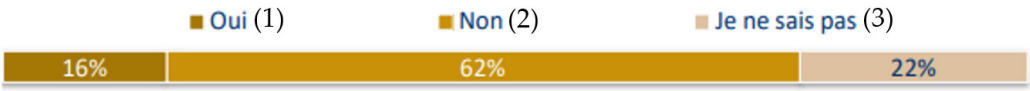


Figure 7. Answers provided to the question "Do you feel the need to benefit from an information session or a training on certain digital services or digital usage in the university?" Left to right: (1) Yes, (2) No, (3) I don't know.

Yet, when asked about specific tools, answers were a bit more mixed, as shown in the table below (Table 3).

- Environment and timeframe

Both temporal (before/after) and environmental (working conditions, lockdown) aspects of the digital university were heavily impacted by the individual and collective experience of previous experiences with online education and particularly the pandemic.

This was all the more the case for students in Phase 1, for whom the notion of the digital university poured salt over the wounds of COVID-19. Such experiences were often mentioned during focus groups.

Whereas in Phase 2 the questionnaire specified that it aimed to assess the digital university "beyond COVID-19", it was often referred to during unrelated open questions, showing that it was a turning point for most students. A specific section was also allocated to previous experiences, and to the particular experience of the COVID-19 pandemic (Figure 8).

Table 3. Answers provided to the question "Do you know the following tools proposed by the digital services of Paris 1?".

Tool/Service	I Know and Use	I Know but Do Not Use	I Use if I Have to but do Not Know	I Don't Know
E-mail	93%	4%	1%	0%
Interactive pedagogical interface	90%	3%	2%	2%
Planning	27%	47%	4%	20%
Address list	24%	40%	13%	19%
Library catalogue	43%	28%	12%	15%
Documentary access (Mikado)	30%	24%	9%	33%
Documentary access (Domino)	60%	12%	8%	18%
Office 365	49%	29%	3%	17%
Document transfer (Filex)	9%	8%	4%	77%
Internship and job opportunities browser	14%	42%	10%	30%
Mobility opportunities browser	10%	40%	6%	41%
Forum and chatbox	6%	43%	5%	43%
Collaborative document (Framapad)	6%	14%	3%	73%
Poll (Evento)	5%	14%	3%	74%
Medical appointments tool	11%	28%	5%	54%

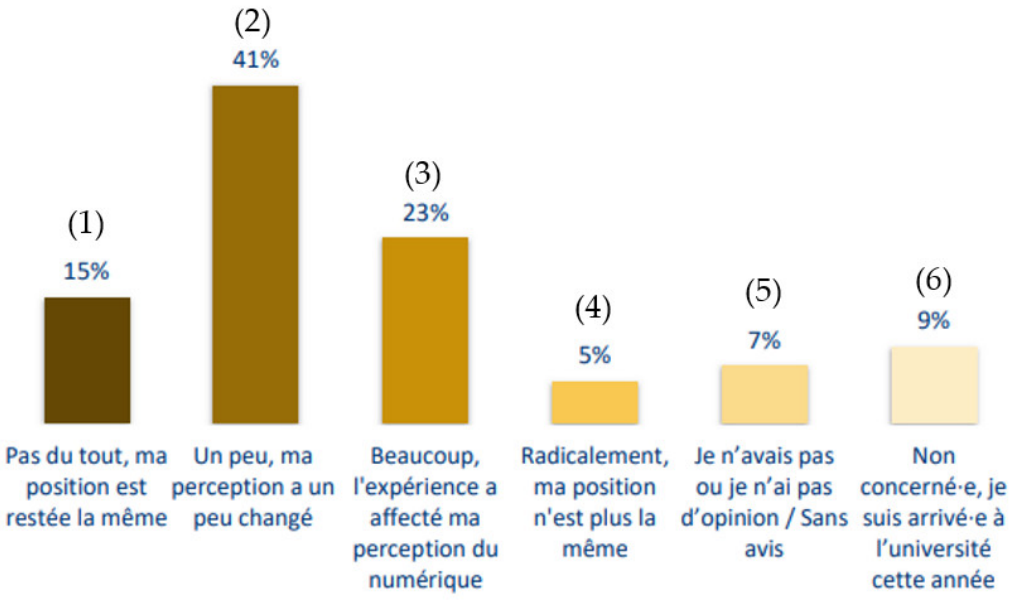


Figure 8. Answers provided by students to the question "Did the COVID-19 experience change or affect your relation to digital?" Left to right: (1) Not at all, my position remains the same, (2) Somewhat yes, my perception has remained the same, (3) A lot, the experience changed my view on digital, (4) Radically, my position is not the same, (5) I did/do not have an opinion, (6) Unconcerned, I have arrived to the university this year.

In view of these answers, it seems reasonable to interrogate the perceived information, and at least to deduce that the perceived information might have been clouded by factors such as the experience of the COVID-19 pandemic, and oriented towards only a few aspects of means, interactions, and environment. It is thus impossible to assert whether there is "a lack of information" (H1: There is a lack of information leading towards a lack of acceptance), and whether such a lack hinders or limits any activities. It is, on the other hand, clear that there was a limited perception of having a lack of information by participants in both phases.

3.1.3. Acceptance of a Digital University

However, this is not to say that a digital university cannot be considered, as showcased by the aforementioned definitions (Figure 2).

Indeed, when asked whether the university necessarily entails physical interactions, 63% of the students replied that whereas physical aspects were important, it was not incompatible with online education (Figure 9). Responses to the favorability towards digital education were slightly more mixed (Figure 10).

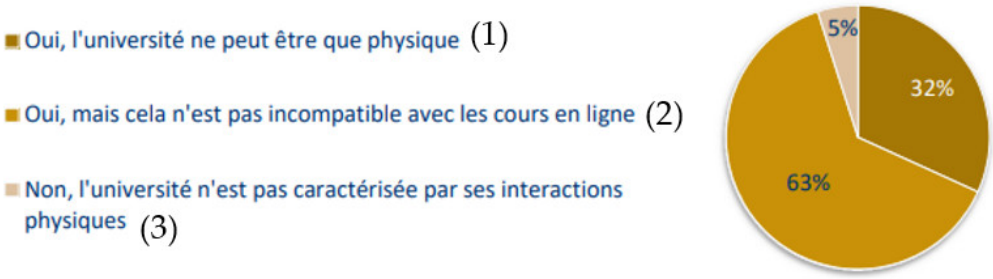


Figure 9. Answers provided to the question "According to you, does the university require physical interaction?" Downwards: (1) Yes, the university can only be on-site. (2) Yes, but this is not contradictory to online courses. (3) No, the university is not characterized by its physical attributes.

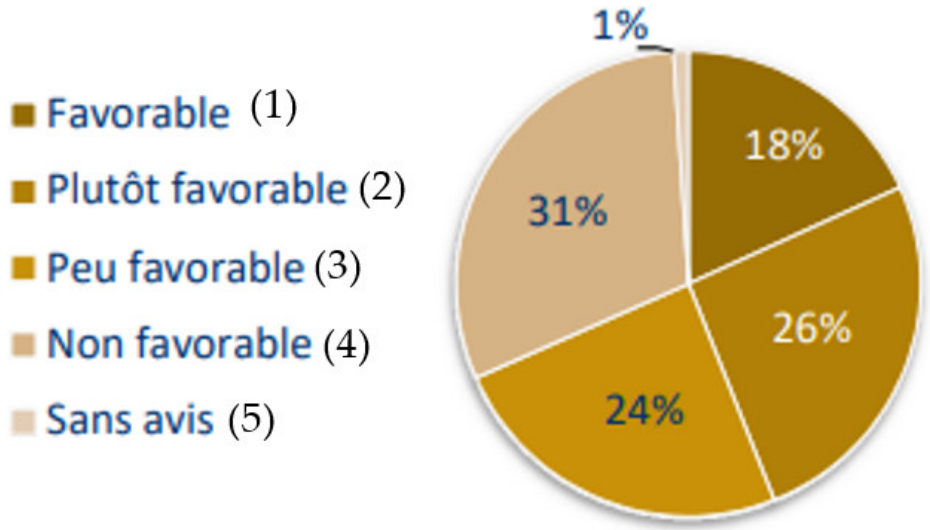


Figure 10. Answers provided to the question "Are you favorable to digital teaching?" Downwards: (1) Favorable, (2) Somewhat favorable, (3) Somewhat unfavorable, (4) Not favorable, (5) No opinion.

However, both figures show that respondents were more inclined towards compromise and that, contrary to what was put forward by H1 (There is a lack of information leading towards a lack of acceptance), there is no radical lack of acceptance towards digital education. H1 is thus not valid in that context.

3.2. Individual and Collective Stances towards Digitalization

Results were cross-referenced with several other variables, among which were discipline, perceived social capital (resources, gender), and interest toward digitalization.

Those results are shown in Tables 4–6.

Table 4. Aggregate trends in favorability and discipline, Phase 2, according to the answers provided to the question "Are you favorable to digital teaching?".

Field	Favorable	Somewhat Favorable	Somewhat Unfavorable	Unfavorable
Social and human sciences	12%	19%	29%	41%
Law and political science	22%	25%	25%	26%
Art	0	3 (43%)	1 (14%)	3 (43%)
Institutes	21%	26%	42%	11%

Table 5. Aggregate trends by discipline and social profile, working environment, and COVID-19 experiences, according to answers provided in Phase 2.

			Total	Social and Human Sciences	Law and Political Sciences	Arts	Institutes
Social Profile	Gender	F	64%	67%	70%	5 (71%)	69%
		M	33%	29%	29%	2 (29%)	25%
	Age	17–24	67%	67%	70%	5 (71%)	47%
		25–34	8%	10%	6%	1 (14.5%)	21%
		35+	25%	23%	25%	1 (14.5%)	32%
	Finance	Yes	72%	71%	72%	6 (85.5%)	69%
		No	26%	28%	25%	1 (14.5%)	26%
	Level (LMD)	Y 1–2	32%	34%	36%	4 (57%)	27%
		Y3	33%	29%	28%	5 (71%)	26%
		MA	36%	35%	36%	3 (42%)	53%
		PhD	4%	7%	4%	1 (14.5%)	0
Working Environment	Good working conditions	Yes	84%	78%	86%	6 (85.5%)	100%
		No	15%	22%	12%	1 (14.5%)	0
	Adequate space	Yes	63%	57%	71%	1 (14.5%)	63%
		No	37%	43%	29%	6 (85.5%)	0
	Equipment	Personal computer	97%	96%	97%	6 (85.5%)	100%
		Internet	76%	68%	82%	5 (71%)	84%
		Webcam	93%	90%	97%	5 (71%)	100%
		Mic	97%	96%	99%	5 (71%)	94%
COVID-19 Experience	Overall	Good	15%	10%	17%	0	5%
		Somewhat good	30%	31%	24%	3 (42%)	42%
		Somewhat bad	24%	23%	33%	1 (14.5%)	11%
		Bad	18%	22%	13%	2 (29%)	16%
	Educational content	Adapted	48%	48%	50%	2 (29%)	63%
		Not adapted	40%	40%	38%	4 (57%)	16%

3.2.1. Factors of Favorability

The status of favorability as a stance motivated by the field remained unfortunately unclear within Phase 1, mostly due to the context and small number of participants that was intrinsic to this particular experiment. Aggregate trends in favorability and discipline resulting from Phase 2 are presented in Table 3.

Table 6. Aggregate trends in favorability and social profile, according to answers provided in Phase 2.

	Resources				Gender			
	Sufficient		Insufficient		Female		Male	
	Num	%	Num	%	Num	%	Num	%
Favorable	36	17%	16	21%	28	18%	12	15%
Somewhat favorable	55	26%	20	27%	42	28%	19	24%
Somewhat unfavorable	54	26%	16	21%	38	25%	18	23%
Unfavorable	63	30%	23	31%	43	28%	27	35%

While it is impossible to assert that a discipline would be more inherently favorable to digital education than another, it is possible to cross-check this data with other variables.

It therefore seems appropriate to review the individual collective experience of digitalization. While such an experience was strongly impacted by the COVID-19 crisis, as mentioned in the previous paragraphs, it was also affected by other invariables that we explore in a more extensive manner in the table below (Table 5).

The data show that the disciplines that were most favorable to digital education, namely, law and political sciences and the institutes, were not necessarily those which suffered the most from social and financial marginalization. In fact, students from both fields recorded slightly higher rates of financial difficulties (28% and 26%). Those fields have also noted a higher number of students with good or somewhat good working conditions and environment, and especially more adequate space compared to other fields, which might be linked to financial resources but also other factors such as psychological and familial ones.

However, those who expressed a more favorable stance also noted a better overall experience and a slightly more adapted educational content during the COVID-19 experience (Table 5), which, on one hand, further reasserted the aforementioned impact of the pandemic, and on the other hand it showed the role teachers can play in facilitating favorability through adapting their pedagogies.

In order to better verify this assertion, data was cross-validated with information on resources (namely, the question "According to you, do your resources cover the needs related to your student life and your education?") and replies on gender. For the latter, the choice of "other" has not been considered in view of its small headcount. Data was recorded in the following table (Table 6).

It is clear here that those who have higher chances of facing social marginalization are not necessarily those who are less favorable to digital education, and while the number of answers is not enough to put forward such an assertion, it might seem to be quite the contrary. This, therefore, invalidates the hypothesis H2 (The aforementioned varies in accordance with social factors, including marginalization).

Conversely, looking at those who are less favorable, or even unfavorable, to digital education is interesting. Digging into their fields would mainly concern the social and human sciences, as too few respondents in the arts field answered. Instead, we choose here to look at responses given to the open question "Why are you unfavorable?" Among the 304 respondents, 158 students answered this question, representing approximately 99% of students who were not in favor of distance learning. As the answers were well documented, a careful reading allowed us to collect 11 expressed reasons, as shown in Figure 11.

Most students reported increasing digital and distance learning fatigue, especially as the health crisis continued to unfold. Overall, they felt more difficulty concentrating, assimilating, and motivating themselves during distance learning courses (as expressed by 46% of respondents). Nearly half of the students also expressed a sense of isolation and loneliness with a lack of interaction among students and with faculty.

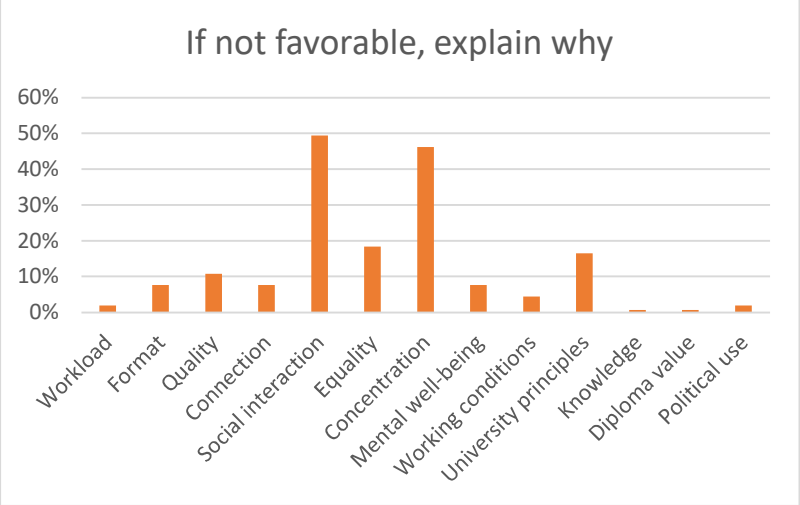


Figure 11. Answers provided by students to the question "If less or not favorable to digital education explain why".

Moreover, the lack of social interaction was identified as one of the greatest difficulties. Some students experienced a double distancing, both pedagogically and socially, which may have led to dropout situations. Thus, 49% of respondents believed that digitalization contributes to isolation and the destruction of social ties. The confusion between the personal environment and the study environment is also difficult to manage for some, all the more so in the particular context of housing in the Ile-de-France region, which is particularly noted by several students who suffer(ed) from living in a "slum".

While 46% of respondents expressed difficulty concentrating and/or motivating themselves in a digital environment, the terms used and the reasons were multiple: the unsuitable environment contributed to this ("A student room is not a classroom"), as well as difficulty keeping up, but students also cited the presence of other distracting activities nearby and feeling less concerned or involved with classes.

Most of the responses were common to all levels of study and all disciplines. The only exception was mental well-being, expressed by 8% of respondents, often attributing it to personal "experience". Approximately 75% of those expressing anxiety, depression, or psychological sequelae were undergraduate students.

Here, yet again, the students' positions were not inconsistent with an occasional usefulness of digital teaching or the fact that it is possible a few times a year. They mentioned in particular time saving, transportation, force majeure, extreme weather conditions, colloquia and conferences, or continuing education.

However, overall about 16% believed that digitization was contrary to the values of the university and to the very principle of studies (e.g., "This is not my idea of teaching", "Nothing replaces face-to-face classes", "A large part of the interest of the university comes from the social link", "The university is a place of exchange", "Learning is not a passive and isolated act").

It is noteworthy that that these principles extend beyond the university space, and also raise questions about the fundamental principles that should lead our society (equality, balance, openness, etc.), e.g.: "What kind of society do we want to lead?", "We are not robots but humans. The school, the university is a space of confrontations and constructions of the individual identity, and the school of the life that is not learned behind a screen but that is lived in contact with others." "This is an aberration that will only contribute to the growing isolation and the rugged individualism that characterizes today's society."

3.2.2. Indifference and Interest towards Digitalization

On the other side of the coin can also lie indifference towards digital education and a general lack of interest.

In some theories, interest is one component of a larger construct which would be mainly motivational and generally positive [35,36]. However, this holds the main limitation of being unidimensional whereas other theories include several items targeting feelings-related valances, value-related valances, the intrinsic character of beliefs, and independent and voluntary reengagement in biology-related content and activities [37]. Most of those factors were mentioned in previous paragraphs, while reengagement will be further detailed in the following section.

That being said, it is already possible to draw some conclusions on interest based on the processes of this study, and namely on engagement.

Phase 1 explored the right to take an interest in your own experience, as Cavell puts it. Indeed, "The inherent issue of appropriateness in human speech (beginning with the question whether to speak, to destroy silence)—challenging as it were the issue of adequacy in making speech realistic . . . is bound up with seeing human speech as expressive, expressive of what matters in a human life, what counts for it, which inescapably puts at stake how much something matters, how deep or permanent or partial or unreflective our interest is in a given case" [38].

The final evaluation of this phase assessed this: 100% of respondents found that they were able during this phase to share their feelings and thoughts about the use of digital technology and its part in the university's ability to deliver on its mission. Responses to the final evaluation showed that this project was successful in helping the focus group better understand their own and other's perspectives when it comes to digital university services, as well as understanding the range of digital services which exist within their university. The project did not have an incidence for the use of digital services, as participants involved stated they were already using the university's digital services before they were asked to take part in the questionnaire, and responses show that behaviors from before the project likely continued after the project was started. Nonetheless, it is also clear that the project had a positive impact on the focus group's opinions on whether they have been able to express their thoughts on the use of digital services and technology within the university, steering away from "Never" as the majority answer.

The focus group format was also successful in rebalancing the situation by giving the floor to inaudible members of the community. This is particularly true of students, some of whom did not hesitate to express their disagreement with the teacher and researchers. All members, and students especially, constantly expressed surprise during the focus groups. A clear expression of enthusiasm was also noted on the part of participants, but especially on the part of students who were involved in the debates (e.g., by taking a stand against their professors) and were able to better understand how the university works (e.g., employing terms usually used by staff members and analyzing existing competition between professors) and extend the horizon of their thinking. This was evidently also shown in the previously stated Figure 4a,b.

Phase 2 also addressed this is in a slightly more straightforward way as students were asked whether they were looking to get engaged via information circuits (Figure 12). A total of 55% of those who answered this question responded affirmatively, showing that while neither feelings, nor value, nor engagement seemed to be radically positive, interest seemed to be held at a stagnant, median point. Results therefore rather pointed to a confirmed H3 (A more participative process is requested by concerned parties).

Figure 12. Answers provided to the question "Do you seek to get informed of university news or projects held by university?" Left to side: (1) Yes, (2) No, (3) I don't know.

3.3. Participative Measures' Impact

3.3.1. Rate vs. Content of Involvement

Despite noted interest, participation in both phases was limited.

One of the qualitative metrics that was foreseen was related to the participants' engagement in the designing process. While the expected number of participants was satisfactorily met, the process in itself brought to light some shortcomings. Dissemination was inherently restricted to a smaller, more targeted audience, which was not only interested in digitalization but was additionally interested in the European or EU-funded aspect of it. Received feedback feeds into our understanding of digitalization and its perception in this university:

- The strategic and political level of the university was necessary to support the accompaniment and identification of project leaders and interested networks.
- In spite of the call explicitly mentioning "teachers-researchers, BIATSS and students", members did not necessarily assimilate themselves to the word "users".
- The call for expression of interest raised some questions with regards to the readability of the project, as well as multilingualism. Terms such as "focus groups" are still viewed as being neoliberal and illegible.
- Students also expressed the need to have a dedicated readable platform; mailbox is mainly used by professors and students' unions.

Initial adherence to such collective interfaces therefore seemed to be more limited than expected, and this in spite of using multiple channels (social media, targeted e-mails, internal newsletter, university website) and offering financial incentives. Several obstacles were noted, including: lack of assimilation to the word "user", limited ownership by strategic level, and existing (somewhat negative) perception of European projects.

In Phase 2, 304 participants answered the survey from among more than 40,000 students. Though the aim was not for the survey to be representative, but rather to collect insights, this is still less than 1% of the Paris 1 student population. Objective obstacles to the responses were the use of an online questionnaire, as traditionally used by the institution, and the period during which the questionnaire was launched, which coincided with the end of the scholar year. However, despite the low response rate, this seemed to roughly match the distribution of students across levels/units and their fields.

These outcomes therefore allow us to confirm the H4 (When existent, participative processes remain quite lethargic due to a lack of incentive).

Nevertheless, this did not correspond to a lack of involvement throughout the project. In Phase 1, all partners were present during all of the sessions, despite other obligations (Figure 13).

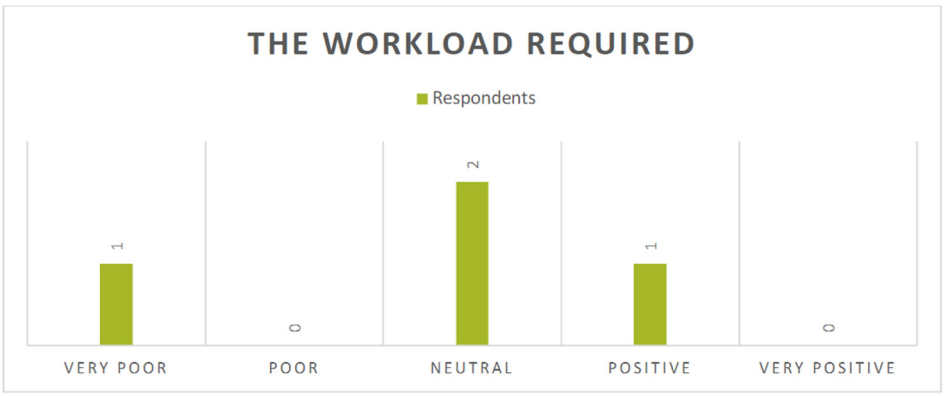


Figure 13. Workload required during Phase 1, as perceived by participants.

In Phase 2, our attention was particularly drawn to the open-ended questions. Unlike closed-ended questions that limit responses to the options given and are chosen by the writer, open-ended questions allow respondents to go deeper into their answers and gain valuable information about the topic at hand. The open-ended nature of the questions allowed

respondents to respond based on their knowledge, feelings, and understanding. The responses were therefore used to obtain detailed and descriptive information about a topic.

Open questions were optional, yet had a fairly decent response rate. In particular, questions about alternatives to the way digital education was dealt with during the pandemic and the reasons behind unfavorable stances had response rates of 28% and 50%, respectively. This suggests that the students who responded to the survey felt involved, as answering an open-ended question requires more involvement and time from the respondent. Moreover, it was noted that most of the responses given were longer than 10 words, and were often supported by examples or explanations.

Other answers were even more straightforward on that paradox, such as the following one:

> *"Following a question, I would like to point out that the information mailing lists are non-existent in my eyes or very badly managed. I am an MBA student at IAE Paris Panthéon Sorbonne and I am bombarded with emails that make no sense for my training (language catch-up for the Bachelor's degree, why inform me of that?) but especially my profile. Or I will be informed of initiatives (sport, language, una europa...) in which I can't even participate when I ask for it (you are not concerned/eligible), because it seems that the pro students of the IAE Paris Panthéon Sorbonne in continuing education are not part of the students of the Sorbonne in fact, which is very sad and deprives us of exchange with other courses. We lack availability during the day of course being in professional activity in parallel with the training, but conferences or other could interest us. Also, it is curious that we receive everything (and anything?) concerning the Sorbonne, but we are not informed of the conferences of the IAE, or at least only by the screens on-site, and we are only present every 2 weeks. In short, I would be delighted to participate much more in the academic life of the Sorbonne and hope that this survey will help to mobilize in the future all the students of the university, whatever the training. Thank you for your thoughts on the subject!"*
>
> (Phase 2)

This paradox does not allow us to draw a link of causality between participation and favorability (Figure 10). It is clear, however, that those who responded, and were even more involved, were not necessarily the most favorable. The H5 (Participative processes only concern and include those who are favourable to the topic of digital education) is therefore not confirmed.

3.3.2. Incentives for Deeper Participation

We have showed above that offering incentives, namely, monetary incentives to participate in the experiment, were put forward as one way to reduce attrition or outright refusal to participate in an experiment. This, however, had a limited impact, as explained in the previous paragraph. We therefore suggest in the following that the reasons for contribution to such a participative process be explored [39].

- Direct, personalized interaction

Despite being a very diverse group, we show in Figure 14 the distribution of participants (1, 2, 3 . . . 12) in relation to the person in charge of the conception of the project (named A) and their own informal networks (B).

Out of 12 participants, 9 participants knew directly or indirectly the researcher who had initiated the project. Only three bore only an interest in the project, related to their functions in the university.

This was once again reaffirmed in responses given during the survey in Phase 2. When asked what would encourage them to participate in projects, students (both those having worded the survey and those having answered) mostly pointed to direct or personalized contact (Figure 15). Several answers were possible.

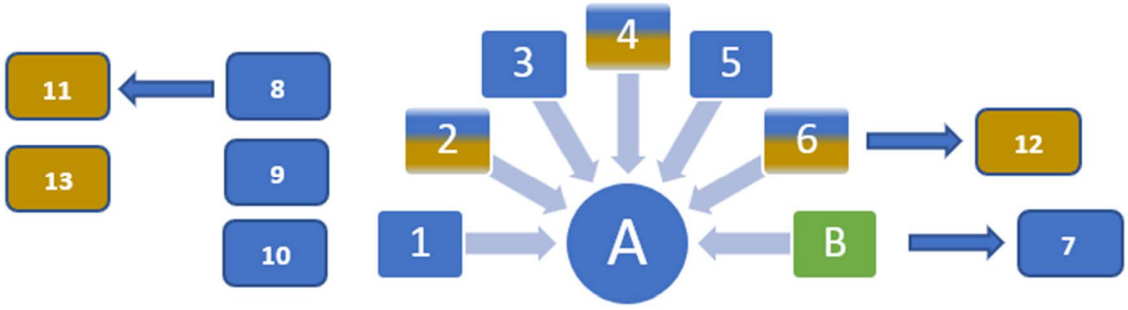


Figure 14. Map of participants in relation to contact person of the project (A).

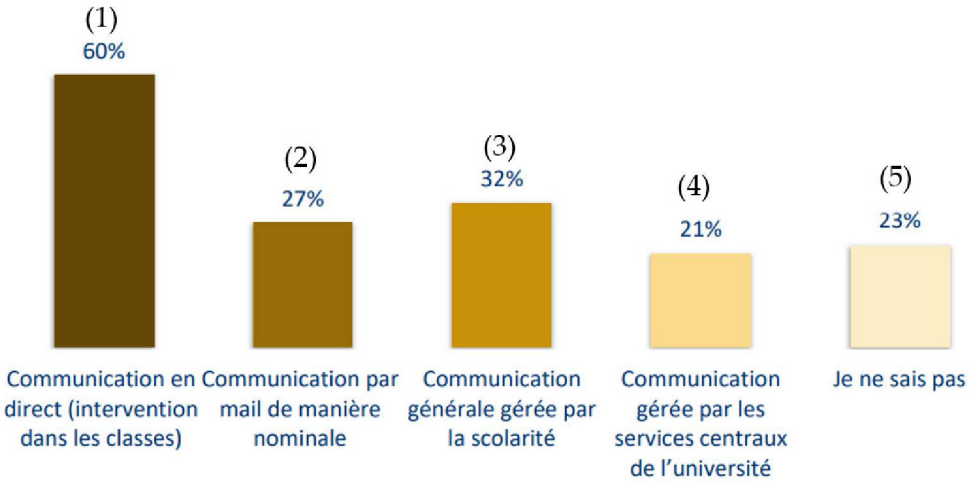


Figure 15. Answers provided by students to the question "Which (communicative) factors would empower/enable you to participate in the university's projects or activities?" Left to right: (1) Direct communication (intervention in classroom), (2) Nominative communication by mail, (3) General communication by department offices, (4) General communication by central services, (5) I don't know.

Informal networks therefore play a big part in such projects, proving that individual initiatives remain predominant in the university's landscape [40].

- Ownership of decisions

Results of both phases draw our attention to the empowerment that stems from such participative phases, and its capacity to attract participants.

In the first phase, one of the main outputs was a policy note. According to participants, this political text aimed to establish the state of the art of digital technology in universities and to offer a certain number of recommendations that, although not exhaustive, seemed to the group to be essential political elements. They were thought of and organized as a political base guaranteeing that universities avoid abusing digital technology.

These recommendations were obviously impregnated with an ideological and political matrix advocating free and open digital practices and use, which is why the focus group also "wanted to propose" pedagogical tools to complement the political recommendations. Those offered "fun" tools allowed pushing the different actors of the universities to open their critical thinking and their creativity through graphic supports. In both cases, the objective was to offer theoretical and methodological tools in order to comprehend the stakes, the limits, and the fears about digital technology in the French and European universities.

It is worth noting that among the political directives lies the wish to further participate, which further reasserts that a more participative process is requested by members of the community. Indeed, participants of Phase 1 requested the involvement of different university bodies in the development and definition of internal and inter-university collaborative

policies, as well as the involvement of different university bodies in the development of policy frameworks (especially in finding ways to enforce good practice).

In the same spirit, students who participated in Phase 2 wished to put forward in the very first lines of their survey the following:

> *"Designed by a group of students from different disciplines, this survey is aimed at the entire student community of the University of Paris 1 Panthéon-Sorbonne. Its aim is to find out your needs and expectations (both in times of crisis and outside of them) to feed into the current thinking. Your point of view and your experience will be brought to the attention of the institutions involved in the digital transformation. It is therefore a way to become actors of change, and to actively participate in the evolution of our university, and to potentially be heard. It is in this context that we would like to collect your opinion."*

- Pedagogical gain, scientific benefit

Participants were interrogated at the beginning of both phases as to why they were interested in participating in these processes. Their answers, provided anonymously, are highlighted below.

> *"I have never heard of the project, and would have never had, had I not met [person]. The topic interested me and I wanted to learn more"*
>
> (Phase 2)

> *"I hope that we can share the word and arrive at collective answers"*
>
> (Phase 1)

> *"I would like to see what this project can give as a result"*
>
> (Phase 1)

> *"I would like to make the project more concrete: talking about one's fears and expectations is a first approach, but in the rest of the project, the ideal for me would be to talk about the articulations of the future digital university because how to express one's fears vis-à-vis of a project that does not even have a substance or a form? So try to give ideas to "optimize" the platform in its practical and functional aspect."*
>
> (Phase 1)

There is also much to be said about the tools developed at the end of Phase 1.

Reactions clearly showed that focus groups provided participants, and trainers especially, with ideas for interactive training, animating and even tool designing, and opened their minds to new perspectives. Trainers expressed that they had learned from the facilitator and were keen to implement their method. Tools used and developed were requested for further use. The meeting with the two experts was also particularly enlightening, as shown in the additional optional answer given below.

> *"[I liked] especially:*
>
> *-the context allowing the meeting between the different bodies of the universities (students, admin, profs)*
>
> *-the meeting with the external speakers and the whole day of work*
>
> *-the political discussions on the digital issues"*

Ultimately, in addition to the policy recommendations produced, and in order to show the difficulties in constructing and guiding these recommendations, two sets of games were proposed. These were viewed as a "reflection support" that not only proposed an open and objective format, but also integrated concepts related to the political, social, educational, and ethical structures of the digital university. Game number 1 proposed players list qualities and their opposites, thus offering a large degree of freedom, while game number 2 involved several constraints to select some qualities among some chosen by the designers.

This device presented was designed to be used as "an accompaniment to the reflection process on subjects that concern the university, its internal management policy and its

relations with other entities, as well as the transformations that accompany the daily life of the institution and any other form of collaborative work necessary for the proper functioning of academic institutions."

The accompanying narrative explanation further explains: 'Insofar as they are collective games, they can be mobilized as much in the work within already constituted teams that compose a level of organization of the universities (a service, an office, a pedagogical department, a class) as well as within groups constituted ad hoc in the framework of the various projects carried out by the institution. The Spark Game can be used in the "conciliator" or "medium" mode to define a state of affairs based on the suggested items. Participants could engage in a "builder" mode session linked to the IN game where their imagination is solicited to envision the shape of the project to come".

It seems reasonable to conclude, based on those elements, that participation is related to interest (H6), which is in itself dependent on other factors such as direct interaction, scientific gain, and the ability to have an impact.

4. Discussion and Conclusions

4.1. Lessons Learned

Throughout this paper, we have explored the perceptions, interest, and participation of university members within and in relation to their institution's change.

Results have shown that participants were found to be interested in the topics at hand when willing to contribute. However, this interest was not randomly or equally distributed. Theoretical models identify situational factors as critical in the development of individual interest [41–43], but they also show that learning contexts can promote maintained situational interest if they cause individuals to feel empowered by the knowledge presented to them in the situation [41,42]. The interest approach can also be related to situated learning as defined by J. Lave and E. Wenger [44], wherein they stress how learning processes are always intertwined with management issues, particularly those connected to the inclusion of the "learner" into the community of practitioners that such a process implies. In the learning process, knowledge and the inclusion in the community of practice can be seen as expressing the individual interest [45], explaining in this way why our experiments' results have not shown a clear or radical refusal or acceptance of digitalization as such, but have rather been more oriented toward policies and the management that embodies such policies.

At the same time, the conducted experiments show that learning, and more broadly, garnering an interest, is congruent to the context, or the process, in which it is enabled.

Lave and Wenger's works [44] have shown that learning a subject is related to the quality of the apprenticeship relationship: the peripheral position of beginners, while useful for the acquisition of skills, is at the same time a source of frustration when it does not lead to a central engagement in the activity and a clear inclusion in the community of practice [46] that emerges from the gathering of individuals engaged in a shared activity such as the "making" of HEIs. Results of the Phase 1 and Phase 2 experiments indeed draw our attention towards deontological and ethical issues underlined in the recommendations. It is assumed here that digitalization hides ethical issues common HEIs must deal with. Policy suggestions point to considering digitalization as an additional opportunity, but not as the solution to management problems, nor as a shortcut that allows dodging what is at stake in these ethical and deontological issues.

It therefore appears that trust was at the core of such processes. In both experimentation projects, the methodology adopted recognized that to have confidence in others is to recognize their power to act and to support them in the development of their abilities, e.g., by allowing members to equally express their opinions. This, put simply, points to trusting relations being the basis on which inclusion can be established. Conversely, inequal distribution of technical or institutional knowledge is shown to lead towards a mistrust in the technological tool and at the same in European projects [47]. When it becomes a restricted concern of few people, the lack of inclusive processes entails a loss of empowerment and trust, and a growing level of disengagement by actors whose contributions are important

for the projects, which can be simply translated as a loss of interest and exclusion. As such, the inclusion of actors into the community of practice can be considered as a central factor related to the management strategies implemented in such communities. This suggests that a deontological issue is intertwined with digitalization, not because of the technical infrastructure on which it relies, but due to the social organization of the work, the sharing of knowledge and the strategies of inclusion and exclusion that such a management entails, assuming that management can be understood as the way policies are embodied in social practices. In this view, "trust" in the institution can be inferred from the critical approach shown toward digitalization and technology as a whole.

At the same time, and digging further into the ethics, ownership of the research—both the process of action research and its outcomes—appears to be an important issue in collaborative research due to its participatory nature and democratic approach. Dealing with ownership—the juridical propriety and the legitimacy of any contribution—requires drawing a higher level of attention to the management of the research process. New ethics in research stress the unequal position of different participants in the process, where some are designated as leaders and others as simple contributors, enhancing a hierarchical distribution of roles and responsibilities. Fair ethics suggest considering participants as equals, both with the researchers and with each other, sometimes being designated as the "object" of the inquiry. There might be tension between the initiator of the change and the other participants. The action research process might be seen as coercive if the necessary preparation has been lacking.

The methodology adopted for the Phase 1 and Phase 2 experiments was designed in a way that allowed it to tend towards an ethical approach: Phase 1 gathered participants in the academic community belonging to different statuses, but the supposed hierarchy implied by their statuses did not impact either the cooperation or the importance of contributions. Phase 2 was implemented by students acting as a research group, defining the targets of the survey and designing the questionnaire in collaboration with experienced actors in the field belonging to the same university. The attempt was made in the initial phase to generate the awareness of acting together in pursuit of a common goal, sharing experiences, and considering contributions as being at the same level and of equal importance and consistency with the project. By acting in this way, the social organization of participants (governance of the experiment) was the initial point of the focus group fixing the inclusion strategy (participation) and common rules (deontology) as the starting point for a common work. Emphasis was placed on the social aspects of learning and sharing, rather than solely on the individual or the environment. Learning by 'observing and pitching in' could easily apply.

Once these conditions were settled, participants were able to engage themselves in the imaginative process required by Phase 1, suggesting that a trusting atmosphere initiated by the ethical approach had led to creative response.

In terms of policies, our analysis relied on an innovative, adaptive, and imaginative response to change, which demands an organizational climate of autonomy, immunity from interference, trust, openness, encouragement of risk-taking, and tolerance of failure; in other words, it demands the existence of freedom in Sen's 'process' sense (Sen, 1998 [48]). Freedom as an 'opportunity' represents the driver of creativity, but this opportunity can only arise in a situation where there is knowledge, and knowledge comes into being firstly 'on the ground' (in the community of practice), where creativity happens. Knowledge as the fruit of creativity appears to generate opportunity and thus freedom. It is also knowledge that creates the organizational opportunities to pursue and to achieve those outcomes which are defined as 'valuable' in terms of organizational purpose.

The perspective adopted thus leads us to consider learning in terms of inclusion or exclusion in the community of practice. The two experiments suggested a different consideration for the digital tool: the knowledge which is at stake here does not only concern the contents of the learning opportunities, whether they are on-line or face-to-face [49]. They suggested that digitalization is an issue in so far as we look at it as the final target of apprenticeship and not as middle learning. Knowledge here should be seen as

meta tool, or, on a meta-learning level, as the way users can learn how to learn with the digital tool, a knowledge that concerns the way to acquire knowledge, learning to learn through the digital tool, leading to inclusion in the greater community of digital users and successful students. The fears expressed related sentiments of isolation and an overall incapacity to engage in a deep and authentic learning process.

4.2. Ethical Limitations and Recommendations for Future Research

While we have already addressed quantitative limitations that challenged the representativity of answers given by respondents, this study also embraced important limitations that should be addressed in future research.

Nowadays, and as an extension of the climate of mistrust that was previously mentioned, policy debates appear as an oppositional moment where stakeholders raise questions and challenges to the authority and rationality of governance. For these reasons, the artificiality of the experimentation has been perceived and has fed mistrust in the project (which proves in itself the mistrust participants nourished against the institution), not towards other participants, but towards the ultimate goal. While managing the group in order to create a peaceful and positive climate, it was clear to all participants that the results would not be used by the project managers in intervening in a policy-making process at a high authority level [50]. Recommendations, one should say, are not policies. It was rightfully noted that participants were not official and institutional stakeholders normally engaged in local, national, or international policy making.

While on one side this limit does not reduce the impact or invalidate the results, it underlines the point that the experimentation itself would not have resulted in an intervention in the policy-making process, despite being aligned with a top-down vision of a policy-making process.

Opposite to a top-down framework in policy making, a bottom-up approach should have led us to the conception of a different experiment grounded on field observations (ethnography of uses and organizations) based on cultural studies' lesson pointing to a reflexive knowledge that is always present and belonging to practitioners even if it not formalized in the scientific format. Such a bottom-up approach would have therefore also led to recommendations pointing towards an adequation of the governance to the existing practices in order to enhance, facilitate, or support them [51], assuming that such practices were the result of a local rational engagement of actors in a social distributed knowledge environment.

Instead, it is not surprising that participants produced items and tools useful to facilitate discussions and debates about changes in HEI responding to the main targets of the project with a need to instruct a larger debate on the issue, embodying the position of investigators and watchdogs rather than decision makers (consistent with the drafting of recommendations).

It thus seems that participants simultaneously adhered to a top-down framework and to the vision of the political importance of digitalization and Europeanization of HEIs, and engaged themselves in a project supposedly conceived in the top-down framework. Nonetheless, mistrust for the top institutions that must carry out the changes in HEIs continues to grow, and outcomes produced ultimately do not resemble recommendations, probably because of the ambiguous position they were occupying as both bottom users and experts. The artificiality of the situation should drive us to a conception of research that puts users at the center of the observation process into the field, raising social knowledge about the practices, and eventually engaging them in the policy-making process as experts of such practices and communities of practice in a bottom-up framework.

The commitment in research processes transforms subjects and triggers the emergence of a different consciousness about the epistemological background of social practices and the knowledge involved in it, producing performative effects and transforming a social group from "object" of research to "subject" of knowledge.

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Article

Creating an Online Social Learning Platform: A Model Approach for Open Development, Open Access and Open Education

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Abstract: The importance of online learning platforms in the face of the challenges of the 21st century cannot be stressed enough. Multiple approaches based on different didactic concepts and software have already been discussed. At Karlsruhe Institute of Technology, our team supports the development of an innovative digital infrastructure in creating a virtual campus that provides a portfolio of digital skills and key qualifications for students of all disciplines. The following paper presents this open source-based social online learning platform called *hocampus*: it aims to function as a model approach for future learning platforms connecting unsupervised learning, peer communication and tutoring as well as teaching. However, our platform is not a mere technical architecture that employs online learning and communication possibilities: it is characterized by a strong correlation of structure and content. For this, we advance a didactic concept focused on empowering students to strengthen their cross-disciplinary key competences and 21st century skills. We also depict the digital infrastructure and tools being used in the creating and operation of *hocampus*. Lastly, the general design principles for digital platforms are put forward. This paper also presents a firsthand account of how to implement such a learning platform by showing what hindrances need to be overcome, how students benefit from a social online learning platform and how digital learning can develop and change in the coming years. Thus, it can function as a manual portraying the necessary steps for the realization of concrete didactic concepts in a digital space.

Keywords: e-learning; didactic concept; digitalization; design-strategies; hybrid classroom; key qualifications; digital skills

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1. Introduction

Studies similar to [1] have shown that online social learning platforms can be beneficial for the academic training and that students are open-minded about online learning possibilities [1–3] Tomczyk et al. even refer to students preferring digital content over traditional learning offers [1]. Today, the idea of digital social learning mainly occurs on third party platforms with a commercial focus, e.g., messaging services, video providers, social media. [4], for example, focuses on the use of MIRO, a commercial web tool hosting all content on its own servers. The authors name visual attractiveness and an interactive and intuitive interface as key factors in choosing MIRO for their educational purposes. Over the past years, researchers especially praised social media not only for its attractive design language and usability but also as providers of a sphere of truly independent learning that allows the formation of learning communities [5–7]. Students, being used to those popular platforms early on, naturally adapt to the content provided and utilize their technology in a mixture of private and academic interests. Studies such as [8,9] show that even though the efficacy and implementation of online social learning platforms are being discussed, they mostly rely on commercial third-party options, which only enforces the preferences of the students. However, those third-party providers fully rely on students and tutors to

generate content as they are not able to produce it themselves. The success of e-learning, however, as the TPACK-theory (Technological Pedagogical Content Knowledge) states, relies not only on attractiveness but also on the relevant educational content as well as methodological knowledge [1]. Third-party tools also have a commercial focus and are prone to distorting content with advertising while neglecting user privacy [10]. The academic realm, on the other hand, can be seen as a shelter with its technological infrastructure, its quality-controlled content and its social role as an institution of certification. Recent studies show that these aspects are on the minds of students as well [11]. Many universities employ open-source software and server architecture for their digital offers. Those tools have been proven to be safe, to respect user privacy and are based on standardized or open exchange formats.

Additionally, open source is seen as the format to achieve digital sovereignty. As the *Aktionsrat Bildung* states, organizational digital sovereignty is a core requirement for personal digital sovereignty and is therefore of utmost importance for students who want to learn, study and work independently [12].

Trying to implement an online learning platform at the House of Competence, Karlsruhe Institute of Technology, we aim to provide our students with the maximum possible benefits that online learning settings can provide.

At universities, we already find a broad offering of technical infrastructure and tools that can be used to create an attractive and safe setting for learners. However, we realized that three aspects are fundamental to deal with if a social online learning platform should succeed:

Firstly, we need to learn from the alluring design, attention mechanisms and ease of use presented in social media. As the Technology Acceptance Model (TAM) suggests, the digital learning environment requires a focus on the usability of content and tools provided as well as ease of use [1]. Secondly, we need to adapt appealing factors such as social interaction and collaboration in our didactic concept [1]. Lastly, we are convinced that the structure of the platform should correspond with the presented content to reinforce each other.

hocampus at the House of Competence can be seen as the result of the aforementioned aspects: it is an LMS (Learning Management System)-based social online learning platform that provides key qualifications for students of all disciplines. Being liberated from domain-specific curricula, the platform can freely test the concept of independent and social learning discussed broadly in current publications about digital learning within an academic context.

Consequently, *hocampus* also supports the development of so-called 21st century skills (communication, collaboration, creativity and critical thinking) [13] by providing new and extended settings, while simultaneously providing access to the research-based teaching content of the House of Competence.

With *hocampus*, we strive to achieve proof of concept of a social online learning platform based solely on campus-provided software. Such a platform allows tutors to offer a broader range of teaching approaches via the interactive possibilities supplied while at the same time inspiring students to move to a digital sphere that focuses on learning and the learner itself. That way, *hocampus* retains advantages such as autodidactic learning and peer-to-peer exchange that researchers awarded social media with and ties them back to the scientific standards of the university.

2. Methods

hocampus shifts focus from a training-/teaching-based environments to a learning community, thus fitting Kerres' et al. definition of a social online learning platform (see Section 2.3) [5]. In addition to learning in conventional teaching settings, students can participate, communicate and study autonomously. *Hocampus* offers a portfolio of cross-disciplinary key qualifications (e.g., competences in the spheres of writing, learning, presenting, knowledge of scientific methods and self-determination). Those key qualifications can be learned via classroom and online courses, but also with the help of multimedia

resources such as digital tests, podcasts, handouts, etc. This content is provided by the scientific research of the House of Competence, an institution at Karlsruhe Institute of Technology solely focused on key qualifications. We also create an environment that provides students with opportunities to deepen these learned key competences through cross-linking (e.g., showing related content), digital forms of participation (e.g., by providing online workspaces for learners (see Section 3)) and specific design choices (see Section 2.2). To ensure the success of those measures, *hocampus* needed an adequate didactic concept.

2.1. Didactic Concept: Digitalization as a Catalyst

The aforementioned concept rests on Gnahs' observations about competences: firstly, he differentiates between domain-specific competences and cross-disciplinary competences. Focusing on the latter results in the competence types of social competence, methodological competence and personal competence. According to Gnahs, social competence refers to every aspect in our behavior that helps to interact, to mediate and to enable teamwork.

Methodological competence describes techniques for solving problems, for analyzing, for decision-making and for presentation. Personal competence is characterized as the ability to work independently, which includes, among other things, time management, autonomy and, in our opinion, resilience [14].

We combine Gnahs' model of competences with the 21st century skills mentioned above. All 21st century skills are always present in a digital context but, depending on the interaction with the cross-disciplinary competences, one or more of them might be dominating while others are in the background. For example: if you want to work on your social competence, collaboration can be a helpful instrument to train interaction skills. At the same time, you may improve your personal competence when you arrange schedules with your team members and integrate these into your own timetable. Communication is clearly a basis for social competence, but can also, similar to our schedule example, lead to the exchange of knowledge and therefore to the extension, innovation and optimization of your methodological competence. Creativity is dominant between methodological and personal competence: it is needed to find acceptable solutions for unprecedented questions, to create an interesting and compelling presentation and to structure and shape your personal life. A part of the methodological competence is critical thinking, which ensures that developed methods are adequate for the context and requirements as they will be revisited and reworked if needed. If your aim is to enhance your critical thinking skills, social competences such as interaction and exchange of insights may be possible ways. In its annual report of 2016, Hochschulbildung für die Arbeitswelt 4.0, the Stifterverband für die Deutsche Wissenschaft postulates eight theses concerning the future academic workplace that will be predominantly influenced by digital technologies. For this reason, it demands the enforcement of digital learning and teaching on all levels, emphasizing that this step simultaneously would transform learning from a mere consuming state into an active and creative education [15]. This necessity to strengthen the digital skills of students to prepare them for their future workplace is also stated by [4,16]. To support this transformation, the Stifterverband für Deutsche Wissenschaft develops a concept of competences that includes discipline-specific competences and work-oriented as well as personal competences, combining them with a digital dimension [15]. Different from their concept, we avoid categorizing specific digital competences, but place the process of digitalization between the three cross-disciplinary competences. Thus, digitalization acts as a connector of distinct competences and in this way as a catalyst for training 21st century skills. We favor this approach because of the critique formulated by Selwyn: "In particular, some of the most misleading assumptions about education and technology are the deterministic claims that technologies possess inherent qualities and are therefore capable of having predictable 'impacts' or 'effects' on learners, teachers and educational institutions if used in a correct manner." [6] It is not enough to postulate a positive effect of digitalization; it needs to be applied in a specific function to have a positive effect. To

translate this idea into action, we developed *hocampus* as a social online learning platform. A visualization of our concept is shown in Figure 1.

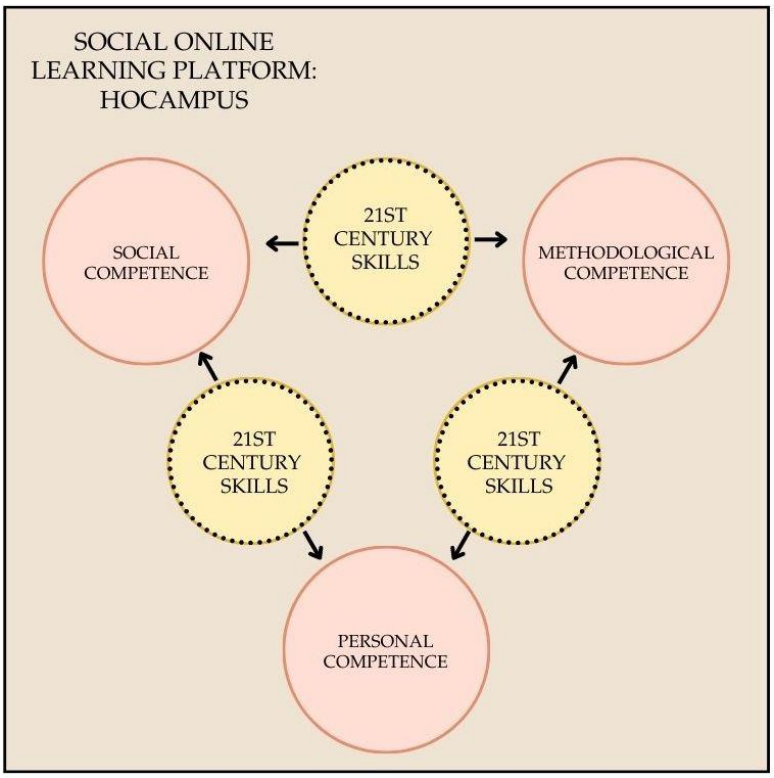

Figure 1. Concept of cross-disciplinary competences integrating the digital potential of our social online learning platform *hocampus*. The three cross-disciplinary competences are being linked with each through the learning platform. Those bonds allow the 21st century skills to grow and are strengthened by them at the same time.

2.2. Design Strategies of Hocampus: Design in Service of Content

Designing a social online learning platform within an academic setting poses a multitude of hurdles and challenges (even when leaving monetary concerns aside) beginning with the LMS your academic institution has decided upon. *hocampus* is running on the LMS ILIAS, which can be customized but only to a certain extent. In some cases, you are stuck with grey text boxes and edged design elements. At the same time, our didactic concept (see Section 2.1) called for specific design strategies. The design of *hocampus* is therefore partly a consequence of the circumstances we were confronted with while creating the platform.

With these challenges in mind, the following design principles and strategies do not claim to be a rigid guideline but rather concepts that any given platform might want to emulate depending on its technological background, didactic concept and goals.

The visual presentation is a deciding factor for the usability and attractivity of any digital educational offer. Studies have shown that an aesthetic design can positively influence the curiosity of learners in their interaction with a platform [17]. With that in mind, the design should always be in service of the type of content you want to present to a learner.

The content can be typified and located on a continuum from poetic to scientific. It is recommended that scientific content (e.g., data, studies, etc.) is displayed in established information hierarchies and structures. With the objective of avoiding biases, it should be presented without the aim of receiving an emotional response. The poetic content, on the other hand, needs to be experienced in a more involved way. The user should interact and experiment with it. The poetic content elicits an emotional response. It cannot be placed in clear and already established hierarchies; it is conceptual and may only be categorized [18].

Focusing on instilling cross-disciplinary competences (see Section 2.1), our content tends to fluctuate between pieces of scientific and emotional information. To ensure the engagement of our learners we needed a design that, on the one hand, centers on the content and, on the other hand, invites learners to explore and interact with the learning platform.

As a result, our design remains playful while also being able to display 'hard' facts. It does not stray too much from general design principles, ensuring that users can fall back on their knowledge of using other online platforms (e.g., Reddit, Instagram, YouTube) [19].

We identified and focused on seven general design principles: First off, our design follows a consistent logic. A left click always does the same, no matter which category the student is currently working on. This also applies to the structure of the different categories: They all follow the same logic and the content is structured in a similar way [18]. The second principle is an unambiguous starting point for all interactions on the platform. On the landing page, we provide five easily identifiable starting points for our different categories (see Figure 2). Those starting points are highlighted via color and placing, they are the first thing you see on the landing site. Inextricably intertwined to this is design principle number three: an obvious option to end or reverse the interaction. We ensure this by implementing a sidebar that enables effortless category switching. Additionally, a click on the banner at the top end of the page always brings the user back to the landing page. During more specific interactions, such as videos, H5P-elements or tests, we rely on established iconography: e.g., a click on 'x' terminates the current interaction. Fourth, there need to be design landmarks that allow the user to identify and navigate different conceptual spaces. We achieve this by reusing the set of icons employed for the general categories (see Figure 3). Furthermore, every category has a distinctive color scheme that encourages users to associate specific colors and icons with different concepts: for example, a coffee mug with a brown background is applied to all content related to taking a break (see Figure 4) [18]. Customizability permits users to adapt the platform to their own needs and is our fifth design principle. Especially in the category 'Collaboration', we empower our users by allowing them to create their own digital working spaces. Not only are they enabled to create specific objects (such as forums, blogs, videos, etc.) but they may also change the design of their working spaces to a certain extent. The students can choose the hierarchy of their objects via drag and drop, change icons and the color scheme of their group [18]. A direct consequence of this is principle number six: the user must at all times have the option to request help. The idea that children, teenagers and young adults who grew up during the digital age are more competent in the usage of technology has been widely refuted [20]. For that reason, we need to anticipate the difficulties our users may encounter during their stay on the platform. Not only do we provide a forum for questions and feedback but we also offer help in the form of tutorial videos wherever users might be in need of them. The same applies for tutors using the platform. We support them with the implementation of their seminars, workshops, etc. by offering them templates for courses on the LMS and video tutorials on how to use the plethora of tools in a teaching scenario. Those tutorial videos are highlighted and placed right next to the content that might cause difficulties [18]. The last principle, visual attractiveness, is connected to the belief that an attractive design has a positive effect on the perceived valence of the social online learning platform.

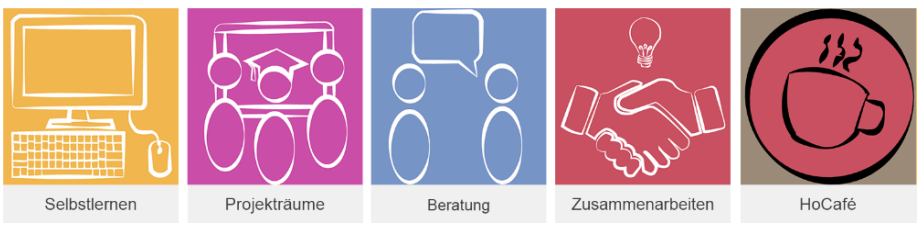

Figure 2. The five categories of *hocampus*: 'Self-learning', 'Academic project rooms', 'Tutoring', 'Collaboration', and 'HoCafé' (from left to right).

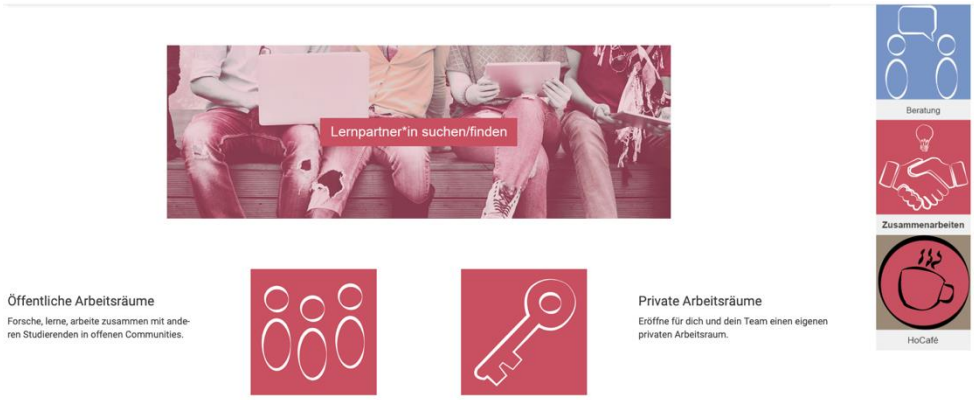

Figure 3. A snippet of the category 'Collaboration' highlighting the continuous color-scheme and returning icons of the central categories.

Figure 4. The coffee mug as a recurring icon signaling the need to take a break.

Meta-analyses have shown that warmer saturated colors and an iconography that relies on rounded edges can produce the aforementioned effects [17]. This can be subsumed under the concept of emotional design. You can see the influence of this design strategy in all aspects of *hocampus*. Beside a specific color scheme, we utilize anthropomorphized elements (see Figure 5) to draw the attention of users [21]. Furthermore, the selected hues produce the strongest possible contrasts that result in a design using complementary or close to complementary colors [19]. The chroma is also chosen to harmonize with the general color scheme of all official Karlsruhe Institute of Technology content. We likewise try to avoid the usage of grey tints and icons with sharp edges wherever the chosen LMS allows for it.

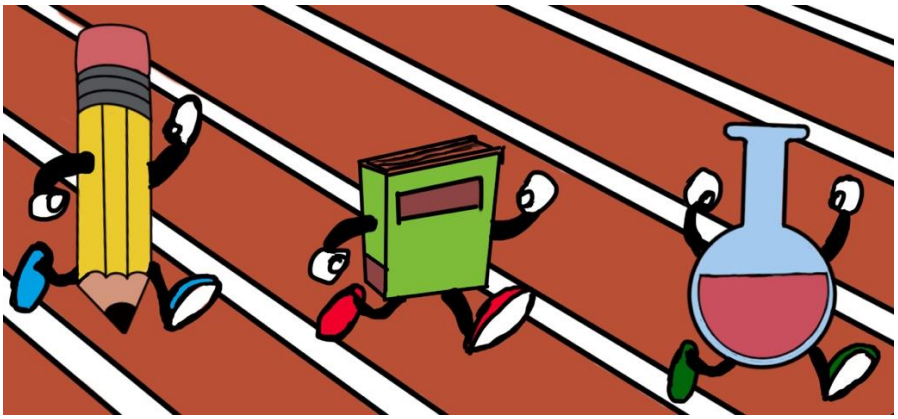

Figure 5. An example of anthropomorphized design elements. This graphic called 'semester-sprint' is used for advertising courses related to topics needed at the end of a semester, such as scientific writing, how to search for literature and how to find the right methodology.

As mentioned at the beginning of this section, the outlined design principles and strategies can be applied to different kinds of online platforms. No matter what your goal is, you can extrapolate from the principles above. Depending on the content you want to present some tweaking might be necessary, for example you might want to choose a

more hierarchical way of presenting content. In our case, the design of *hocampus* is a direct consequence of the aim to enable a didactic approach to strengthen 21st century skills.

2.3. Advantages in Creating a Social Online Learning Platform

The implementation of *hocampus* follows the remarks of Kerres et al. about transforming traditional learning platforms into social learning platforms. While the former works with defined and separated classrooms, the latter focuses on the learners' activity and interaction in order to create an environment in which collaboration as well as communication is not only possible but attractive.

Kerres et al. emphasize that, on a social learning platform, learners are provided with the opportunity to get to know each other, to communicate (in writing as well as verbally), to build up relations and collaborative workrooms. The learners do not have to stay in predefined teaching constellations but can choose their own learning partners and learning groups [5].

The idea of activity being a precondition to the act of learning was already formulated as early as in Benjamin Bloom's *Taxonomy of educational objectives* (1956) [22]. In addition, the works of Lev Vygotsky postulate a sociocultural concept of learning as a mainly social process [23]. The idea of social learning follows the logic of a constructivist approach to learning based on Jean Piaget and Jerome Bruner [24,25]. Selwyn elaborates on this line of didactic tradition, citing key theories from constructivist to sociocultural views, to answer the question of what education is and how it could be improved by technology [6]. It is in this vein that newer studies on social learning and technology follow. Following these approaches, studies today see a clear connection between the success of e-learning and social interaction resulting in a call for high levels of collaboration [1]. Through collaboration, the students build up task-based relationships that increase the attractiveness of the learning process. In completing these tasks in heterogeneous teams, they adopt different social personas, e.g., planning the project at hand, learning to discuss with empathy and respect and exchanging knowledge on a peer-to-peer level.

E-learning proves to be best suited for a collaborative knowledge construction via a problem-solving approach that also strengthens a student's action competences [4,11].

On *hocampus*, our design allows students to act and move effortlessly, spontaneously and intuitively (see Section 2.2). The digital structure of *hocampus* ensures in its permeability that our users always have access to options such as supervised classrooms, self-determined learning, social collaboration, de-stressing and even external resources such as podcasts, feeds and journals: interactions between participants lead them out of closed classrooms to an open exchange of ideas in self-organized groups. This self-organization is accompanied by further recommendations such as peer-tutoring and content of unsupervised learning. That way, we try to achieve our goal of creating a discipline-independent learning community, built on similar interests or similar academic advancements [5], which is attractive for students due to the easy access to diverse and individualized learning scenarios [1].

3. Results—*hocampus* as a Model Approach

With the didactic concept and design in place, we now shift our focus to the concrete digital tools and functionality of *hocampus*, thus answering the call for examples of practices regarding the development of digital skills [26,27]. Before describing the functionality of *hocampus* we want to emphasize two points. First, even though our platform runs on the LMS ILIAS, the general design and didactic principles that we apply can still be used for the development of platforms on different LMSs. They are adaptable to the specific needs and restrictions of other platforms (e.g., Moodle, Blackboard, etc.). Secondly, we want to change the way teachers and students interact with their university's LMS. Most students only use the university LMS for downloading files and course organization. With *hocampus*, however, we aim to integrate a platform for acquiring digital skills and key competences into the existing LMS, thus providing a seamless transition from coursework toward competence development and e-learning.

For our didactic concept to work, users need to be able to interact with the content of *hocampus* at the right time of the student life cycle utilizing the proper digital tools for the task at hand. To support self-organized but also collaborative learning on one digital platform, the right technical framing is indispensable: in order to fulfil Karlsruhe Institute of Technology-standards, *hocampus* is implemented merely as one of many digital classrooms within the LMS ILIAS. Besides technical limitations (as described in Section 2.2), this provides us with a couple of advantages in designing and integrating the platform in the infrastructure of the university: first up, every student at the Karlsruhe Institute of Technology already has an account and access to ILIAS, resulting in a potential user base of 20,678 Karlsruhe Institute of Technology students (as of 24 June 2022). For *hocampus*, we turn the concept of ILIAS classrooms upside down: instead of only addressing an exclusive group as a consequence of access-limitations and the need for extra applications, the platform is open for every student whenever they choose to join. Additionally, we do not have to worry about security or user privacy as we never leave the Karlsruhe Institute of Technology realm that already controls those aspects. It always lies with the students to decide whether they choose anonymity above revealing their identity to fellow students. Although research suggests that unambiguous virtual identities of participants can be part of a motivational concept to commit users to a social online learning platform [5], we prefer freedom of choice over such strategies.

Plus, we have access to a multitude of premier content: as one of many ILIAS classrooms, *hocampus* can easily link to or integrate parts of other online classrooms and courses, especially those of the House of Competence.

hocampus is divided into five subcategories that are advertised on the landing page (see Figure 2, Section 2.2). In the category 'Self-learning', students find materials relating to key competences formulated in our didactic concept. 'Academic project rooms' is a category that promotes and contains different projects and courses teaching the aforementioned competences. Offerings of peer tutoring on writing, learning, presenting and future skills are found in the category 'Tutoring'. 'Collaboration' comprises all tools, spaces and projects enabling students to study, learn and work together. The 'HoCafé' is a room of relaxation, where students can take a well-earned break from their academic ambitions. A big difference of our platform to standard online classrooms lies in the option for students to move freely between those content categories at their own speed and to use the tools provided in a way that suits their specific needs. There is no given curriculum or path leading through *hocampus*. This aspect is especially apparent in interactive learning nuggets: those H5P-elements convey learning units on key competences in a playful graphic processing (fitting our general design principles described in Section 2.2). Besides interactive elements such as tests, there is multimedia content such as podcasts and videos on topics of key qualifications or even practical instructions (e.g., on how to effectively design a break from a learning session), that students can freely choose from. By integrating learning content within the student life cycle, learning nuggets support independent, unsupervised learning on demand. Being merged with the possibilities of a full-fledged LMS allows us to link these nuggets to online courses providing the bigger context on a subject. Both are designed to be explored by students unsupervised. This way, students receive exactly what they need at the time they require it the most:

Nuggets are sorted to advertise competences regarding learning structures, on how to speak in front of class, etc., at the beginning of the semester, while highlighting online courses on academic writing toward the end of a semester when students are working on their papers.

Moreover, *hocampus* integrates a learning partner exchange hosted on the House of Competence website that helps students in finding peers of their own discipline. This way, we facilitate forming study groups for exams, for finding motivation to write a thesis or to practice in front of test-audiences for presentations. Once they find their peer group, we provide them with the option to exceed the limits of standard online classrooms by creating their own virtual room for group collaboration. They can either open a private

or a public space, invite their peers to join them and choose between different templates that offer tools such as file sharing, a forum, wiki or blog. Public working spaces can be moderated to integrate on-campus services from different institutions such as an online reading room provided by the Karlsruhe Institute of Technology library or virtual events such as guided learning sessions accompanied by tutors. Every working space may be linked to the communication software Microsoft Teams provided by the Karlsruhe Institute of Technology for videoconferencing, chat, file sharing and collaborative editing. Of course, an open-source videoconferencing solution would be preferable. Tools such as Big Blue Button even allow for a far deeper integration in ILIAS. In the case of *hocampus*, we are stuck with the option the KIT provides. On *hocampus*, the students are free to create their own team there for private conversation and to further ease their digital collaboration. Videoconferencing is also used for consulting offers by special-trained tutors in scientific writing, learning strategies and presentation skills. In consequence, peer-groups can ask tutors to join their conversation to help out on specific questions. Not only do we focus on private peer groups, but similarly on semi-public communication within the student body of Karlsruhe Institute of Technology. The students are able to meet up spontaneously with their fellow students and start a conversation on chat or a videoconference via pre-created public groups on Microsoft Teams. Convinced that students really benefit from peer knowledge and discussions, we also host a public forum for the free exchange of questions on scientific methods. This forum supports the opportunity to rate topics of quality and importance to cause those to be more visible for others. To ensure some quality control, this forum is moderated by tutors.

Still, there is room for another aspect of a social online learning platform: we call it 'hybrid classrooms with a twist'. Didactic research today demands a shift from a mere reproduction of expertise by students to the idea of life-long learning as an answer to the fundamental changes brought by digital technology enforcing the adoption of new knowledge in all areas of life [6,13]. Key competences such as learning, collaboration, communication in writing and presenting are the foundation that students build on to adapt to those ever-changing demands. *hocampus* strives to integrate online classrooms provided by ILIAS via a transformation of the existing teaching structure (may it be in physical or online classrooms) by the means of digital options such as networking and collaboration described above. On our platform, the students are able to easily find and connect with the participants of courses they attend, even if the course itself is not a part of *hocampus*. This facilitates student activities such as sharing independently acquired knowledge in the form of blog entries, wikis and mind maps via audio or video casts. By going one step further and linking classes with *hocampus*, we enable students to overcome the limits of the classroom and carry its topics, discussions and inspirations into the social field of semi-public peer-communication described above. It is this social aspect of the digital campus we consider not only as a driver for academic learning in general but also as a core tenant of the academic and modern work environment [4]. By learning and improving their key competences on *hocampus*, students simultaneously have the chance to train working in a team, to communicate efficiently and to perform in different social roles.

Besides the learning scenarios sketched above, *hocampus* in addition functions as a hub for live events on Microsoft Teams or Zoom organized and hosted by the House of Competence. Those events include talks, presentations or podium discussions such as *future talk* on onboarding in professional life, *Tag der Abschlussarbeit* on academic writing or *Kickoff Klausurenphase* on techniques and strategies to improve the ability to learn. Integration with our learning platform enhances those events by providing additional material and documents, technical support, event communication and interactive enrichment via related learning nuggets. This way, events that could only be attended in presence can become hybrid events: we allow the event to be live streamed on Microsoft Teams or Zoom and provide a moderator who can answer questions of the online audience. Depending on the format of the event, such as in the case of podium discussions, this moderator may also interact with the participants of the live event and pose questions of online participants for

all people in attendance to be heard. To sum up, our technical framing allows for individual, asynchronous and space-independent social learning scenarios by connecting unsupervised learning, peer communication and tutoring as well as teaching in one social platform.

An example of such a social learning scenario could be students at the end of their semester who are confronted with the challenge to write an essay for course completion. If those students decide to look for help on *hocampus*, they will find prompt support in our category *Self-learning*. Here, we created learning nuggets that provide first insights on the basics of scientific writing. If the learning nuggets peaked the student's curiosity, a link presented in the learning nuggets leads to a corresponding online course. In their own time, focus and extension, the student can enhance their writing skills. However, we are convinced that students who are writing their first or second academic text need personal support and feedback during their writing phase. Therefore, they have the option to book an appointment for peer-to-peer tutoring or to organize a writer's group with other students on *hocampus*. Thus, solitary writing turns into a social activity that can increase motivation, exchange of insights and reflection about the writing process. Apart from such ideal scenarios, in some cases, the students do not have the time to work in groups for weeks or to struggle through a complete online course. These students can receive an overview on the topic in the form of talks and presentations of prior events about scientific writing stored in our archive or listen to podcasts in the *hocafé*.

4. Discussion

In regard to developing and launching a social online learning platform as we sketched in the prior sections, two factors need to be stressed: the importance of content and the onboarding of students as well as tutors/teachers. As mentioned in Section 1, students are already using third party tools to cooperate and communicate. We have shown that it is possible to learn from those third-party tools especially in the realm of visual attractiveness, but it would be delusional to believe that students would abandon known apps and programs for an in some ways inferior option. To realize this is a common occurrence; one must only think of the numerous projects by *Google LLC* that did not succeed to penetrate the market and were consequently abandoned (e.g., *Google Hangouts*, *Google+*, *Google Spaces*, to name just a few), despite the financial backing and infrastructure the company could provide. This again demonstrates the importance of content: if a platform offers content that on the one hand satisfies a need of students, in our case learning cross-disciplinary competences, and on the other hand is only available in one place, it significantly raises the chances of the platform to be successful [28].

However, the availability of content on its own is not enough. The students need to know and need to be familiar with the platform early on in their student life cycle. To achieve this, students must be informed about the existence of the platform via multiple channels: at introductory events for first-semester students (official events and student organized events), via advertisement before lectures for freshmen, on social media, on official websites and in seminars. It should be apparent that this cannot happen without the support of teachers and tutors [1,16]. To ensure their backing, we implemented a support system, allowing them to realize their own learning environment easily via ready-made classroom templates. These diminish most of the difficulties that teachers will likely encounter in developing online teaching options according to a survey by [2]. Furthermore, we offer personal support whenever needed, enabling teachers and tutors to build up their own online classrooms on our platform step by step. As studies such as [16] have shown, it is crucial to boost the digital competences of teachers and tutors. To further advertise the platform, we also host onboarding events that highlight the benefits of *hocampus* for both teachers and learners.

To ensure not only an efficient launching but also a successful performance of the platform, in our opinion, a continuous optimization through the integration of user feedback is essential. On *hocampus*, we installed message boards for feedback and are turning proactively to students' unions and student councils to gather their insights as we already

have in our development phase. Furthermore, we plan to obtain user data where privacy settings permit but, due to being in the beta phase, we have not yet collected enough data to present in the current stage.

5. Conclusions

hocampus, as presented in the sections above, can function as a model for the implementation of other social online learning platforms. We focused on exemplifying our didactic concept, the digital tools offered on the platform and our design strategies. Didactically, *hocampus* concentrates on enabling students to develop cross-disciplinary key competences in general and more specifically so-called 21st century skills. Digitalization therein is seen as a means to an end: a catalyst for training the latter. The same is true for the digital tools that we supply our students with. They are chosen to empower them to work, study and learn independently, while also being able to connect with their peers and their teachers: all within the secure realm of an open-source platform placed within the digital infrastructure of the university and adhering to its data privacy guidelines. Lastly, our design too is in service of the goals formulated within our didactic concept. Employing general design strategies (e.g., consistent logic, clear starting and ending points of interactions, landmarks throughout the platform, customizability, etc.) and 'emotional design', we try to ensure that interacting with the platform is as pleasant as possible while also stimulating students to keep exploring, learning and studying. We have shown that especially the choice of the tools being offered as well as the design of the platform are highly reliant on the digital ecosystem of the university in question. The developers need to be flexible, adjustments need to be made and workarounds need to be applied to realize the goals of a specific platform.

Lastly, we want to point out our vision of the future for *hocampus* specifically and social online learning platforms in general. Arnold et al. formulate the idea of a virtual education room that is connected with other institutions, learning platforms, communication options and the internet [29]. Similarly, Kerres et al. see the potential of a stronger connection and permeability of the learning platform to the internet for a more vivid, intensified and broader exchange of insights [5]. Right now, such platforms are mostly relegated to single universities even though the content of those platforms is of interest for students of all educational institutions alike (one might argue that this is not limited to students). A platform similar to *hocampus* has the potential to be scaled to a more global scope without sacrificing its advantages in the realm of data privacy. It can be also be connected with other platforms that work on an open-source basis and inside the academic system. Identity management systems such as *Shibboleth* can ensure a safe login for all students, tutors and professors of different institutions [30]. The COVID-19 pandemic has shown a huge difference in e-learning capabilities of different institutions and even countries [16,27]. Thus, it not only poses a hurdle but also highlights the need for global solutions and practices. Leaving organizational problems aside, a global social learning platform would allow 21st century skills to flourish: collaboration and communication between students at different universities, even countries, on one platform. A potential digital accumulation of information will be established that can be critically analyzed and refined by the community. It would be a place in the digital realm where students could live their creativity. This might be a utopia never to be realized, but it is a vision worth striving toward.

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Closing the Policy Gap in the Academic Bridge

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Abstract: The highly structured nature of the educational sector demands effective policy mechanisms close to the needs of the field. That is why evidence-based policy making, endorsed by the European Commission under Erasmus+ Key Action 3, aims to make an alignment between the domains of policy and practice. Against this background, this article addresses two issues: First, that there is a vertical gap in the translation of higher-level policies to local strategies and regulations. Second, that there is a horizontal gap between educational domains regarding the policy awareness of individual players. This was analyzed in quantitative and qualitative studies with domain experts from the fields of virtual mobility and teacher training. From our findings, we argue that the combination of both gaps puts the academic bridge from secondary to tertiary education at risk, including the associated knowledge proficiency levels. We discuss the role of digitalization in the academic bridge by asking the question: which value does the involved stakeholders expect from educational policies? As a theoretical basis, we rely on the model of value co-creation for and by stakeholders. We describe the used instruments along with the obtained results and proposed benefits. Moreover, we reflect on the methodology applied, and we finally derive recommendations for future academic bridge policies.

Keywords: policy evaluation; higher education; virtual mobility; teacher training

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1. Introduction

The design and implementation of policies must fit societal needs, but this is not always the case. Closing such policy gaps requires the professional development of well-targeted groups in order to translate the higher-level policies to local strategies and regulations, and disseminate supporting resources, such as guidelines, effective programs and assessment tools [1]. A policy/evidence-practice gap can be defined as "the difference between what is known from the best available research evidence and what is practised in reality (through delivery of medical care or drafting of policies or guidelines)" [2].

Activities regarding closing policy gaps require strong cooperation between all (for our field: educational) players to establish concrete co-creation values. Co-creation can be found in the education field to describe the cooperative relationship between teachers, trainers and students, as well as the cooperation between higher institutions.

The policy gaps in our research context can be identified as the following: First, there is a vertical gap in the translation of higher-level policies to local strategies and regulations [3]. Second, there is a horizontal gap between educational domains regarding the policy awareness of individual players [4]. From our findings, we argue that the combination of both gaps puts the academic bridge [5] from secondary to tertiary education at risk, including the associated knowledge proficiency levels.

Closing the policy gaps is crucial, because on one hand it will serve to narrow the angle in the horizontal dimension between different academies as a critical need in the digital age. This policy gap poses a problem because there is a 'risk of non-usage' or 'risk of usage not as intended' on the grounds of structural complexities of (and between) educational domains [4]. On the other hand, filling the policy gap builds a robust academic bridge between secondary schools and higher education (HE) institutions as a vertical dimension. Bridging policies vertically is important because there can be a "loss in translation", starting

from implementation to an unfolding at the local level ([3], p. 6). Generally speaking, there is always a risk of policy gaps in all policy-induced systems / services to society (e.g., [6,7]). Our paper covers an aspect of a general risk with policies within all societal systems (in our case the educational field).

A theoretical foundation is required for policy making. Further development by evidence-based data to feed and confound policy making is necessary. To this end, aiming for distinct goals and research questions, such as our study focused on closing policy gaps in the educational field, an evaluation provides evidence in order to formulate recommendations to policy makers and the solutions that are linked to them. Evidence should be gathered by evaluating the experimentation through several phases. Experimentations aim to test new policies in a small-scale setting and search for generalization potential on a larger scale [8]: "The deliberateness of experimentation resides in the planning of the process, and in particular, in the ex-ante decisions of what is going to be implemented and how its effects will be measured." ([8], p. 169). It is a set of possible knowledge in the line of research that needs to give the researchers and policy makers a scientific base to describe the status quo and lead them to reasonably believe that something is true or happened by accepting or rejecting their hypotheses. According to Davies, the evidence-informed policy based on well-defined target groups is an approach that "helps people make well-informed decisions about policies, programs and projects by putting the best available evidence at the heart of policy development and implementation" ([9], p. 3).

In this paper, we present our findings from two case studies on policy evaluation in the educational sector: the first on virtual mobility in HE, the second on teacher training in AI and Data Literacy. Both projects are funded by the European Commission in Erasmus+ Key Action 3 on policy experimentation and evaluation. By contrasting both cases, we were able to derive recommendations not only in the respective fields, but also on a more general level.

The project "Online Pedagogical Resources for European Universities" (OpenU) is guided by the question: How can inter-university cooperation, innovative pedagogical teaching and learning, as well as academic mobility, be strengthened throughout the project? The OpenU project brings together representatives of European HE institutions, six ministries of HE and research (France, Germany, Belgium, Latvia, Portugal and Spain), and four European networks around the topic of digitalization in HE. The objective of technical development and educational experiments in two rounds is to contribute to the emergence of innovative policies, encourage mutual learning and strengthen long-term strategic and structural cooperation between European HE institutions [10].

The project "Teacher training for Data Literacy and Computer Science competences" (TrainDL) wants to reduce the digital skills gap in and across educational systems in Europe. In three countries (Germany, Austria and Latvia) the digital competencies of data literacy (DL) and artificial intelligence (AI) are tested in a policy cycle consisting of three experimentation rounds. Results from these teacher trainings provide insights for recommendations to policy makers regarding the implementation of DL and AI in national framework curriculums and educational systems [11]. Furthermore, the digital divide is to be prevented.

Both projects are part of the (educational) EU activities, which "are designed to bring an additional international dimension to studying, teaching, researching and making policy in higher education" [12]. Some of the most significant goals of Union action in HE are student and teacher mobility, as well as the encouragement and development of distance education. In addition, cooperation between the education systems of Member States and educational institutions is created/promoted [12].

OpenU and TrainDL share commonalities: They are both working on the promotion of themes in digitization (OpenU: blended learning, virtual mobility; TrainDL: DL, AI). Both are situated in the educational field. The same methodological approach is used (questionnaires). However, there are some differences between the projects: They are targeting different educational (secondary and tertiary education) and institutional levels

(OpenU: HE; TrainDL: school level). This is also the very reason for combining both projects in the presented manner because we want to bridge the policy gap between the levels.

This article investigates the role of digitization and other factors related to digitization to fill the policy gaps in the academic bridge. The knowledge proficiency levels between secondary and tertiary levels are different. We utilize value co-creation as a theoretical basis in the context of digitization in education in both HE institutions (tertiary level) and secondary schools. This paper discusses the value co-creation for and by stakeholders and what they expect from or ascribe to educational policies. We answer the research question: Which values do the involved stakeholders expect from or ascribe to policies, with respect to the themes of the policies in the selected field of digitization in education (virtual mobility, blended learning, data literacy, artificial intelligence)? To this end, we analyzed the questionnaire data of the second evaluation phase of the OpenU project, as well as the first evaluation phase of the TrainDL project.

The remainder of this paper is structured as follows. The next section shows the theoretical background as well as related research. The Section 3 investigates the horizontal and vertical policy gaps, which contain the value co-creation model of this study. Sections 4 and 5 explain the evaluation methodologies that were used in both projects to gather data about the vertical and horizontal dimensions respective of the values. Section 6 summarizes and discusses the preliminary results of this study, while Section 7 provides several recommendations and flexible solutions for policy makers and stakeholders. The last section suggests future research work.

2. Theoretical Background and Related Work

2.1. Service-Domain Logic and Value Co-Creation

The value of policies only arises through cooperation/co-creation with the involvement activities within the educational institutions. In the following, we are presenting the concept of value co-creation, which stems from the service-dominant (S-D) logic. Edvardsson et al. [13] argue that S-D logic holds that all providers are essentially service providers, and that resources are distinguished into two categories: (1) operand resources, which are typically physical and (2) operant resources, which are typically human, such as skills and knowledge.

The operant resources operate on resources to match the institutional needs and operational experiences, which are often invisible and intangible. Generally, they are core competencies or organizational processes. They are likely to be dynamic and infinite and not static and finite, as is usually the case with operand resources. Because operant resources produce effects, they enable humans to multiply the value of natural resources and create additional operant resources [14]. All actors within contexts where value is produced are "resource integrators" ([15], p. 7). The resources do not have an inherent value, so in order to be of value, they have to be put to use and integrated into value creation processes [16].

Vargo and Lusch [14] extended S-D-logic, as described above, towards firm–customer-relations in economic exchanges and into different forms of value configurations—"economic and social actors within networks interacting and exchanging across and through networks" ([15], p. 5). S-D logic suggests that through collaborative competence in such contexts, value is co-created [13].

There are different conceptualizations of value co-creation:

(1) Value is not a fixed term and is dependent on a variety of factors. Vargo and Lusch mention that value perception is a relational phenomenon [14]. The consumer determines and perceives it as "value in use" ([14], p. 7). Therefore, "analysis of value creation in terms of a service system blurs the distinction between the role of the producer and the role of the consumer" ([13], p. 331). For Vargo and Lusch, from an economic perspective, S-D logic is process oriented and it is only through customer collaboration that market offerings/value can be created. The customer becomes an involved co-creator of value [13,17], instead of being an uninvolved recipient/consumer.

This is because the value is phenomenologically and idiosyncratically determined by the beneficiary. The creation of value by the beneficiary means that the supplier of the resources or services, on which grounds the value is created, can only offer value propositions [15]. Hence, Vargo and Lusch define value co-creation concerning beneficiaries/consumers in exchange systems.

(2) Kinnula et al. utilize a different emphasis, while integrating most of the groundwork achieved by Vargo and Lusch: Value co-creation is a process in which all stakeholders in a given context create value "that is relevant for themselves as well as for others" ([18], p. 464). The success of value co-creation is dependent on whether all stakeholders perceive receiving value from the service. Their school-based study concludes that, although value experience is different [18], "similar experiences of value emerge for different stakeholder groups" ([18], p. 490).

We are focusing the second approach upon analyses of the values of evaluated stakeholders and target groups in the projects, in connection to the other project partners and formulated project aims. In addition, the integration of policy contexts and institutional structures are processes that can only be initiated and re-confirmed with stakeholder participation.

From the value co-creation perspective, educational institutions collaborate for many reasons. Institutional reasons could be to increase the instructors' experiences and skills, to enhance the quality of education or to improve their image. Other reasons could be giving students a chance to learn from other institutions, time efficiencies, expansion in terms of internationalization purposes, etc.

2.2. Value Co-Creation in OpenU and TrainDL Projects

In OpenU and TrainDL, value (regarding policies) is co-created from the experimentations on digitization and education in different spheres and at different levels. Value co-creation has been affected by several factors that are related to the effect of the experimentation and the implementation outcomes.

Value co-creation in OpenU takes place in its experimentation phase. It has two dimensions. The first dimension is the value co-created by the educational designers and teachers across the European universities through experimentation partnerships and international collaborations, which reflect on the respective influence of national strategies and policies. The second dimension is from the experimentation on feedback to bridge practices and policies at the institutional level. Value co-creation, from the two dimensions that are mentioned above, is helping to fill the vertical gap locally and nationally.

Value co-creation in TrainDL also takes place in its experimentation phase. It also has two dimensions. First, in the experimentations, value is generated under the participation of the teachers (experimentation target group) in so-called "interventions". When referring to an educational intervention, we mean an action (e.g., teacher training) that can be used to measure content, concepts, and related effects; it is connected to policy changes (teacher trainings) and offers insights for the evaluators. Secondly, later interventions with other target groups will be specified and, in the end, this will lead (through recommendations) to horizontal policy integration across schools and educational systems in European countries.

One aim of the involvement of stakeholders in the process is to guarantee a successful implementation from theory to practice, by considering each of the individual players' perspectives. This is closely linked to the single and shared values of the stakeholders, and the values they each ascribe to the project and its (ongoing) results after implementation. Therefore, disseminated values within the ongoing project between the stakeholders are linked to the value once the project ends and policy implementation begins. Moreover, comparing these processes across both cases helps to address horizontal policy gaps.

2.3. Related Research

Evidence-based policy making has been studied through many research works. Davies [9] emphasizes the role of evidence in developing the best policies and strategies, as well as their implementation. In many projects, researchers prefer to use the term 'evidence-based' rather than 'evidence-informed' when the evidence is intended to be used in decision making. Pellegrini and Vivanet [1] argue that many European initiatives are preferring to use the term evidence-informed education They insist that the use of the term 'evidence-informed' education has implications for research and policy: "For policies, the European Union (EU) documents provide guidance rather than stipulations regarding the use of evidence in educational decision making" ([1], p. 2). Janušauskienė and Dvorak confirm the contribution of evidence-based policy in HE for implementation and goal achievement, but also underline a dependence upon the effectiveness of the evidence-based policy regarding policy problems and goals [19]. Turan and Kılıçoğlu (2017), as well as Lassnigg (2016), argue for policy evidence systems in centralized education systems, using Turkey and Austria as examples (e.g., [4,20]).

However, there are significant differences between the education sectors, which make it difficult to make phase transitions or change tracks. That is why Kift et al. propose a so-called "transition pedagogy", to bridge the vertical and horizontal gaps in the education system for HE students in their first-year experience (FYE); this would "transcends the silos of academic, administrative and support areas to enact a holistic, systematically-managed, vision for the FYE that is truly student focused" ([5], p. 14). In addition to this pedagogical perspective, we further investigate policy issues affecting the effectiveness of the academic bridge.

Many researchers utilized S-D logic for HE services to reframe the role of students. The research of Díaz-Méndez et al. [21] advocates for the improvement of educational services by developing an alternative framework that is more appropriate for addressing the usual student-teacher dyad, within the HE services of teachers as service providers and students as service customers. Instead, teachers should be seen as value facilitators and students as value co-creators in order to consider the HE "as a network composed of several actors who use and integrate resources among themselves to obtain benefits together with the network resources, such as university policies or educational politics, which are also integrated into the process" ([21], p. 8). This value co-creation process at a university is the learning process, while the service is learning, rather than the teaching or educational process. Both student and professor use their resources in the co-creation of learning and they receive support from resources in their network, which may include other students, professors, libraries, books and Information and Communication Technology (ICT) systems. We make use of this perspective, considering insights into policies as an additional value, co-created from the evaluated educational experiments.

S-D logic is grounded in an increased focus on operant resources and especially on process management [14]. Edvardsson et al. [13] argue that S-D logic essentially states that service is linked mainly to competence (knowledge and skills). They also insist that the co-creation process at a university is a learning process, while the service is learning. Both students and professors use their resources in the co-creation of learning and they receive support from other resources in their network. The competitive advantage is primarily created through operant resources because they operate on resources to solve problems, fulfill needs and produce a favorable customer experience [14].

Edvardsson et al. ([13], pp. 333–335) suggest four propositions for applying key concepts from social construction theories to S-D logic:

- "Proposition 1: Value has a collective and intersubjective dimension and should be understood as value-in-social-context.
- Proposition 2: How resources are assessed depends on the social context
- Proposition 3: Service exchange and value co-creation can be asymmetric
- Proposition 4: Service exchanges and actors' roles are dynamic in adaptive service systems."

Propositions 1 and 3 are related to our research work. They make a point of values being different. Before measuring these differences, we investigate the horizontal and vertical gaps. Researchers have emphasized the need to understand the differences between societies and their educational systems [22]. To this end, a model has been created that visualizes the occurrence of values in different contexts in order to fill the gap horizontally and vertically.

3. Investigating the Horizontal and Vertical Policy Gaps

The gap between policy and practice is a common problem faced by many (national) education systems [22]. Closing the policy gaps vertically and horizontally between HE partners on one side, and the secondary schools on the other side, relies on several factors. In both projects, the factors and evidence that have been gathered can be classified into three categories. The first category is the (1) experimentation level: It includes criteria such as barriers and difficulties (during experimentation), the effect on the target groups and their acceptance of the experimentations. The second category is the (2) implementation level: It can be described through the actual steps that need to be completed to integrate a policy into practice (may be in connection with milestones, etc.). It includes institutional policies and strategies, recognitions, legislations and infrastructure, translating the policies and quality assurance. For example, in OpenU, virtual mobility certifications belong to this level. For TrainDL, an example would be necessary steps to bring DL and AI into the framework curriculums. The third category is the (3) acting and sustaining level: The third level is mainly connected to the outcomes of the experimentations, in order to inform the policy makers with the aim of anchoring and sustaining the virtual mobility experimentation (OpenU) and the 'success' of framework curriculum integration (TrainDL). For both projects, monitoring of the acting level can be conducted.

An example of a great change is establishing value through cooperation between partners, in order to bridge secondary and tertiary education. Each of the partners has the role of adding value to close and fill the gaps between partners, on the one hand, and establishing the flow of knowledge between the institutional policy level and the level of good practice, on the other hand.

Key Action 3 (KA3) provides support to policy cooperation at the EU level, thereby contributing to the development of new policies, which can trigger modernization and reforms in the fields of education, youth training and sport. One of its aims is to gather evidence and knowledge about education, foster policy dialogue with stakeholders and contribute to identifying and disseminating good practices [23]. Another aim is to identify such gaps and find solutions to bridge and close the gap between policies, through several well-defined experimentations across the European partners, as well as on the institutional level. Secondary education also faces a challenge to match its policies and regulation with the HE institutions' policies, as the universities recruit first-year students from the graduated students of secondary schools.

In OpenU, experiments in different European universities were conducted in two phases and through several partners as cross-institutional and cooperative online activities. The first experimentation phase was launched in July 2021, while the second phase was launched in June 2022 to identify needs, produce knowledge, encourage the development of close-knit cooperation activities; to enable an analysis of their effect, an online hub and its functionalities were applied. The experimentations were conducted by university research professors, along with their students and local teams. Each phase of experimentation had at least 6 peer learning sessions, including 10 partners, each represented by experts/researchers/teachers, students and staff. One of the evaluation roles in the OpenU project was to investigate the practices of the national and institutional policies, as well as the administrative solutions for international cooperation, virtual mobility and blended learning in two evaluation cycles. To this end, the results of the second evaluation phase showed the valuable role of policy experimentation in potentially bridging the gap between policy and practice using a bridge of research evidence [3].

TrainDL's evaluation of the three cycles of experimentation aimed to gather evidence about competencies and the models of best practices and circumstances, regarding teacher training, for teaching DL and AI at the school level. The results presented in this paper are collected in the first phase. The slight alteration of the evaluation concepts to maintain a high comparability of results between intervention cycles (adjusted to different target groups of teachers) is planned. Questions target multi-dimensional assessments and challenge the actual knowledge of teachers in DL and AI. Therefore, the evaluation of the first round already produces feasible estimations for implementation and bridging from the secondary to the tertiary level.

Figure 1 shows the overarching value co-creation model between different partners in tertiary and secondary education, to close the vertical and horizontal gaps and to gain the best practice advantages.

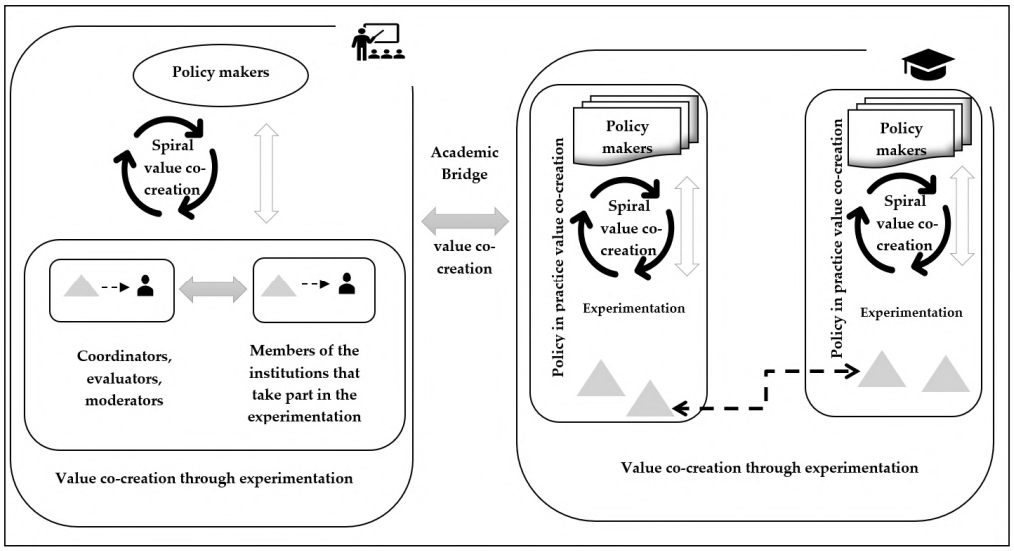

Figure 1. Value co-creation model between partners in tertiary and secondary education.

At the secondary level, members of institutions take part in different experimentation formats that are then evaluated. In a spiral evaluation, results will be shared with policy makers and, based on recommendations, consequently fed into modified concepts in the following experimentation cycles. In both projects, the required organizational steps are clearly chronologically defined and emphasized in the required action (e.g., implementing changes into the next cycle). Based on the guiding results and the implemented changes following them, it is the intent of both projects to build sustainable bridges both vertically between policy and practice, as well as horizontally between the secondary and tertiary education sectors.

4. The Evaluation Methodology in the OpenU Project

Written questionnaires were the evaluation method applied by both projects. It was used because this method is highly standardizable, meaning that there was strong predetermination in questions, and that their sequencing and choices were also given. Through these means, it is possible to facilitate comparison between cases; this is the main reason for using the written questionnaire [24].

The used methodology aimed to gain data about the vertical domain, i.e., knowledge and evidence from the second experimentation phase of OpenU. The experimentation in this project practices the policies and the strategies at the institutional level, regarding virtual mobility and blended learning, as well as the international cooperation between the partners at the European institutional level.

The first evaluation cycle of OpenU included evaluation activities, represented by analyzing the strategic documents that were collected from the OpenU partners. These doc-

uments relate to the institutional strategies of three spheres of the project: blended learning, virtual mobility and international cooperation. In the first phase, a pre-design questionnaire was used and several interviews were conducted with selected experimentation leaders.

In the second evaluation cycle, a questionnaire was submitted to OpenU project partners after the second phase of their experimentation, to investigate the practices of blended learning, virtual mobility and international cooperation in practice. The survey targeted two main groups. The first group was educational designers who participated in the OpenU experimentation, while the second target group contained administrators and stakeholders at the institutional level; this included the CIO offices, the international teaching and cooperation office staff and IT specialists.

The questionnaire was adjusted based on the answers of the respondent's position, as shown in Figure 2. One of the survey parts for the educational designers contained general questions related to the priority actions, target groups and goals of their experimentation. Then, the educational designers were asked several questions to measure the effect of the experimentation, the acceptance of the experimentation, the factors that stimulate or hamper the experimentation, the added value from the experimentation partners, the translation of the policies and the strategies at the institutional level.

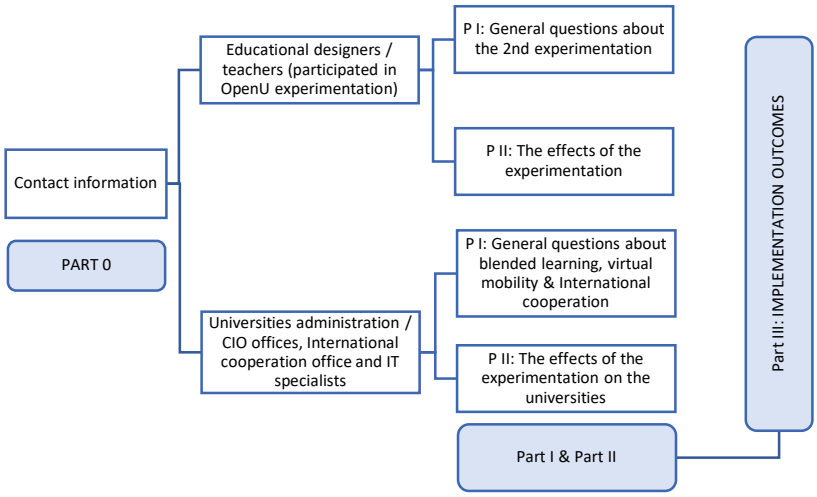

Figure 2. The design of the questionnaire in the second evaluation phase.

However, the admin group was asked several questions about the institutional policies and strategies for implementing blended learning, virtual mobility and technology-enhanced learning. In the second part, the questions were about the effect of the experimentation. Some of the questions were asked with the goal of estimating the effect of blended learning and virtual mobility experimentation, the role of translating the university policies, and how one could bridge the policies and practices at the institutional level. Other questions aimed to rate the acceptance of virtual mobility and blended learning in the educational environment. The administrators were also asked about how they recognize the teaching staff's efforts in practicing virtual and international collaboration, and ensuring the quality of the Technology Enhanced Learning and the certificates that should be provided for students' virtual mobility.

Following this two-part assessment, in the last part, the questionnaire was designed to ask the participants (both target groups) about the implementation outcomes that were intended to be reached. In this part, all of the respondents answered questions to measure the factors that stimulate or hamper a fully digital workflow of mobility at the institutional level, estimating the virtual mobility types based on the strategic importance and the quantity in the last year. Other questions targeted the challenges that the experimentation was facing in terms of sustainable virtual mobility settings, as well as the granularities and the student activities suitable for virtual mobility.

The questionnaire ended with two questions; one was about the respondents' overall feelings towards virtual mobility at European universities. The questions were designed in different formats, including selection, scaling, ranking, and rating multiple-choice questions with an option to add individual comments that are always from minimum to maximum agreement. A total of 25 respondents completed the whole questionnaire. The results are presented in Section 6.

5. The Evaluation Methodology in the TrainDL Project

The questionnaires and competency tests were designed to evaluate the effect of the interventions (through direct comparison of repeated questions before and after the intervention), gather multidimensional assessments (e.g., outcomes and policy-related questions) and get insight into demographic data.

Competency tests: Before the intervention was conducted, the teachers were sent a competency test, which they were asked to fill out off-site. They were also asked to complete a second competency test directly after the intervention (on-site). These tests' purpose was to gather data about the self-estimation of knowledge in DL and AI in one part, and actual knowledge through knowledge questions about them in the other. In both instances, the tests included exactly the same questions. Estimation and knowledge questions were referring both to DL and AI. For evaluation purposes, it was clearly marked which of the knowledge and estimation questions were linked to which of the two topics.

The number of questions and topic distribution was as follows: Self-estimation—15 DL-based and 10 AI-based questions for different knowledge aspects of these topics. The possible answers were given on a Likert scale. Knowledge—14 single and multiple-choice questions were used for 4 DL and 10 AI-based questions related to different dimensions/hypothetical problems. The maximum possible score for each question was one point, so in total 14 points could be scored.

Questionnaires: For the two questionnaires, the participants were asked to fill them out directly before and after the intervention on-site. Through these questionnaires, three questions were repeated: effect (e.g., self-estimation of knowledge for DL and AI, and how it is usable in courses), outcome (assessment of DL and AI and their added value for pupils in the future) and policy aspects (e.g., assessment if DL and AI are missing in the respective framework curriculums of teachers' subjects).

The three intervention rounds were based on different target groups of teachers respective of school level. They comprised: (1) Informatics teachers at the secondary level; (2) Non-Informatics teachers at the secondary level and (3) teachers at the primary level. This paper presents the results from the questionnaires/competency tests for the first round of interventions.

All assessment questions were realized through Likert scales, nearly all of them with six items. Other questions were designed in different formats as multiple and single choice options, with a few spaces where the teachers could give free formulated answers or where choices were not given. Figure 3 shows target groups, sequencing and contents plus dimensions/results that were targeted in the first phase/intervention.

Other instruments: These are not included in the paper. A personal interview was conducted directly after the intervention. This gives deeper insight into motivations and assessments of the intervention and suggestions and, for example, on changes and challenges (barriers) regarding structural integration. In addition, a short follow-up evaluation, consisting of a questionnaire and a short interview after approximately half a year after the intervention, is planned. Here, an implemented usage of DL and AI after the intervention can be discussed. This gives insight into best practices after the intervention.

In the next chapter, we present statistical matters for the used method—the questionnaire. This is necessary for better classification and understanding of both projects' results.

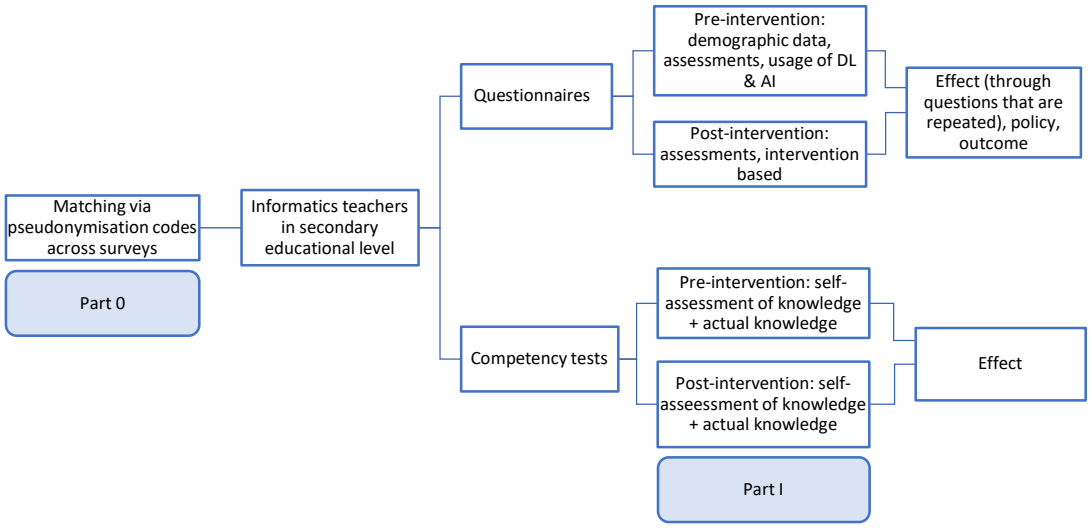

Figure 3. The design of the questionnaires in the first intervention phase.

6. Statistical Types of Errors, Programs/Tools and Operations

6.1. Statistical Types or Errors

Because of the relatively small sample size in both projects, we want to mention the compromising of statistical power (or higher probability for Type II error (β)); this is especially for weak and also, but lesser, moderate correlations, and for statistical comparison tests, with power getting greater from minor to major differences/effects (also depending on n). Additionally, in order to prove the results as significant (rejecting Type I error (α) for a significance level of 0.05), higher level results are needed than for experimentations with a more sufficient number of n within a given context.

Connected to that, among other things, for scientific purposes, it is usually recommended to have at least 30 persons, or a number slightly below that, in a sample (e.g., [25,26]).

6.2. Statistical Programs/Tools

The questionnaires of both evaluation methods in two projects were designed using QUAMP [27], which is a modular software platform for setting up web-based feedback systems with a focus on the collection, management and analysis of empirical data. Several statistical operations/functions were used to analyze the collected results. We utilized RStudio as a tool to analyze the data that was collected from QUAMP in both projects.

6.3. Statistical Operations

We applied one-sided testing for comparison tests for after-intervention effects (for greater values post-intervention), and one-sided testing for correlations was performed when applicable (for positive correlations).

For this case, alternative hypotheses for different tests with ordinal data and one-sided testing (only TrainDL) state: The rank sums of two variables after the intervention are greater than the value before (intervention effect). The null hypotheses read: The rank sums are the same (no intervention effect).

For correlations and one-sided testing, the following alternative hypotheses were formulated (only TrainDL): The correlation between two variables is positive. The null hypotheses in these instances are: No relationship between variables can be found.

For two-sided testing and difference tests (OpenU and TrainDL), these hypotheses are formulated: The rank sums of two variables are different. Null hypotheses state: The rank sums of two variables are not different from one another.

Regarding correlations, there are alternative hypotheses (OpenU and TrainDL): There is a correlation between two variables. The null hypotheses read: No relationship between two variables is detected.

The following statistical operations were used:

Measures of central tendency—For metric data, only the arithmetic mean is used. For ordinal data, both mean and median are applied. While calculating a mean for ordinal data is usually seen as not very meaningful [28], if distances between predetermined items/scales can be interpreted as equal it can also be applied [29]. For our study, this was used when sensible.

Correlations—Most variables use Likert scales as items, so the choices were limited to Spearman or Kendall's Tau, both of which can be applied in the case of ordinal data [30]. It was decided that Spearman would be used, because it is recommended for bigger scales, such as five-point scales or above [31]; these were used most of the time in both projects. For metric data, the Pearson correlation was used if conditions are met [32].

Difference tests—For paired (dependent groups) and ordinal data, the Wilcoxon test was applied, and for unpaired data (independent groups) the Mann–Whitney test was utilized [33]. For comparison of dependent groups with metrical data, the Wilcoxon test was also used, because the sample size was smaller than $n < 30$. Below this threshold, it is advised to not use a t-test [34]. An asymptotic calculation of the p-value was applied.

For correlations, the following classification strength was utilized: No correlation [0, 0.3), weak correlation [0.3, 0.5), moderate correlation [0.5, 0.8), and strong correlation [0.8, 1] [35]. This was subsequently also used for comparison tests.

After this statistical embedding, in the next chapter we present the results of both projects.

7. Discussing the Preliminary Results

In both policy experimentation projects, studying the implementation of policies in practice is a focal point, not only for the experimentation results but also for long-term cooperation and sustainability. To this end, this section introduces the preliminary results of the experimental evidence in order to later introduce several recommendations and solutions to fill gaps between policy and practice, and the academic bridge between secondary and tertiary education levels.

Several intersectional questions were selected to discuss the relationship between the vertical and the horizontal gaps from both evaluation methodologies, based on effect aspects, outspanning assessments, and policy and good practices levels.

Because both projects have a sample size smaller than 30, the results are to be understood as preliminary.

In the following, we present the analysis results and we reflect on the value/value co-creation as a concrete lens to lay the groundwork for several recommendations and proposed solutions to fill the gaps between policies and practices in the HE institutions on one side, and closing the policy gap in the academic bridge between secondary schools and HE on the other side.

In the results section, the number of persons who completed the questionnaires is given. However, sometimes within these data a slight loss for variables occurred (for various reasons). For the most part, these instances will not be mentioned.

7.1. The Preliminary Results on Virtual Mobility Experiments

First, we discuss the preliminary results from the second evaluation questionnaire of the OpenU project. The selected results have been determined to provide evidence related to investigating the implementation, as well as good practices at the institutional and international level regarding virtual mobility and blended learning, and as a vertical gap.

One of the challenges of designing virtual mobility activities is that they need special skills in technologies, pedagogical materials and knowledge of context as well as internationalization skills. This also reflects the institutional policy of the cooperating partners.

Facing this diversity of required skills and involved people, the questionnaire contained four parts targeting these segments. Through several questions, the questionnaire measured the effect of the experimentation and the implementation outcomes, as well as the good practices of the institutional policies within the framework of virtual mobility and international collaboration. From around 50 contacted persons, 25 completed the questionnaire and were distributed into two groups: 12 from the educational designers and 13 from the administration group (distributed as follows: Three from the CIO office, six from the International Office, three from IT specialists and one from the Information Office at the faculty level). This paper will only present the results that are closely related to the research aspects.

The results will be presented in three categories: (1) the results of the educational designers. (2) An analysis of the results of the administrators' group. (3) An analysis of the implementation outcomes based on all of the respondents' answers. To this end, correlations and comparison studies will be presented based on the target groups' answers.

Scales go from maximum approval (lowest number = 1) to minimum approval (highest number). Most of the time, four-point Likert scales are used.

7.1.1. Analyzing the Educational Designers' Answers

- The majority of the educational designers that participated in the questionnaire selected the "collaborative experiments that complement each other" as one of the most important factors that stimulate the experimentation. This emphasizes the importance of the value co-creation role in complementing the experimentation roles.
- When asked if their experimentation translated the university policies related to vertical mobility and international collaboration into good practice, about 42% of the educational designers answered "no" and 25% selected the option "I do not know". Approximately 33% answered "yes" and some of them provided links to relevant information in this regard.
- Half of the respondents recognized the added value of this experimentation because of the collaboration between partners. However, about 42% of the educational designers selected the "no estimation" option.
- In their comments, the educational staff highlighted the benefits received from the experimentation regarding the blended learning and virtual mobility courses; in addition the benefits and the added values through the exchanges and peer evaluation were said to be very constructive. In some other cases, the added values were not as expected because of several barriers, such as the language, intercultural competencies, development of cooperation among partner universities and resource sharing.
- Correlation studies based on the educational designers' answers show:
- The correlation between the **effect of the experimentation** on the target groups (The original question asked is: "How would you estimate the impacts of this experimentation on the target groups?") and the **acceptance of the experimentation** ("How satisfied are you with the acceptance of such experimentations based on the target group engagement?") was tested: There is a moderately significant correlation—which is positive—to be found ($r_s = 0.74$, $p < 0.05$).
- There is a moderately significant positive correlation between the **effect of the experimentation** on the target groups and the **experimentation results,** and blended learning and virtual mobility services ($r_s = 0.72$, $p < 0.05$).
- No correlation between the acceptance of the experimentation and the experimentation results and services could be found.

7.1.2. Analyzing the Administrators' Answers

- The administrators were asked if their universities have provided dedicated strategies and clear policies regarding the implementation of virtual mobility. Approximately 38% have such strategies, whereas 46% selected that they "do not have yet" such strategies, but are in the process. Only 2 out of 12 of the participants answered "no".

This is remarkable considering that having such an institutional policy in place was a formal requirement for participation in the funding scheme.

- The answers to the question aimed at measuring the legislation and infrastructure supporting virtual mobility and internationalization activities, are varying. About 38% of the participants from the admin group selected the option "not yet, but currently under discussion", whereas 31% answered that virtual mobility settings are well-defined and recognized through the university legislation, and the institutional infrastructure is ready for further cooperation with other partners. Still, 31% preferred to select the option "I do not know".
- In total, 54% of the respondents answered that the effect of the virtual mobility experimentation on translating the university policies is "in expectation", and there is increasing interest in practicing blended learning and virtual mobility scenarios at the university; this is expected to expand to sustainable cooperation with other partners in EU universities that are bridging the policies and practices at the institutional level. However, about half of the participants from the administration group estimated "less than expected", suggesting that much more work is recommended to engage the institutional staff and stakeholders in practicing blended learning and virtual mobility scenarios.
- Correlation studies based on the administrators' answers show:
- A moderately significant positive correlation was found between the **effect** of the experimentation on translating the university policies and the **acceptance** of the experimentation in the educational environment at the institutional level (r_s = 0.53, $p < 0.05$).
- No correlation between the **dedicated strategies and policies** ("Does your university have a dedicated strategy and clear polices that specifically addresses the implementation of blended learning, technology-enhanced learning or virtual mobility?") and the **effect** of the experimentation on translating the university policies and bridging policies and practices could be detected.
- No correlation between the **dedicated strategies and policies** for implementing virtual mobility and blended learning scenarios and the **legislation and infrastructure** ("Do you think that your legislation and infrastructure are supporting the blended learning and virtual mobility experiments to be anchored and sustainable at your university?") could be detected.

7.1.3. Analyzing the Answers Regarding the Outcomes of the Policy Implementation

- The answers show that the top three challenges affecting anchoring and sustaining virtual mobility are the awareness of the regulations, limited resources and the gap between the policy makers and teaching staff.
- The technical infrastructure is the factor with the biggest effect rate for stimulating or hampering a fully digital workflow of mobility at the institutional level. Awareness of the regulations ranked as the top factors anchoring or sustaining virtual mobility scenarios. ECTS is regarded as having high strategical importance but is not frequently used.
- We asked all participants about their overall feeling toward virtual mobility at their universities. The answers reflect that about 37% of the respondents feel that virtual mobility is an opportunity for students and instructors who have barriers preventing them from participating in various physical mobility activities. Indeed, 17% have a feeling that strong infrastructure and policy agreements are required. In total, 12.5% have a feeling that it is in the way of sustainability, especially after the COVID-19 pandemic.

The Mann–Whitney test has been used for comparing target groups. As shown in Table 1, Mdn_1 refers to the median value from the educational designers' answers and the Mdn_2 refers to the median value of the administrators' answers. The presented results go from maximum approval (lowest number = 1) to minimum approval (highest number = 3 or 4).

Table 1. Comparing studies of two groups: educational designers and administrators.

Comparing Studies	Mdn_1	Mdn_2	p
Dedicated strategies and policies from one side and **implementing**/translating the university policies	3	2	0.078
Experimentation results and services provided from one side and the **effect of the experimentation** on the other side	2.5	2	0.793
Acceptance of the experimentation from one side and the **acceptance of virtual mobility and blended learning** on the other side	2	3	0.175
Effect of the experimentation on the target groups from one side and the **effect of translating the university policies and strategies** on the other side	2	2	0.789

The results show that there are no significant differences between the answers of educational designers and administrators.

7.2. The Preliminary Results from the Teacher Training Experiments

In the following, we present the preliminary results of TrainDL from the first-round questionnaires and competency tests. The first intervention took place in June 2022, and 24 persons participated in the event and completed the questionnaire. The four written questionnaires (pre- and post-questionnaire and pre- and post-competency test) were filled out electronically. Except for the pre-competency test all tests were filled out on-site.

The number of usable cases n for the questionnaire was as follows: 23 (pre), 21 (post) and combined for both 20. For the competency test, the cases were as follows: 17 (pre), 20 (post) and combined for both 15 (also the same number when results are combined with the results from the questionnaires). Because there are comparisons/correlations to be executed between all four tests (pre- and post-questionnaire, pre- and post-competency test), data in this could be matched via raised pseudonymization codes.

Scales go from zero approval (lowest number) to maximum approval (highest number). There are always six-point Likert scales used, if not mentioned otherwise.

Results are presented in three categories: Effect (before–after results without relation to outcome and policy), outcome and policy.

The presentation is classified into three categories: (1) Effect—directly measurable through repeated questions for pre- and after-intervention (mainly knowledge-based self-estimations and actual knowledge), (2) assessment of outcome via the added value of DL and AI for pupils in the future and (3) policy implementation (assessments for DL and AI are missing in framework curriculums, plus these topics are of socially sufficient importance to integrate them in framework curriculums).

7.2.1. The Immediate Effect of the Experiments on Competencies

Effect in the context presented here is to be understood as effects resulting from the experiments that are foremost on a personal level, not the impact of the policies behind them at a broader level. The following results relate to knowledge levels (self-estimations in different contexts and actual knowledge) and compare them between pre-and post-intervention.

First, we want to share different means of (subjective) **self-estimation** of knowledge.

1. One measurement is a **self-estimation** regarding **specific usage for using DL and AI in courses** with the statement "I know how the contents of DL/AI can be used in class." (pre- and post-intervention (questionnaires), $n = 20$). For both DL and AI, significant differences in rank sums can be proven: DL (before: $M = 2.45$, $Mdn = 2$; after: $M = 4$,

Mdn = 4) shows a strong effect size on assessment depending on measured time frame, respectively, before and after intervention (Wilcoxon one-sided; $r = 0.8$, $p < 0.05$). The same can be said for AI, but with an even higher effect size (before: $M = 2.35$, *Mdn* = 2; after: $M = 4.65$, *Mdn* = 5) (Wilcoxon one-sided; $r = 0.85$, $p < 0.05$). The comparison of rank sums of DL and AI, after the intervention, results in a moderately significant effect size in favor of AI (Wilcoxon; $r = 0.56$, $p < 0.05$). While DL shows a significantly and positively moderate correlation between pre- and post-measurement ($r_s = 0.55$, $p < 0.05$), AI offers no significant correlation.

2. The second is a **self-estimation** regarding **general knowledge of DL and AI.** This is based on 15 questions for DL and 10 for AI, that ask the participants how they would rate their knowledge in specific areas of these topics: DL: cleansing, visualization of data etc.; AI: Principle of unsupervised learning, supervised learning (pre- and post-intervention (competency tests), $n = 15$, five-point Likert scale). For these assessment questions, scale means had to be calculated. The effect is shown through significant differences between pre-and post-results; the intervention has a moderate effect on self-assessment regarding DL (before: $M = 2.28$; after: $M = 3.24$; Wilcoxon one-sided; $r = 0.73$, $p < 0.05$), a strong effect for AI (before: $M = 2.4$; after: $M = 3.73$; Wilcoxon one-sided; $r = 0.88$, $p < 0.05$), and the assessment for all questions together (before: $M = 2.33$; after: $M = 3.43$; Wilcoxon one-sided; $r = 0.83$, $p < 0.05$). Between pre- and post-results for each of the topics, no or no significant correlations can be traced.

Through both measurements, it can be shown that the intervention boosted the knowledge estimations of the participants.

Correlation with another variable shows:

- **Self-estimation** regarding **specific usage for using DL and AI in courses** (pre- and post-intervention (questionnaires), $n = 15$): DL does not show correlations when the results from self-estimation of general knowledge before and after intervention (competency tests) are compared with self-estimation for specific usage in DL and AI courses for the same time points (before-before and after-after). AI does show a weakly positive and significant correlation between before results ($r_s = 0.49$, $p < 0.05$) and a positively significant and moderate correlation between post results ($r_s = 0.69$, $p < 0.05$) (all tested one-sided).

Secondly, after the estimation of knowledge, the actual knowledge is measured.

For 14 **knowledge questions**, actual/objective knowledge and sums of points were calculated. There were 4 questions for DL and 10 for AI (pre- and post-intervention (competency tests), $n = 15$). Of most interest is the difference between pre- and post-results. As shown in Figure 4, only 1 of 15 participants has less points (−1.9) in total than before, with 5.2 points being the biggest positive difference:

While the points for DL show no significant differences (before: $M = 1.9$, after: $M = 2.3$; Wilcoxon one-sided; $p = 0.088$), both AI (before: $M = 4.8$; after: $M = 6.39$; Wilcoxon one-sided; $r = 0.77$, $p < 0.05$) and the whole test (before: $M = 6.7$, after: $M = 8.69$; Wilcoxon one-sided; $r = 0.78$, $p < 0.05$) reveal moderate intervention effects. However, because DL has only 4 in contrast to AI's 10 questions, errors in DL's questions have a higher effect on its separate results than in the case of AI. Nearly all pre–post-correlations are significant (moderate effect size—AI (before-after): $r_s = 0.75$ and total (before-after): $r_s = 0.71$; weak effect size—DL and AI (before): $r_s = 0.56$ + DL and AI (after): $r_s = 0.61$; all $p < 0.05$). The sole exception is DL before–after for having a non-significant correlation.

In the end, actual knowledge and self-estimation are looked at together. In Table 2, correlations of actual knowledge between the variables regarding the two self-estimations of knowledge show only two significant correlations; these are boldly marked.

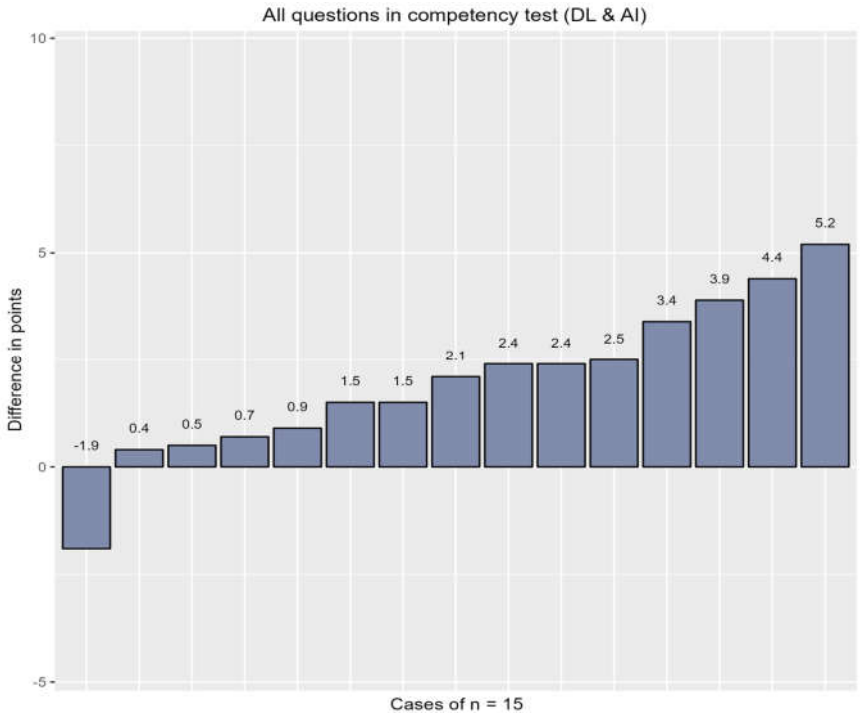

Figure 4. Point differences between before and after intervention results for all knowledge questions in competency tests per case (maximum score possible: 14).

Table 2. Correlation of actual knowledge between: (1) specific estimation (how to use DL and AI in courses) and (2) general estimation (knowledge dimensions of DL and AI).

Variables	DL	AI	Total (DL and AI)
Before:			
Specific estimation of knowledge (usage of DL and AI in courses) and actual knowledge	0.21 ($p > 0.05$)	−0.29 ($p > 0.05$)	not applicable
After:			
Specific estimation of knowledge (usage of DL and AI in courses) and actual knowledge	−0.09 ($p > 0.05$)	−0.07 ($p > 0.05$)	not applicable
Before:			
General estimation of knowledge and actual knowledge	**0.45 ($p < 0.05$)**	0.42 ($p > 0.05$)	**0.59 ($p < 0.05$)**
After:			
General estimation of knowledge and actual knowledge	−0.11 ($p > 0.05$)	0.14 ($p > 0.05$)	−0.007 ($p > 0.05$)

Although actual knowledge has experienced gains (but not-significantly for DL), there are almost no (significant) correlations with both knowledge estimations (specific and general) to be found. This relates to the self-assessment of value (in the context of knowledge) for the target group. Although value can be ascribed to a matter (topics DL and AI), its hypothetical value is interpreted depending on the self-estimation of knowledge,

whereas the quality in usage (also, value for others) is, among other things, dependent on the actual knowledge itself.

7.2.2. The Outcome of the Experiments Regarding Later Implementation in School

For the second layer of results, assessments for possible outcomes on an objective level are looked at.

For this, **value for pupils** with the statement "The teaching of DL/AI will bring added value to the students in the future." is discussed (pre- and post-intervention (questionnaires), $n = 20$).

For DL, the data show no significant differences between assessments pre-intervention ($M = 4.45$, $Mdn = 4.5$) and post-intervention ($M = 4.5$, $Mdn = 4.5$) (Wilcoxon one-sided; $p = 0.589$). However, a significant difference can be proven for AI before ($M = 4.6$, $Mdn = 5$) and after ($M = 5.4$, $Mdn = 6$) with moderate effect strength (Wilcoxon one-sided; $r = 0.5$, $p < 0.05$). DL proves to be significantly and positively moderately correlated ($r_s = 0.56$, $p < 0.05$) while AI shows no significant correlation between both times. How DL and AI measure against each other should be assessed, especially in regards to the after results. Here, the rank sums of AI are significantly higher than DL's with moderate effect strength (Wilcoxon; $r = 0.71$, $p < 0.05$).

Correlations with other variables show:

- **Self-estimation** regarding **specific usage for using DL and AI in courses** (post-intervention (questionnaire), $n = 21$): While DL does not reveal a significant correlation, AI shows a significant correlation that is moderately positive ($r_s = 0.47$, $p < 0.05$).
- **Enthusiasm for DL and AI projects by pupils** (post-intervention (questionnaire), $n = 21$): For DL a significantly moderate and positive correlation can be traced ($r_s = 0.73$, $p < 0.05$). For AI, there is no significant correlation. The sole comparison of rank sums for this variable between DL ($M = 4$, $Mdn = 4$) and AI shows higher values for the latter ($M = 5.29$, $Mdn = 6$). The difference is significant and shows a moderate effect size (Wilcoxon; $r = 0.66$, $p < 0.05$).
- **Own capacity to excite pupils for DL and AI projects** (post-intervention (questionnaire), $n = 21$): Neither DL nor AI show (significant) correlations.

AI has a higher estimation of added value for pupils in the future and its post-results are significantly higher than before. In addition, the enthusiasm of pupils for it is rated higher than DL. Both differences are significant in comparison to DL.

The assessment of added value for the future gives way to potentials that lie in integrating transferable knowledge and its potential usage from secondary to tertiary education levels; the academic gap is, therefore, bridged if the corresponding implementations and conditions on both levels are met.

7.2.3. Policy Issues Regarding the Teacher Training Experiments

In this part, results for policy-level questions concerning the integration of DL and AI into curricular frameworks are explicated.

Missing contents for DL and AI in curricular frameworks with the statements "I think that the content on DL/AI is missing from the current curricular frameworks in the subject [...]." (pre- and post-intervention (questionnaires), $n = 20$): The intervention was conducted for **Informatics** teachers only. The usable data for them is $n = 18$. There are no significant differences for DL pre- and post-intervention (before: $M = 4.25$, $Mdn = 4$; after: $M = 4.17$, $Mdn = 4$) (Wilcoxon one-sided; $p = 0.805$). The same holds true for AI (before: $M = 4.25$, $Mdn = 4$; after: $M = 4.56$, $Mdn = 5$) (Wilcoxon one-sided; $p = 0.482$). Between before (Wilcoxon; $p = 0.9301$) and after (Wilcoxon; $p = 0.202$) results for comparing DL and AI, no significant differences can be found. Between time points—before and after—DL is not significantly correlated, while AI shows a moderately positive significant correlation ($r_s = 0.57$, $p < 0.05$). In general, approval of DL and AI is high.

The second most taught subject is **Mathematics** (pre- and post-intervention (questionnaires), $n = 20$). Mathematics was indicated $n = 14$ times. Comparison of both time

measurements shows no significant differences for both DL (before: $M = 3.86$, $Mdn = 3.5$; after: $M = 3.79$, $Mdn = 4$) (Wilcoxon one-sided; $p = 0.586$) and AI (before: $M = 4.64$, $Mdn = 6$; after: $M = 3.93$, $Mdn = 4$) (Wilcoxon one-sided; $p = 0.937$). Again, comparing pre- (Wilcoxon; $p = 0.203$) and post-intervention results (Wilcoxon; $p = 0.638$) for DL and AI yields no significant differences. Both DL and AI show significant correlations between pre-and post-intervention results: DL displays a highly positive ($r_s = 0.81$, $p < 0.05$), while AI has a moderately positive correlation ($r_s = 0.66$, $p < 0.05$). Agreement is less high among Mathematics compared to Informatics teachers.

The assessment of social relevance of DL and AI was measured with the statements "The topics DL/AI are of enough societal importance to integrate them in the curricular framework." (post-intervention, $n = 21$): The comparison between DL ($M = 5.19$, $Mdn = 5$) and AI ($M = 5.52$, $Mdn = 6$) shows a significant difference in favor of AI, with weak effect size (Wilcoxon; $r = 0.43$, $p < 0.05$). Both variables show a moderately positive correlation, which is significant ($r_s = 0.55$, $p < 0.05$). These are very high approval ratings. We think it is very important, but the implementation of this topic in the classroom still needs to be explored.

Correlations with other variables show:

- **Missing contents for DL and AI in curricular frameworks for subject: Informatics** (post-intervention (questionnaire)): Results for DL and AI show significant correlations: DL reads for a moderately positive ($r_s = 0.63$, $p < 0.05$) while AI reads for a weakly positive one ($r_s = 0.49$, $p < 0.05$).
- **Missing contents for DL and AI in curricular frameworks for subject: Mathematics** (post-intervention (questionnaire)): There are no correlations for DL and AI.

There are no significant differences between DL and AI and when they are compared to each other. This holds true for both subjects (Informatics, Mathematics). The social importance of integration into the curricular framework is rated significantly higher for AI than DL, and both correlate with the missing assessments of DL and AI in the subject Informatics.

Although the approval for missing DL and AI does not significantly change for the subjects Informatics and Mathematics, and value assessment stagnation for this variable is recognizable, a potential factor that might have influenced the replies has to be mentioned: The topics are already in the curricular frameworks, but in different states (for example: AI is specialization area, but not a compulsory one in the state of Berlin). This research has to be developed in future questionnaires in another way to appropriate the actual circumstances.

8. Conclusions, Recommendations and Future Work

Stakeholders expect from and ascribe varied values to educational collaborations and secondary schools in the academic bridge. The recommendations that will be presented in this chapter reflect the experiences of the stakeholders and aim to fill the gaps between policy and practice based on the evaluation and observation study made in both projects.

In the OpenU project, the educational designers were faced with a variety of barriers and difficulties in the second phase of the experimentation; this was reflected in the experimentation results and outcomes. The barriers that the educational designers emphasized are mainly in regards to the need for flexible solutions, recommendations to reduce these difficulties, barriers to reaching out to sustainable collaboration and successful virtual mobility scenarios. The participants highlighted that there is a disconnect between what central educational support services would like to implement and/or see developed, and the academic and teaching staff who are mentally prepared for another major switch. Meanwhile, the experts insisted on the advanced skills that educational designers should have to produce high-quality online mobility content. It needs technological, pedagogical, context knowledge and awareness of the internationalization regulations, as well as the intercultural learning dimension, which is not usually easy to find with many of the instructors in all universities.

As a consequence, we can testify to an obvious vertical gap regarding implementation of virtual mobility policies evolving into practice. While political demand, as well as

educational need and willingness are clearly a given, structural anchoring, effective support and guidance on an institutional level are missing; i.e., there is a pipeline leakage in transformation of (inter)national policies to institutional strategy and regulation, as well as their subsequent implementation. At the same time, policy awareness among HE educators is remarkably low [3].

This is a significant contrast to the very strong policy awareness in the area of teacher education, where both faculty and teachers involved in the training revealed a detailed knowledge of applicable policies and a distinct personal opinion on their possible adjustments. We consider this noteworthy, since the case study in teacher training is also carried by HE institutions, i.e., in practice it is subject to comparable structures as the case study in the field of virtual mobility. However, additional influences obviously come into play here, which have a positive effect on policy awareness and implementation. We draw two major conclusions from this:

1. There is a cultural break in the area of the academic bridge between secondary and tertiary education. Since not only learners, but also teachers are active in this transition, friction losses should be avoided in order to avoid impairing the development of competencies and personalities, which is particularly sensitive here.
2. Experiences from policy making and implementation in the field of teacher education could be transferred to the field of HE in order to promote policy awareness and impact there. This will require an adapted form in order to avoid unduly restricting the freedom of teaching in HE. However, a more precise translation into institutional policies and their more consistent implementation into practice (including adequately funded and skilled support structures) seems urgently needed.

We are now narrowing the focus to answer our research question based on the two case studies: Which value do the involved stakeholders expect from or ascribe to educational policies?

In OpenU, educational designers and IT specialists are the focal points in co-creating value. At the institutional level, value co-creation could be established through a spiral evaluation model as the preliminary outcome from the experimentation results and the policy makers. The added values establish a concrete feedback loop to fill the gap between policies and practices from one side, and strengthen the institutional infrastructure by increasing the operant resources. On the regional level, partnership agreements between the European institutions establish value co-creation nationally or even internationally, where much of the operand resources could be limited without value co-created by the operant resources. The immediate educational value is confirmed by the participants, while they are rather reluctant towards a value of policies.

In TrainDL, insight into value expectations is offered through questions that find (predominantly more) agreement after the intervention. Regarding this context, the answers of the target group nudged into these expectations. This study found that the participants see more value in AI than in DL, not only in general but in means through these dimensions (e.g., added value for the future or societal importance through curricular framework integration). However, it is important to take into account context factors, such as the intervention (e.g., distributed time for the DL and AI) or personal predispositions (e.g., usage of DL and AI in courses). Implicitly, they ascribe high value to current policies, such as curricular frameworks and their continued update. These value-charged processes are also hinting at the direction of future usage at the tertiary educational level and beyond, and are connected to the pupils that the courses given are targeted at. With highly rated means of future values and societal importance, the connection to the secondary educational level can be drawn.

Insights for recommendations were gained through the results presented above, but also through the construction of questionnaires and the experimentation process that helped foster the recommendations. We propose three groups of recommendations to close the identified gaps in different dimensions:

Recommendations for the field of virtual mobility:

- Draw attention to the importance of building a common vision among partners through involved institutions, interested stakeholders, as well as existing contacts between staff members and departments in the framework of value co-creation advantages.
- Put a strong emphasis on translating the applicable policies and strategies into practice, which requires structural anchoring and might benefit from a spiral model of experimentation.
- Co-create the value from the experimentation using a triangle between three players: The policy makers at the institutional level, the educational designers, and the targeted students.
- Establish design teams that contain experts in technological and pedagogical knowledge, with international and multicultural skills.
- Recognize the efforts of the educational designers in order to encourage and reward them to implement digital learning content and virtual settings.

These points will play a steering role to close the vertical gaps between higher-level policies and good practices on-site.

Recommendations for the field of teacher training:

- AI is established as more of a buzz-word [36]. Therefore, it should be ascribed with scientific value to objectify it. DL seems to be the more neglectable for participants. Here, a two-fold-approach can be advised: (1) Drive home the interconnection between the two topics and (2) make clear (in conjunction with, but in demarcation, to AI) what both topics can do and cannot do.
- Concerning DL and AI, the value that can be taught when and how it is connected to later usages should be demonstrated. These dimensions have to be in sync, not only to foster post-school usages (career choices or usage in non-connected or inter-connected work fields), but also to guarantee the interconnectivity between different educational levels and bridging them.
- There is a divide between self-estimation and actual knowledge (for both DL and AI) on the teachers' side. After integration of DL and AI into the curriculum, the hard ´currency´ could be training and testing knowledge (not only estimating), and therefore formulating testable knowledge targets that are to be carried/adapted over from secondary to tertiary education level.

These points might contribute vertically to further adapt higher-level policies to current practical needs.

Some general recommendations across both fields of education follow:

- Dedicate the concept of value co-creation between partners in policy experimentation and at different institutional/regional levels.
- Modify experimentations to match all target groups' needs (students, educators and policy makers).
- Use experimentation projects to defuse barriers between practice and policy, and for disseminating policy awareness/acceptance at different educational levels.
- Boost the evidence-based culture in education through systematic evaluations using a consistent framework for sustainable change.
- Pay more attention to the experimentation that interoperates HE policy, locally and internationally.
- Provide the policies and strategies in very plain language for experimenters, trainers, students and teachers at schools.
- Define future goals clearly and make existing or potential risk areas transparent. Provide monitoring and support structures to mitigate risks.
- Establish a community network for the exchange of knowledge and experiences on educational reforms, and as a basis, share evidence and best practice examples in open repositories.

These points might help to close the horizontal gaps in policy making and implementation between different fields of education.

Comparing the results in TrainDL across all three evaluation phases for different target groups, is a core research goal in our next steps. This could be cross-matched with the results of the second evaluation phase of OpenU.

The research presented in this article is an example of cooperation between two Erasmus+ KA3 projects. Such cooperation is advised to merge and match different project aims in a meaningful way. In this case, both projects contribute to insights and recommendations in order to fill the policy gaps in the academic bridge. Such cooperation is a good show case for interlinkage and could encourage other researchers for such kinds of research work.

Depending on the current status of involved fields, future research might focus rather on making policy gaps visible or on analyzing how to further finetune existing policies and policy processes. Further attention should be paid to the mechanisms and barriers at work in the respective fields for the translation and implementation of policies. We strongly recommend a participative approach (such as value co-creation as presented here) in order to involve the perspectives of all involved stakeholders.

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Article

Measuring and Activating iSTEM Key Principles among Student Teachers in STEM

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Abstract: Graduates with a STEM profile are in great demand, yet the outflow from these fields of study is highly insufficient. This is partly due to the fragmented way STEM learning content is taught in secondary education. Although the problem can be mitigated with the use of integrated STEM education (i.e., iSTEM), teachers are often unfamiliar with this type of education. To support teachers in implementing high-quality iSTEM education, a digital collaborative learning environment called "CODEM for iSTEM" was created. This study examined to what extent student teachers were immersed in six key principles of iSTEM education through cooperative design of iSTEM learning tools in multidisciplinary teams, namely "problem-centered learning", "integration of different STEM disciplines", "modeling", "inquiry-based learning", "design-based learning", and "cooperative learning".

Keywords: iSTEM; teacher education; online learning; collaborative learning

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1. Introduction

In order to face the environmental, economic, and societal challenges in our globalized economy, the need for more science, technology, engineering, and mathematics (STEM) professionals is widely recognized among (inter)national organizations, governments, companies, and actors in the educational field [1–3]. Recently, the call to educate STEM-literate citizens who are able to understand and function in our information and communication society that relies more and more on technology is becoming louder [4]. Multiple sources [5–8] have proposed a definition of STEM literacy, but they all share the common idea that STEM literacy enables an individual to integrate content or skills from separate STEM disciplines to tackle problems in their everyday or professional lives even if the individual does not pursue a STEM study or career [4].

Integrated STEM (iSTEM) education has been proposed as a vehicle to increase both STEM literacy and STEM specialization for elementary, middle, and high school students. iSTEM refers to an educational approach in which boundaries between traditional scientific, technological, and mathematical school subjects are removed. The level of integration can vary from *multidisciplinarity* (in which skills and contents are learned separately for each discipline but are related to a common theme) to *interdisciplinarity* (in which students learn concepts and skills from two or more disciplines that are closely related) to *transdisciplinarity* (in which real-world problems are solved by applying concepts and skills from two or more STEM disciplines) [9].

A systematic literature review provided a framework for instructional practices in integrated STEM secondary education containing five key principles [10,11]: (1) the integration of content and skills between the different STEM disciplines (i.e., INT); (2) problem-centered learning by posing a real-world challenge that is motivating and engaging (i.e., PCL); inquiry-based learning by questioning, examining, gathering information, and interpreting results (i.e., IBL); design-based learning by using a technological or engineering design (i.e., DBL); and cooperative learning through collaboration among the team members (i.e.,

COO). Another key principle that was underexposed in the systematic literature review is modeling (i.e., MOD), which refers to the use of a scientific model in order to better understand a phenomenon. It is an important part of the STEM framework of the Flemish ministry of education in Belgium [12].

Previous research has shown that integrated STEM education has the potential to increase pupils' learning outcomes [2,3,13] as well as their interests in and motivations for STEM (study) careers [14–16].

Despite iSTEM's apparent benefits, designing qualitative iSTEM projects and implementing these in the classroom are not at all straightforward for high-school teachers [2,8,10,17]. Among other reasons, this is because most them have had training in only one or two STEM disciplines [18], and class periods are typically organized separately for each STEM subject. Shernoff et al. [19] interviewed 22 teachers and four administrators to identify challenges and needs for support to aid iSTEM implementation. The teachers indicated that they had difficulties envisioning what teaching iSTEM looks like and that they needed to experience good examples of iSTEM education from the perspective of a student. Concerning pre-service teacher programs, the teachers expressed the need for coursework on learning standards in all STEM subjects and STEM pedagogical practices such as cooperative (i.e., the iSTEM key principle COO) and project-based learning (i.e., PCL). Furthermore, in-service professional development (PD) should focus on having teachers themselves experience problem solving (i.e., PCL) or the engineering design process (i.e., DBL) first-hand. Using classroom implementation data and interviews, Dare et al. [17] identified three common challenges faced by teachers: (1) integration of STEM learning content (i.e., INT); (2) an apparent dichotomy between incorporating engineering design and science content (i.e., IBL and DBL); and (3) providing a realistic and authentic yet feasible design challenge to elicit and maintain student engagement and motivation (i.e., PCL).

Pre-service teacher training and in-service continued PD should prepare (prospective) teachers to tackle these challenges. Research has shown that characteristics of effective PD are: (1) a focus on subject matter content and how students learned that content; (2) a focus on pedagogical knowledge; (3) coherence of PD learning objectives with government and school policy, research evidence, and teachers' own knowledge and beliefs; (4) accommodation ofteachers' needs and interests (ownership); (5) the use of active and inquiry-based teacher learning methods; (6) the use of cooperative or collaborative teacher learning methods; (7) extended and intensive activities; (8) applicability in the daily teaching context; and (9) trainer knowledge and skills [20,21]. The iSTEM key principles relate to several of these characteristics as shown in Table 1, which suggests that PD focused on letting teachers gain active experience with the iSTEM key principles inherently incorporates several characteristics of effective PD. This is interesting because it is known that to prepare teachers to implement new instructional principles, it is a good practice to immerse them in these instructional principles themselves [22].

Table 1. Preliminary analysis of relation between characteristics of effective professional development and iSTEM key principles.

iSTEM Key Principle → **Effective PD Characteristic ↓**	**INT**	**PCL**	**IBL**	**DBL**	**COO**
Content-focused	x				
Coherence	x		x	x	
Active and inquiry-based learning		x	x	x	
Cooperative learning					x

In Flanders, which is the Dutch-speaking region of Belgium, a large research project called STEM@School investigated the effectiveness of iSTEM implementation on students' learning outcomes and their interests and motivations regarding STEM between 2014 and 2018 [2,16]. In the scope of this project, iSTEM learning materials were developed [1,23],

as well as an iSTEM design methodology called "CODEM for iSTEM" (i.e., Collaborative Online Design of Educational Materials for integrated STEM) [24]. Since 2019, KU Leuven has opted to include a mandatory course on iSTEM project design and a corresponding internship that are based on the "CODEM for iSTEM" methodology in its "Master of Teaching in Science and Technology" program. During this course, student teachers (i.e., pre-service teachers) are grouped in multidisciplinary teams, in which they cooperatively design iSTEM learning units that correspond to the iSTEM key principles. An online environment guides the student groups through subsequent evidence-based design phases. The approach using the "CODEM for iSTEM" methodology (provided via the online platform) and the organization in multidisciplinary teams were chosen for the following five reasons. First, through the design of iSTEM packages in multidisciplinary teams, student teachers themselves should experience all iSTEM key principles [22] and the approach incorporates many characteristics of effective professional development [1,20,21,25], including: (i) INT/content-focused: student teachers experience integration, and the task of designing an iSTEM learning unit adhering to the iSTEM key principles is inherently content-focused; (ii) PCL and DBL/active learning: student teachers experience problem-centered and design-based learning because their challenge is to design an iSTEM learning unit that adheres to the iSTEM key principles; (iii) IBL/evidence-based learning: by incorporating findings from the relevant (educational) literature, student teachers learn based on inquiry; and (iv) COO/cooperative learning: as student teachers design the iSTEM materials in multidisciplinary teams, they are required to collaborate. Second, experiencing these principles can boost the teachers' self-confidence regarding the implementation of the principles in the classroom [26]. Third, an integrated, multidisciplinary approach with more hands-on experience could improve the ability to teach an integrated STEM course [19]. Fourth, involving teachers in the design process of the curriculum is also beneficial to the realization of that curriculum in the classroom [27]. Finally, the iSTEM design using the online platform can be seen as an authentic learning experience that supports reflective learning and allows teachers to gain comfort in using digital tools [28].

In order to assess the effectiveness of this teacher training course, this study aimed to investigate two research questions:

- "To what extent does the digital collaborative learning environment immerse student teachers in six key principles of iSTEM education?" (i.e., RQ1);
- "How does the activation of these key principles progress throughout the development process?" (i.e., RQ2).

We hypothesized that the learning environment would sufficiently activate the iSTEM key principles in student teachers but that integration of learning contents would require more support than the other five principles because it is the key principle that student teachers would have the least experience with and thus the lowest starting position. We further hypothesized that student teachers would show increasing activation of the key principles during the development process due to the accumulation of iSTEM experience. However, the growth pattern of the key principles might show some deviation from a perfect linear trajectory because the development process comprises different phases, and certain phases might require or result in a stronger activation of a specific key principle.

In the following sections, first the materials and methods will be described (Section 2), starting with an introduction of the course on interdisciplinary education, continuing with a detailed description of the "CODEM for iSTEM" methodology, further situating this research in a commonly used PD evaluation framework, and ending with a description of the methods and measures used for the PD evaluation. In Section 3, the developed measurement instrument as well as the results are described. Finally, in Section 4, the selected research approach and results are discussed in relation to the relevant literature.

2. Materials and Methods

2.1. KU Leuven Course on "Pedagogies of Interdisciplinary STEM Education"

In Flanders, two teacher education programs exist: one at the bachelor's level (180 ECTS), which prepares students immediately after high school to teach lower and middle secondary education; and one at the master's level (120 ECTS), which prepares students to teach middle and higher secondary education. Student teachers enter the Master of Teaching in Science and Technology program either after completing a domain-specific (e.g., science, mathematics, engineering, etc.) bachelor's degree or a domain-specific master's degree. Students that already hold a master's degree can follow a shorter track of 60 ECTS. Due to the promising yet demanding nature of iSTEM education and in an effort to optimally prepare prospective teachers, the Master of Teaching in Science and Technology at KU Leuven contains two mandatory courses on interdisciplinary education: (1) "Pedagogies of Interdisciplinary Education"; and (2) "Internship in Interdisciplinary Education". Each student who envisions teaching a subject either in science (biology, chemistry, earth sciences, or physics), mathematics, or technology (engineering, ICT, etc.) is automatically enrolled in the interdisciplinary education courses as well.

In the interdisciplinary education courses, student teachers design and implement an iSTEM learning unit in multidisciplinary teams. For the 2021–2022 academic year, exactly 100 students who were studying at nine different campuses across Flanders subscribed to the iSTEM design course. Although all of the students held at least an academic bachelor's degree in mathematics, science, or engineering, it was a very diverse group that consisted of both full-time and part-time students who were combining the master's program with a teaching job, a non-teaching job, or a family. These students were divided over 19 multidisciplinary teams based on their geographical location and chosen subjects. From these teams, a random sample of eight teams was selected for observation. Each observed team consisted of four to five members.

The multidisciplinary teams gathered at least once a week for two hours over the course of approximately 10 weeks between the second half of October and the end of December 2021. These weekly team meetings were recorded. The final goal of each team was to develop an iSTEM learning unit with the backbone written as a "script" containing a central, authentic, real-world challenge for pupils to solve; intended learning objectives; and learning activities. Each team had a team coach who was an experienced teacher that clarified the design process if necessary, aided the team with practical questions concerning the design or internship, provided formative feedback, resolved conflicts if they occurred, and eventually performed the summative evaluation of the iSTEM learning unit and internship implementation. In additon to the coach, an online learning environment guided the teams through the design process based on the "CODEM for iSTEM" methodology [24], which is described in the next subsection.

2.2. "CODEM for iSTEM" Methodology

To support (student) teachers in implementing high-quality iSTEM education, a digital collaborative learning environment called "CODEM for iSTEM" was created [24]. The "CODEM for iSTEM" methodology was developed based on a multiple-case study that identified crucial, counterproductive, and missing steps in the design process of four multidisciplinary iSTEM design teams. The iSTEM design process consists of five phases with each consisting of one or more stages (see [24] for detailed information):

1. Context-analysis phase: identification of the target group for which the iSTEM learning unit will be developed, the target groups' prior knowledge, and scanning of (Flemish) curriculum guidelines to select learning contents that could be integrated.
2. Theme-selection phase: discussion of possible themes comprising the selected learning contents from the different STEM curricula.
3. Content/challenge brainstorm phase:
    a. Defining the learning objectives for each theme;
    b. Identifying competencies to be linked + linking;

c. Discipline-specific educational literature review;
d. Definition of central challenge;
e. Division of central challenge into subproblems;
f. Study of requirements and feasibility to solve challenges;
g. Selection and formulation of concrete learning objectives;
h. Design of leaning activities and instructional strategies.

4. Reporting phase: presentation of preliminary script and materials and exchange of feedback among peer design teams.
5. Development phase: finalization of script and construction of student syllabus.

Phases 1–3 of the "CODEM for iSTEM" methodology were integrated in an online collaborative learning environment to support student teachers in their design process and for use in a blended course setup due to the multicampus model. The online learning environment was centered around flowcharts representing the five phases and their stages. Each flowchart block provided textual information for each stage (key issues to consider, evidence-based good practices and pitfalls, and scaffolding questions), and reflective questions to assess the design at critical points (Figure 1).

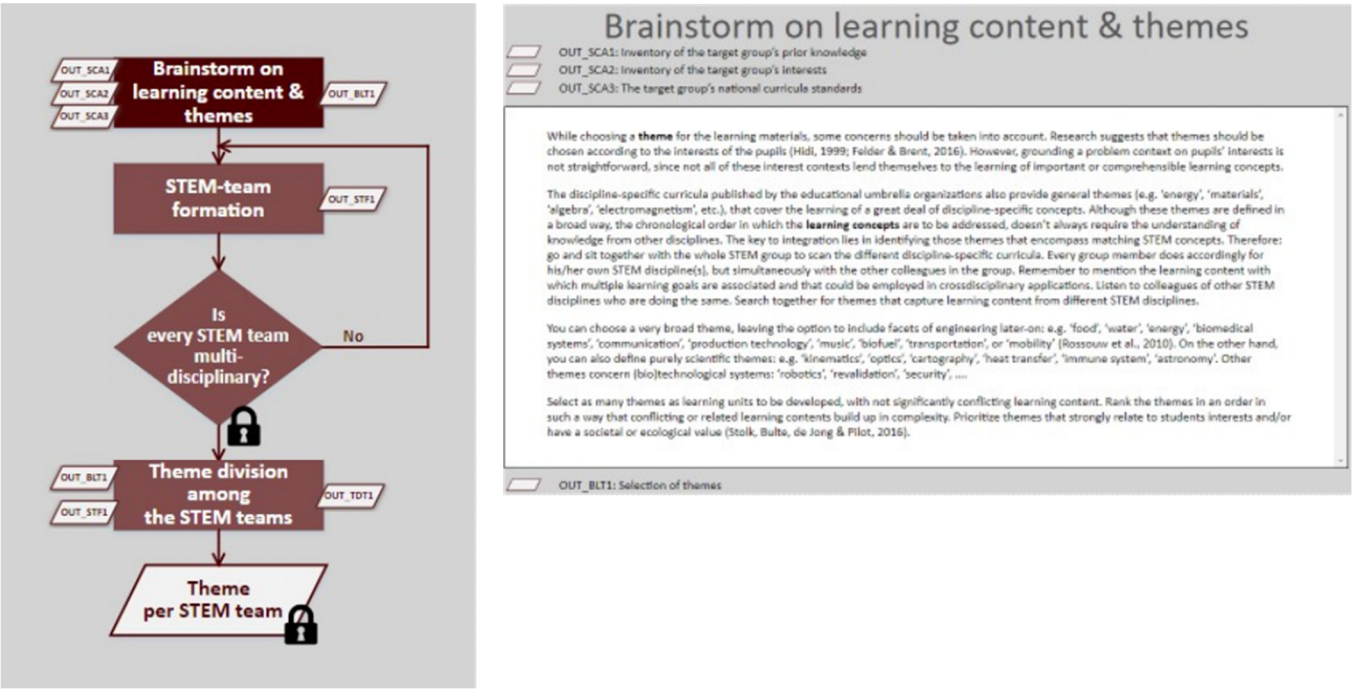

Figure 1. Screenshot from the "CODEM for iSTEM" online collaborative learning environment (theme-selection phase). The left shows the flowchart containing stages (rectangle), a reflective question (rhombus), and a milestone (parallelogram); textual information is on the right.

This study aimed to investigate the effect of the "CODEM for iSTEM" methodology provided via the online learning environment on prospective teachers' preparedness for iSTEM classroom implementation. The next subsections situate the approach in a conceptual framework for professional development evaluation and discuss the measures used.

2.3. Evaluation of the Effectiveness of the "CODEM for iSTEM" Methodology Provided via an Online Learning Environment

Desimone proposed a conceptual framework for studying the effects of professional development on teachers and students [21] that consists of four components: (1) the core features of professional development, which (could) result in (2) a change in teachers' knowledge, skills, attitudes, and beliefs that (could) elicit (3) a change in instruction, eventually leading to (4) improved student learning.

This study aimed to evaluate the effectiveness of the "CODEM for iSTEM" methodology provided via an online learning environment by focusing on the first two components of Desimone's framework and with a specific interest in the active experience of iSTEM key principles by student teachers.

Merchie et al. provided an overview of measurement methods that can be used to assess the components of Desimone's [21] and Merchie's extended framework [25]. In this study, a qualitative measure was selected to provide answers to the research questions as recommended by Desimone [21]. Qualitative research methods provided detailed insights into the complex interactions that took place in the multidisciplinary design teams. More specifically, the video recordings of the eight randomly selected iSTEM teams' meetings were analyzed using a scoring rubric (i.e., CiSTEM^2-TTR). Informed consent to use these video data was obtained from all of the student teachers who participated in the study (Institutional Review Board approval number: G-2021-3888-R2). The intensity of the data gathering was limited because the iSTEM design teams usually met online due to the blended nature of the "Pedagogies of Interdisciplinary Education" course. Still, the scoring and analysis of these recordings was very time-intensive. However, no other measures such as interviews or self-report questionnaires could provide similar detailed, fine-grained, and time-specific answers to the research questions.

2.4. Scoring Rubric for iSTEM Key Principles

Given the novelty of the concept under investigation, validated evaluation instruments to assess the activation of the iSTEM key principles during the iSTEM design process were unlikely to be available. To the best of our knowledge, no such instrument exists in the scientific literature. Consequently, a scoring instrument for iSTEM's key principles had to be created, which led to the development of the CiSTEM^2-Teacher Training Rubric (i.e., CiSTEM^2-TTR) (see Appendix A) as part of the CiSTEM^2 project (i.e., Cooperative interdisciplinary Student Teacher Education Model for Coaching integrated STEM). A video-observation analysis generally requires the video to be partitioned in segments of equal lengths of time. However, the iSTEM design process as described in Section 2.2 contained different phases and stages that varied in duration between the teams. Moreover, the teams can collectively ignore the work for a phase or stage or perform an additional phase or stage iteration. Consequently, comparing fixed video segments of equal size between the teams was impossible. Therefore the CiSTEM^2-TTR scored a stage in its entirety.

The construction of the CiSTEM^2-TTR was the result of an multistep process that consisted of a literature review, expert refinement, and a pilot study. The systematic literature review by Thibaut et al. functioned as the backbone of the rubric [10]. The findings of the review; i.e., the iSTEM key principles, that made up the items of the rubric were supplemented with additional items that were suggested by experienced iSTEM experts as crucial to activate the iSTEM key principles. These experts were former and current iSTEM coaches of the "Pedagogies of Interdisciplinary Education" course at KU Leuven. Finally, we tested the rubric in a pilot study in which two observers scored a team during the first half of the development process. This pilot study resulted in additional adjustments that increased the inter-rater reliability of the rubric.

For each item, the rubric contains four scoring criteria: insufficient, sufficient, strong, and very strong. Achieving a higher scoring criterion always assumes that the criteria of the lower scores are also fulfilled. For example, the table in Appendix A shows that when a team achieves a "strong" score on the item "Explicitly formulating expected objectives/results" of the PCL key principle, this indicates that the team not only fulfill the criterion of the "strong" score ("Showed awareness of the underlying reason/usefulness why these results should be achieved", but automatically also the criterion of the "sufficient" score ("Explicitly formulated which actions should be taken and what the result should be"). Logically, in order for a team to be aware of the results' usefulness, it first needs to formulate what the results should be.

According to the literature review, the iSTEM key principle of PCL is seen as the conception of an authentic real-world challenge that is motivating and engaging [10]. The iSTEM experts regarded this interpretation of PCL to be somewhat narrow and suggested additional items, namely formulating expected objectives and results, identifying preconditions, splitting a problem into smaller (sub)problems, and determining priorities. Afterward, these items were tested in the pilot study. The item criteria for achieving sufficient vs. strong vs. very strong activation were based on expert opinions and later confirmed in the pilot study based on their frequency of occurrence. The initial main PCL item of posing an authentic real-world challenge showed absolutely no variation during the pilot study: all teams reached the maximum score due to the fact that the assignment they received explicitly demanded a real-world iSTEM challenge that was of interest to the target group before a team could continue to the next phase. Therefore, this item had to be removed from the CiSTEM^2-TTR.

The iSTEM key principle of INT was operationalized by Thibaut et al. as the integration of content and skills over the different STEM disciplines. This was captured in the item "Achieving a high level of integration". The scoring of this item was based on the aforementioned levels of integration, with sufficient INT activation requiring the linking of different disciplines to the central challenge but not directly to each other (i.e., *multidisciplinarity*). Strong scores were an indication of several links across disciplines while still allowing the use of one's own discipline-specific terminology because the two disciplines were closely related (i.e., *interdisciplinarity*). Very strong scores were achieved after linking across disciplines while using concepts, principles, or analogies of different disciplines to solve the central challenge (i.e., *transdisciplinarity*). The pilot study showed that the search for integration was often performed individually instead of collaboratively. Consequently, an additional item was created to control for this behavior.

The iSTEM key principle of IBL is defined as learning by questioning, examining, gathering information, and interpreting results [10]. These constitute the components of scientific research and are captured by the item that examines the extensiveness of inquiry. The scoring criteria increase with each component of the inquiry process. Sufficient IBL activation is achieved by performing research when prior knowledge is lacking. Doing this, but also questioning the how and why of a (sub)phenomenon, would result in a strong score on this item. Additionally, very strong scores also require a team to reflect upon the inquiry process. Expert refinement resulted in the addition of a second item that took the quality of the examined sources into account. The pilot study showed that student teachers often reached for sources explicitly recommended by the learning environment such as feedback from the coach or governmental curriculum guidelines objectives. Nevertheless, these sources still needed to be processed correctly by the student teachers. As such, these type of sources constituted a sufficient level of IBL activation. Strong and very strong scores were achieved by referring to external sources found by the team members themselves (i.e., non-academic and academic sources, respectively).

The iSTEM key principle of DBL demands technological/engineering design. More specifically, the literature review first emphasized the importance of considering alternative solutions and justifying design choices. We combined these aspects into the item "Generating design ideas". Student teachers were deemed to have achieved sufficient DBL activation when they generated sufficient design ideas, which adhered to the consideration of alternative solutions. Strong scores were achieved when the advantages and disadvantages of those different ideas were regularly articulated but without further ado. In contrast, very strong scores required the design choices to be based on the consideration of the advantages and disadvantages of different design ideas. Second, the literature review emphasized the iterative nature of the design process: the engineering problem needs to be defined and then a solution determined and ultimately tested and evaluated, after which an iteration follows. Expert refinement suggested to differentiate the conception of the engineering problem into (a) scientific/technical requirements (e.g., calculations, physical principles, and results of an inquiry process), (b) practical conditions (e.g., available time, available

material/space, and safety), (c) the level and interest of the target group (e.g., cognitive ability, attitudes, and diversity), and (d) the (learning) objectives for the target group (e.g., self-formulated objectives, curricula, and targets). The scoring on these items followed a stepwise approach: sufficient levels merely demanded awareness of the requirements, conditions, level, interests, and objectives. Strong scores required not only awareness but also a solution. Moreover, very strong scores included the testing of solutions.

The literature review regards the iSTEM key principle of COO as cooperative learning through collaboration and interdependency among team members. This was captured by the item that investigated the collaboration intensity. Since this was an iSTEM rubric, a decision was made to tie the strong and very strong scores on this item to the integration between STEM learning contents or skills identified by team members from different disciplines. Expert refinement added three more items: using effective tools, participating actively, and providing feedback. Strong activation of these items required an efficient use of appointments/tools/methods to optimize the teamwork, active participation of all team members, and constructive peer feedback followed by constructive responses to that feedback, respectively. Very strong activation was achieved when teams reflected on their collaboration tools, all team members participated actively and to a large extent, and teams reflected on their entire collaboration process itself, respectively.

MOD was added to the five original iSTEM key principles and therefore only consisted of one item: the act of modeling itself. This is defined as using a scientific model to understand and communicate about a phenomenon [12]. A sufficient scoring on this item demanded the mapping of the relationships between the concepts, component, parameters, or variables playing a role in the challenge created by a team. Strong levels of activation required awareness of the model assumptions. Lastly, very strong scores demanded testing of the validity of the model at regular intervals so necessary adjustments could be made early.

No observer-specific bias was detected. We examined this by having a second researcher observe one of the eight teams. The inter-rater reliability was $\kappa = 0.82$, 95% CI [0.59, 1.06].

3. Results

Our findings showed that not all teams went through all the stages and phases of the platform collaboratively. As Table 2 illustrates, only five stages (from here on labeled P1 to P5) were completed by all the teams. The other stages and phases were mostly visited individually outside the team meetings and in some cases were even ignored. In addition, the online learning environment contained flowcharts and information texts that encouraged iterations of stages and phases in order to result in a better-designed learning unit. Some teams relied on the script as a guideline instead of the online learning environment. As a consequence, the information texts were not granted proper attention.

Although the activation of the iSTEM key principles varies between the teams, on average, the key principle of "integration of different STEM disciplines" seemed to be insufficiently activated among the student teachers, whereas the other key principles were sufficiently but not strongly activated during the training via the digital collaborative learning environment. These observations confirmed our first hypothesis.

Scoring via the CiSTEM^2-TTR rubric indicated that the insufficient levels of integration seemed to be due to a great need for more activation in making in-depth, cross-disciplinary linkages and searching for such linkages collaboratively. Concerning IBL, it was established that student teachers mainly built on their prior knowledge. PCL did not achieve a strong level due to the lack of insight, reflection, and depth. The extreme lack of testing was the reason for the lower-than-expected DBL activation. Only one team did once test one of the conditions of the design. For MOD, the reason lay in remaining unaware of the assumptions or validity of a model. Finally, it was observed that cooperative learning did not reach a higher level due to the low "integration of different STEM disciplines", which did not allow for building upon the knowledge of the team members. The lack of reflection

and the fact that often at least one team member participated to a lesser degree also played a role in the scoring of COO.

Table 2. Phases of the design process and the number of teams that performed each phase.

	Phase	#Teams
(P1)	Context-analysis phase (i.e., determining the target group)	8
(P2)	Theme-selection phase	8
	Defining the learning objectives for each theme	4
(P3)	Identification of competencies to be learned + linking	8
	Discipline-specific educational literature review	2
	Definition of central challenge	4
(P4)	Division of central challenge into subproblems	8
	Study of requirements and feasibility to solve challenge	1
	Iteration of central challenge and subproblems	3
	Second iteration of central challenge and subproblems (after feedback coach)	4
	Iteration of learning objectives	2
	Second iteration of learning objectives (after feedback coach)	1
(P5)	Design of learning activities and instructional strategies	8
	Iteration of learning activities and instructional strategies (after feedback coach)	4

Regarding the second research question (i.e., RQ2), the iSTEM key principle activation levels varied across the stages of the design process. PCL, DBL, IBL, and MOD showed a modest positive linear growth curve (see Figure 2). IBL and PCL deviated somewhat from a linear trajectory. IBL showed a deviation at the theme-selection stage (P2) and PCL during the context-analysis stage (P1) and the theme-selection stage (P2). During the theme-selection stage (P2) IBL was relatively highly activated because the teams needed to refresh the curriculum guidelines and research unknown aspects of potential themes. PCL was also important during the first two stages. The observed positive linear growth with some deviations due to certain stages demanding more activation of specific iSTEM key principles confirmed our second hypothesis and indicated that the online learning environment had the ability to activate these iSTEM key principles, albeit modestly. In contrast, INT did not exhibit positive growth, as it seemed to increase slightly when participating in the stage in which linking between STEM disciplines took centerstage and decreased afterward during the division of the central challenge into subproblems and the design of the learning activities and instructional strategies. The last key principle (COO) showed a flat trajectory without any growth.

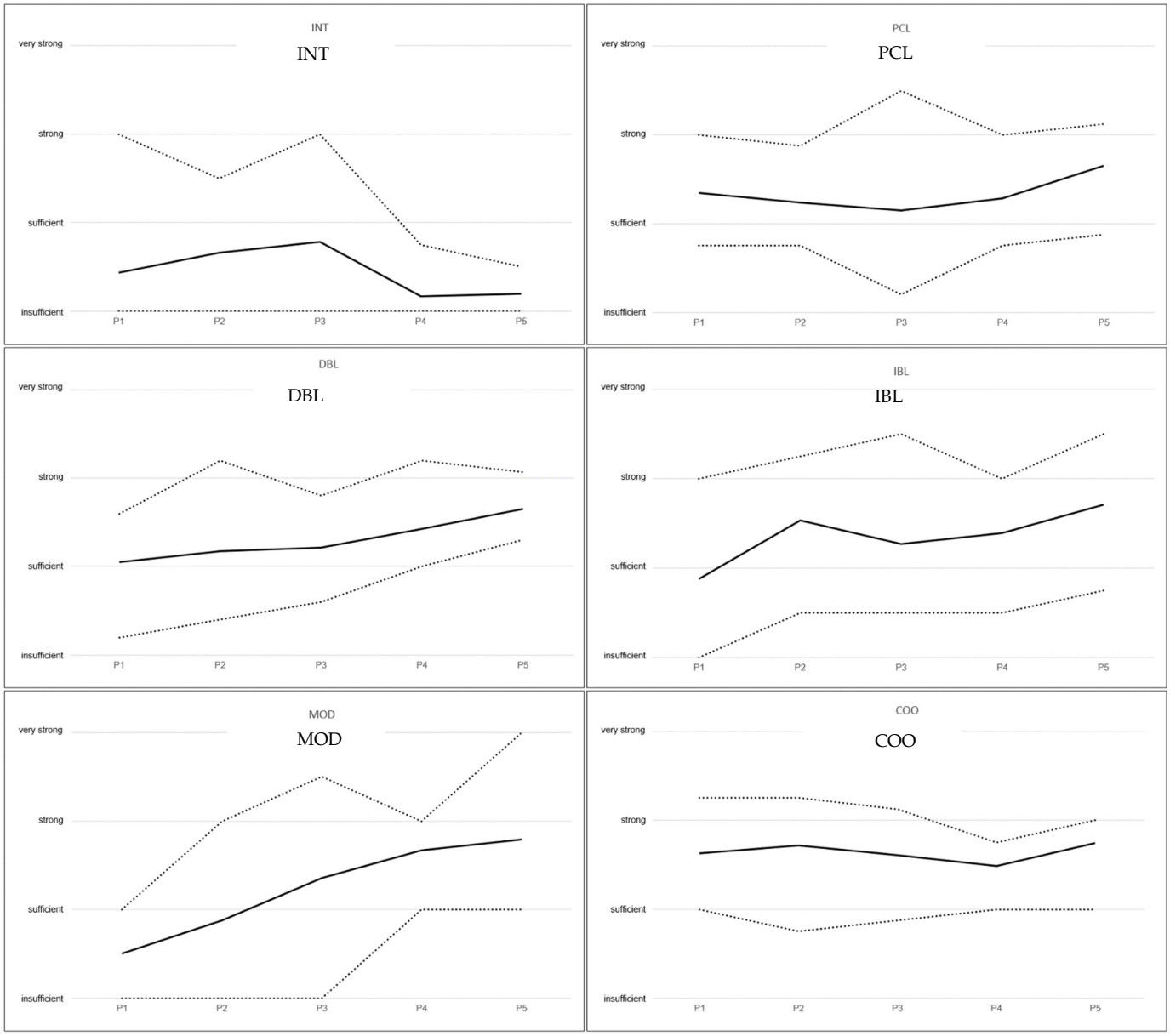

Figure 2. CiSTEM^2-TTR scores for the common phases of P1-P5 on the *x*-axis. The full line represents the mean score across the eight teams, while the dotted lines represent the highest and lowest scores among the teams. Scores on the *y*-axis ranged from "very strong" to "strong" to "sufficient" to "insufficient". See Table 2 for the description of the phases on the *x*-axis.

4. Discussion

4.1. Summary and Interpretation of Results

To the best of our knowledge, this study was the first to investigate the time- and stage-dependent activation of inquiry- and design-based cooperative and problem-centered learning and modeling and integrative practices of student teachers during the process of collaboratively designing an iSTEM learning unit using an online learning environment. An intensive qualitative analysis of the weekly team meeting recordings was used to gain detailed and fine-grained insights into the interactions within the multidisciplinary iSTEM design teams as a first step to explore pre-service teacher competence development using the online learning environment based on the "CODEM for iSTEM" methodology. To this end, a scoring rubric was developed based on a literature review, expert input, and adjustments based on pilot study results.

The results indicated that the "CODEM for iSTEM" methodology and learning environment immerses the student teachers to a sufficient, though not large, extent in most iSTEM key principles, except for "integration of different STEM disciplines"; i.e., INT. The activation of the other iSTEM key principles was sufficiently present during training via the online clearning environment, but here too no strong scores were achieved. Based on low scores on certain items in the scoring rubric, working points were identified that were mentioned in the Results section. The lack of strong scores on the scoring rubric was in line with previous research that assessed general (albeit elementary in-service) teachers' iSTEM competences after professional development during classroom observations. The assessment with a scoring rubric consisting of five domains and four levels, showed that teachers scored "approaching proficiency" (rubric level 2) for all five domains [29].

Our research findings suggest that improvements to the online learning environment are needed to boost student teachers' activation of the iSTEM key principles to higher levels of proficiency. This is in line with previous research which examined teachers' PD needs and ideas with respect to iSTEM educational design and implementation after professional development via self-report questionnaires [30,31]. Regarding the six iSTEM key principles [10], teachers explicitly mentioned needing support related to the principles of INT, DBL, and COO. Additionally, studies that investigated teachers' changes in iSTEM education conceptions after PD initiatives reported on changed perceptions related to the iSTEM key principles, although it remains to be investigated whether the used approaches are also useful for developing pre-service teachers' competences. After taking an iSTEM education course that allowed pre-service teachers to experience STEM education from a pupil's perspective and critically reflect on this experience, they reported an improved perceived understanding of iSTEM education [18]. Radloff et al. also reported improved perceptions of iSTEM education after pre-service teachers' video analysis and critical reflection on iSTEM instructional practices. Both before and after interviews, the pre-service teachers stressed the importance of "seamless" and purposeful integration of learning contents from several STEM disciplines (i.e., INT); working on "real-world scenarios" and hands-on applying of knowledge (i.e., PCL); failing, redesign, and the usage of the engineering design process (i.e., DBL); and student-centered approaches highlighted by group work in which the teacher acts as facilitator (i.e., COO) [32].

The literature related to the iSTEM key principles INT, DBL, and COO will be discussed in more detail. We focused on these three principles because INT exhibited the lowest scores, which also hampered COO activation due to the need for integrated collaboration. DBL in turn showed extremely low frequencies of very strong scores across all the teams, which begs the question whether certain research effects might be to blame.

4.1.1. Integration and Cooperative Learning

The iSTEM key principle of INT consistently showed average activation levels that were below sufficient throughout the design process. This observation is in line with the existing literature and seems to be caused by a great need for better support in making in-depth cross-disciplinary links. Berlin et al. [33] described a five-quarter teacher-preparation program with three courses that were focused on integrated content and three courses that were focused on integrated pedagogy followed by action research and examination. A quantitative analysis that used a semantic differential instrument to probe attitudes and perceptions related to the value and difficulty of iSTEM integration showed that pre-service teachers valued integration equally high before and after the intervention but perceived STEM integration as significantly more difficult *after* the intervention. After the intervention, pre-service teachers showed a more realistic, practical, and cautious approach to integration. This was confirmed by using a qualitative analysis of the answers to open-ended questions that probed what STEM integration meant to the participants. Complementary, Singer et al. observed that upon exposure to a curriculum bearing (albeit non-explicit) chances to build interdisciplinary links, student teachers did not make these connections on their own [34].

A practice that may support student teachers in building in-depth cross-disciplinary links is *collaborative concept mapping*. A concept map is a diagram that contains concepts in boxes and arrows that visualize the links between concepts and provide a textual explanation of how the concepts are linked [35]. Concept mapping is a promising technique for meaningful learning by identifying and tackling key learning concepts and actively constructing knowledge [36,37] as well as for authentic assessment [38]. Previous research into collaborative concept mapping showed promising results. Chen et al. reported significant increases in pre-service teachers' self-efficacy after participation in a mandatory course with a design task to create a technology-integrated interdisciplinary thematic unit (not limited to STEM) for middle school students [39]. The qualitative data once more confirmed that student teachers found making connections challenging yet judged the concept-mapping exercise to be helpful in identifying connections. Collaborative concept mapping is said to be a "messy and challenging" non-linear process that requires communication, sharing ideas, and providing feedback [39]. Cavlazoglu et al. [36] compared the quality of concept maps constructed by teachers individually versus in a group before and after a STEM workshop. Prior to the workshop, no significant differences in quality between the individually and collaboratively constructed concept maps were found; however, after the workshop, the collaboratively constructed concept maps were of significantly higher quality than the individually constructed concept maps.

Concept mapping thus seems to be a promising tool that may enhance both the iSTEM key principles of INT and COO. However, pre-service teachers experienced difficulties during concept map construction: they found the process labor-intensive and time-consuming [40]. Research findings indicated that in our online learning environment, even more emphasis should be put on the importance and potential of collaborative concept mapping to achieve meaningful integration and on the support of student teacher design teams in the concept-mapping process.

Our findings showed a relatively stable sufficient-to-strong activation of the iSTEM key principle of COO throughout the stages of the development process. The flat trajectory of the COO principle could be explained by a high starting position compared to the other iSTEM key principles followed by low growth. The high starting position could be the result of collaboration and interdependency being a constant factor during the development process right from the start (the student teachers would receive a team score at the end of the Interdisciplinary STEM courses). Both growth in COO activation and very strong COO activation levels require purposeful collaborate integration, which was something no team has seemed able to accomplish.

4.1.2. Design-Based Learning

As teaching can be viewed as a design science with the teacher as the designer [41,42], the iSTEM design process is a complex and creative process of analysis, creation, prototyping, feedback gathering, and redesign [43] in which student teachers should activate the iSTEM key principle of DBL.

While an increase in the average DBL activation was observed, again the student teachers did not exceed strong activation levels. The rubric indicates that very strong DBL activation levels correspond with a testing of the design. Testing must be interpreted in the broadest sense by incorporating actual testing but also involving reflecting, gathering evidence, etc. Due to the practical organization of the training course "Pedagogies of Interdisciplinary STEM Education", not all of the design aspects could be tested by the student teachers; e.g., because their target group was not yet known at the time of the challenge conception, making it impossible to assess the interest of the target group in the designed challenge. Furthermore, the rubric expected that student teachers would prototype and test their hands-on learning activities in the development phase of the "CODEM for iSTEM" methodology, which was out of the scope of the training course. Other research has shown that teachers who experience hands-on activities during professional development are encouraged to implement hands-on activities in their classroom practices [44].

Despite the explanations for the relatively low DBL activation levels, further DBL support in the online environment and course guidance may be warranted. Wu et al. [42] compared static (automatic) and adaptive (human-aided) scaffolding during an iSTEM collaborative design process with the assistance of an online platform by analyzing coded group chat data using an epistemic network analysis. Static scaffolding led to the development of routine expertise, mix-and-match strategies of formulating design solutions, and suppressed divergent thinking. Adaptive scaffolding; e.g., a human tutor pointing out incongruent views, led to revised solutions and deeper reflections. Group members also asked for clarification and confirmation of design solutions more often. Adaptive and static scaffolding thus play different roles and should complement each other. Wu et al. concluded "This kind of just-in-time support from a human tutor is critical, especially for novice designers"[42]. The value of coaching support to provide expert content and pedagogical knowledge was confirmed in other studies [45]. Our online learning environment contained static scaffolding by means of reflective questions in the flowchart and supporting questions included in the textual information for each substage. The team coach complemented this static scaffolding by providing demand-driven clarification and feedback (adaptive scaffolding). Whether this support was sufficient should be critically reviewed in further research.

4.2. Limitations and Future Work

4.2.1. Limitations

This study aimed to investigate the activation of iSTEM key principles during the design process of iSTEM multidisciplinary teams. Video recordings of weekly team meetings were scored using a newly created scoring rubric: the CiSTEM^2-TTR. Although this rubric was developed based on a literature review, expert refinement, and a pilot study, its validity should be further investigated in other contexts because the literature base used to construct the rubric was limited.

Although approximately 200 h of video recordings were analyzed, the sample size was still limited to only eight teams. In the future, we intend to analyze the video recordings of the remaining 11 teams to expand the dataset and corroborate the research findings.

4.2.2. Future Work

Within the scope of the Erasmus+ project CiSTEM^2, additional data were collected from student teachers in the 2021–2022 academic year. In addition to recordings of the weekly team meetings, student teachers also filled in a questionnaire before and after the development process that probed their attitudes toward iSTEM education and they answered an open-ended question that asked what approach they would take in designing an iSTEM project concerning a specific theme. These data will provide insights into the learning gains and attitude shifts of student teachers after taking the courses "Pedagogies" and "Internship in Interdisciplinary STEMEducation". The results should be triangulated with the qualitative data of the observed team meetings (this study). Furthermore, when video recordings of all teams have been scored using the CiSTEM^2-TTR rubric, these scores and the metrics detailed above should be compared to the summative scores received by each team at the end of both courses to assess the relationship between a team's process and the quality of their final product.

As part of the CiSTEM^2 project, the "CODEM for iSTEM" learning environment is currently being improved in line with findings of this study. The video observations resulted in multiple suggestions. Firstly, the student teachers often neglected to read the textual information. Therefore, instructional and explainer videos will be added for every substage in the flowcharts. Secondly, the activation of the iSTEM principle of INT was too low for all teams. Therefore, the principle of INT will receive a more central role in the optimized learning environment in the form of concept mapping, and an instructional video demonstrating the iterative process of concept mapping in an iSTEM context will be added. Student teachers' difficulties regarding concept mapping will receive special attention by

providing good and bad examples. Thirdly, for the other iSTEM key principles (MOD, PCL, IBL, DBL, and COO), merely sufficient activation levels were reached. Therefore, explainer videos in the new learning environment will place more emphasis on insight, reflection, research, assumptions, and testing. In each substage, the iSTEM key principles that should be activated will be explicitly mentioned in the explainer video. During the academic year 2022–2023, student teachers will use the new learning environment, while the same measures of iSTEM key principle activation (questionnaire, open-ended question, and video recordings of weekly meetings) will be collected in order to study the effects of using the new environment as a training tool.

5. Conclusions

Integrated STEM has the potential to increase students' interest in STEM education. However, before students can be immersed in the key principles of iSTEM, their teachers first need to be trained in these key principles themselves. For this reason, the online collaborative learning environment "CODEM for iSTEM" was created. Flemish teams of student teachers designed learning materials via the support of the online learning environment. This study investigated to what extent the online learning environment activates student teachers throughout their design process in the six key principles of iSTEM education. Video recordings of the student teachers' team meetings were observed and analyzed with the newly developed scoring rubric CiSTEM^2-TTR. The results indicated that the online learning environment has immersed the student teachers to a sufficient (though not high) degree in the iSTEM key principles of "problem-centered learning", "modeling", "inquiry-based learning", "design-based learning", and "cooperative learning". Except for "cooperative learning", these principles showed modest growth throughout the student teachers' use of the online learning environment. However, the activation of "integration of different STEM disciplines" remained insufficient. Based on these findings, improvements to the online learning environment are currently being implemented as part of the CiSTEM^2 project. The assessment instrument and method developed in this study provide new ways for future teacher training programs to analyze (student) teachers' endeavors in designing integrated STEM education.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of KU Leuven (G-2021-3888-R2; approved on 31 August 2021).

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Appendix A. The CiSTEM^2-Teacher Training Rubric Used to Score Content Experience in iSTEM Based on Six Key Principles

Key Principle	During the Development of the Learning Material, the Team Showed Signs of . . .	0 = Insufficient	1 = Sufficient	2 = Strong	3 = Very Strong
PCL	Explicitly formulating expected objectives/ results	Only formulated which actions should be taken but not what the result should be	Explicitly formulated which actions should be taken and what the result should be	Showed awareness of the underlying reason/usefulness why these results should be achieved	Constructive reflection on the expected objectives/results and their underlying reason/usefulness
	Identifying preconditions (limitations, things to take into account (e.g., missing information, relevance of given/found information, required/available material/space, etc.))	Insufficiently identified which factors needed to be taken into account	Indicated when necessary which factors/ preconditions were inherent to the problem	Made conscious choices based on the factors/ preconditions that must be taken into account.	Made conscious choices based on the expected factors/ preconditions and at the same time anticipated possible unexpected risks (e.g., provided extra material to compensate for defects)
	Splitting a problem into smaller relevant (sub)problems	Insufficiently divided problems into smaller relevant (sub)problems	Always split problems into smaller relevant (sub)problems when necessary	Always split problems into smaller relevant (sub)problems when necessary and explicitly stated how this problem was situated in the context of the larger problem	Explicitly split a cross-disciplinary (sub)problem into smaller relevant sub-problems on the basis of the cross-disciplinary content and not on the basis of separate teaching methods
	Determining priorities when problems arose during the project (e.g., no internship yet, etc.)	Hardly prioritizing when problems arose	Usually prioritizing when problems arose	(Almost) always prioritized when problems arose	(Almost) always determined priorities when problems arose and always implemented them
INT	Collaboratively searching for integration	Did not search or only searched individually for links between disciplines	Sometimes searched cooperatively for cross-disciplinary links	Sometimes cooperatively looked for cross-disciplinary links and was aware of the added value of this compared to individual integration	Usually searched cooperatively for cross-disciplinary links and was aware of the added value of this compared to individual integration
	Achieving a high level of integration	Insufficiently searched for links between disciplines	Linked different disciplines to the central challenge but not directly to each other	Linked related disciplines while using own discipline-specific terminology	Linked across disciplines while using concept/principles/ analogies of other disciplines to solve the central challenge

Key Principle	During the Development of the Learning Material, the Team Showed Signs of . . .	0 = Insufficient	1 = Sufficient	2 = Strong	3 = Very Strong
MOD	Modeling	Insufficiently discussed the relationship between different concepts/ components/ parameters/variables (e.g., only listed concepts)	Mapped the relationship between different concepts/ components/ parameters/variables (e.g., verbal relationships, concept maps, graphs, formulas, etc.)	Was aware of the assumptions inherent to the model	Tested the validity of the model at regular intervals so that the necessary adjustments could be made early
IBL	Performing a full inquiry	Showed little to none inquiry efforts	Carried out sufficient research when prior knowledge did not suffice.	Questioned the "how" and "why" of a (sub)phenomenon	Reflected critically on the collected data, the data collection method, or other steps in the inquiry process
	Using high-quality sources	Referred only to prior knowledge and the assignment itself	Referred to mandatory sources (i.e., feedback coach and learning objectives)	Referred to non-academic sources (e.g., school handbooks, YouTube, blogs, websites, etc.)	Referenced academic sources (e.g., scientific articles)
DBL	Generating design ideas	Generated almost no ideas	Generated a sufficient number of ideas	Regularly articulated the advantages and disadvantages of those different ideas	Usually substantiated the design choices based on the advantages and disadvantages of different ideas
	Designing based on scientific/technical requirements (e.g., calculations, physical principles, and results of the inquiry process)	Did not take sufficient account of scien- tific/technical requirements	Listed scien- tific/technical requirements of the design	Determined an appropriate approach to meet the scien- tific/technical requirements of the design	Tested the design in the function of scientific/technical requirements
	Designing based on practical conditions (e.g., available time, available material/space, and safety)	Did not take sufficient account of the practical conditions	Took sufficient account of the practical conditions	Determined a suitable approach to meet the practical conditions	Tested the design in the function of the practical conditions
	Designing based on level/interest of the target group (e.g., cognitive ability, attitudes, and diversity)	Did not take sufficient account of the level/ interest of the target group	Took sufficient account of the level/interest of the target group	Determined an appropriate approach to meet the level/interest of the target group	Tested the design in the function of level/interest of the target group
	Designing based on (learning) objectives for the target group (e.g., self-formulated objectives and curriculum guidelines)	Did not take sufficient account of the learning objectives of the target group	Tookke sufficient account of the learning objectives of the target group	Determined an appropriate approach to meet the learning objectives of the target group	Tested the design in function of the learning objectives of the target group

Key Principle	During the Development of the Learning Material, the Team Showed Signs of . . .	0 = Insufficient	1 = Sufficient	2 = Strong	3 = Very Strong
COO	Employing effective tools	Hardly used appointments/tools/methods to optimize their teamwork (e.g., appointments, Google Drive, etc.)	Discussed appointments/tools/methods to optimize their teamwork	Made efficient use of appointments/tools/methods to optimize their teamwork	The agreements/tools/methods were reflected upon, compared, and strived for the highest efficiency
	Collaborating intensively	Did not sufficiently use their own professional or subject-specific competences	Shared their own professional or subject-specific competences sufficiently with their team members	Regularly built upon the professional or subject-specific competences of their team members	Very often built upon the subject-specific or subject-specific competences of their team members
	Actively participating	Few team members actively participated	Most team members actively participated, but the other team members did not participate sufficiently	All team members actively participated, but some to a lesser extent	All team members actively participated and all to a large extent
	Providing feedback	There was a climate of insufficient or destructive feedback exchange and/or insufficient or destructive responses to feedback	There was a climate of constructive feedback exchange	There was a climate of constructive feedback exchange followed by a constructive response to that feedback	The entire collaboration process was reflected upon

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Article

Towards the Mainstreaming of Online Mobility at KU Leuven

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Abstract: Online mobility—learning activities where students engage online with other institutions abroad, while physically remaining at their home institution—has been of interest for several decades in Europe and at KU Leuven. This article describes the journey KU Leuven is going through to bring this form of learning into their mainstream offering to their 60,000+ students. Framed in Educational Design Research, this article presents a study where the authors explore the core needs regarding didactic support and student administration to devise interventions facilitating the university-wide uptake of online mobility. They reflect on the steps taken towards policy-level strategic vision development as well as micro-level sustainable support structures.

Keywords: online mobility; blended intensive programmes; higher education policy; international learning; educational design research

1. Introduction

Online mobility is not a new concept and has been researched for over 15 years. Already around the turn of the millennium, pioneers in the field saw the potential of this form of international learning [1]. Moreover, within KU Leuven (Belgium), there have been early adopters since that time, where the university was involved in several (European) projects on the topic [2,3]. In the context of the pandemic, online mobility has (re)gained extensive interest in higher education institutions.

1.1. Online Mobility

Online mobility—learning activities where students engage online with other institutions abroad, while physically remaining at their home institution—creates many opportunities for students, staff and higher education institutions. There are many terms in circulation that—more or less—refer to the same concept as online mobility. Think of virtual mobility, online intercultural exchange, blended mobility or (collaborative) online international learning. It has the potential to open access to an international learning environment and give flexibility to students who would otherwise be unwilling or unable to be physically mobile for whatever reason. Online mobility lowers the cost of a mobility experience, making it more affordable and enabling a greater number of students from partners in low- and middle-income countries to study in an international context [4]. Online mobility widens options for students in terms of topics or subjects offered by partner universities and gives access to experts, (niche) courses and learning materials that are not offered at the home university [5]. It thereby offers the opportunity to become acquainted with other higher education institutions and this could help motivate them to undertake physical mobility (as a degree seeker or otherwise) at a later stage of their academic or professional career.

Experiencing online mobility is valuable not only for personal development but also for creating the opportunity to develop skills and competences needed in working life [6]. Through cross-border collaboration with academic staff and/or peer students

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from other countries and different backgrounds and cultures, students can improve their language skills, their teamwork skills and can train their intercultural competences and skills [7]. Using different collaboration and communication tools, they can also improve their ICT skills. Students are enabled to learn in a transformative way and become critical, autonomous global citizens and lifelong learners [8,9].

From the teacher's and the institution's point of view, online mobility creates opportunities for educational innovation and internationalisation [10]. It increases opportunities for designing flexible individual study programmes, diversifying programmes and expanding the current academic offer, or adapting the offer to make it suitable for online learning [11]. It can be a way of giving MOOCs a structural place in the curricula. Designing online mobility activities can also strengthen cooperation between higher education institutions, working collaboratively on joint course offers, sharing expertise and practices [10]. Online mobility can be a way to stay competitive and attractive and give extra-institutional visibility to excellent knowledge and expertise developed at a given university [11]. It can attract additional students for niche subjects, and can also help to attract a larger, more diverse group of students and to reach out to disadvantaged groups. Finally, online mobility is a sustainable way of realizing a policy of *Mobility for all*, while respecting the ecological footprint [10].

1.2. KU Leuven and the European Context

With the growing interest in online mobility, participation in a European University Alliance and the digital shift as a result of the COVID-19 pandemic, the KU Leuven policy team considered the time had come to give online mobility a sustainable and integrated place in its functioning. With over 60,000 students and 12,000 staff members, KU Leuven is the largest university in Belgium [12]. Through online mobility, KU Leuven wants to contribute in an innovative and accessible way to the objective of *Mobility for all* [13].

A similar trend of an increased focus on online mobility was seen in several of KU Leuven's institutional and faculty partners, as shown for example in the joint courses and programmes within the Una Europa university alliance [14], or the priorities of the CLUSTER consortium [15]. The European Commission made its ambitions concrete by explicitly including virtual mobility in its European University Initiative [16,17]. In the Una Europa *1Europe* project, KU Leuven committed itself to working towards offering a variety of online and blended mobility activities and courses in all programmes and cycles (BA, MA, PhD). Furthermore, the European Commission included funding of Blended Intensive Programmes (BIP) and short-term blended mobility as novelties in the Erasmus+ programme 2021–2027 [18]. Both the organisation of and participation in these online forms of education and learning are now financially supported in the programme. The European Commission thus aims to combine the best of physical mobility (the international and intercultural immersion) and virtual mobility (learning to collaborate digitally in an international context).

Implementing this policy-level commitment into educational study programmes at individual universities is a big task. Since 2013, when the whole higher education system in Flanders underwent a large-scale reform, the study programmes of KU Leuven have been available in 13 campuses on 10 locations spread over Flanders [19]. This decentralised structure of the university is also mirrored in the educational support needs: each faculty at each campus has its own methods, priorities, goals and needs in organising their educational activities. Every faculty has its own policy plans, including internationalisation priorities [20]. To provide adequate support within faculties, the central service departments at KU Leuven work within the KU Leuven Learning Lab, a learning and action network that brings together educational expertise in different faculties and units, to collaboratively provide high-quality integrated, customised support for teaching staff [21]. The most visible aspect of this network is the educational developers located at the different faculties and campuses who are the first point of contact for teachers. In other words, although policy makers at the university may be convinced of the benefits of online mobility, faculties, departments and

individual teachers need to see benefits in undertaking the effort of creating online mobility activities in this decentralised organisation. This is the key challenge in and obstacle to mainstreaming online mobility at KU Leuven.

1.3. Research Objectives and Research Questions

Above, we described the context of KU Leuven and its strategic aim to mainstream online mobility. Within this context, we frame this study as an Educational Design Research (EDR) study [22], because of two reasons:

1. We acknowledge the complexity of the university as an organisation, where processes, responsibilities and activities in different parts of the organisation will be affected in any educational innovation such as the mainstreaming of online mobility [23];
2. We consider support interventions for teaching staff within the university as an issue of organisational design choice [24].

EDR approaches "strive towards the dual goals of developing theoretical understanding and also designing and implementing interventions in practice" [23]. This framework was deliberately chosen for this research on mainstreaming online mobility to effectuate concrete interventions within the university as well as to improve the understanding of the organisational aspects of implementing a large-scale educational innovation. Moreover, it gave us the methodological tools to bring together and combine data from multiple sources to build our insight within the complex environment of the university [25].

Our global research objectives in this study were to understand (a) which organisational design interventions are useful to mainstream online mobility at the university, (b) what the organisational constraints are for their effective implementation and (c) which specific support measures on online mobility are useful for educational development staff and teaching staff at the university.

Within this last research objective, we narrowed the scope of this study around two research questions:

3. What are the support needs of teachers and educational support staff in the KU Leuven Learning Lab in relation to the creation and implementation of online mobility activities?
4. What can a blueprint of an ideal support programme and instrument look like within the context of KU Leuven?

2. Materials and Methods

As indicated above, we followed an Educational Design Research (EDR) methodology [22], illustrated in Figure 1.

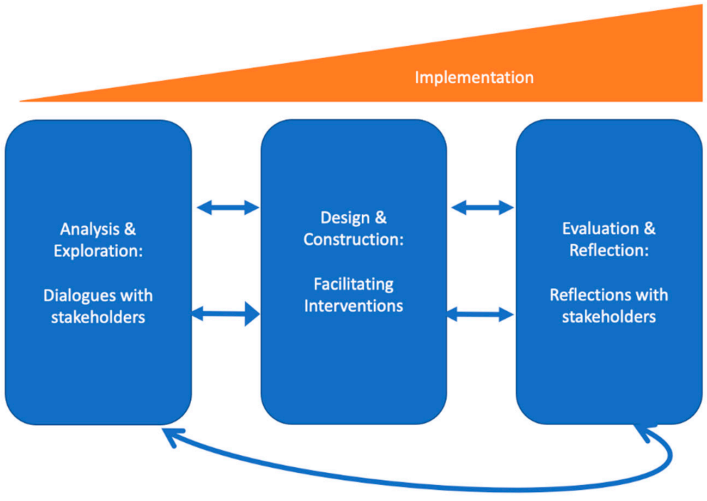

Figure 1. EDR Study Design (following McKenney and Reeves, 2018).

We will describe the phases here in a linear fashion, although they were interweaved throughout the project. The activities described here took place between September 2020 and September 2022. Qualitative data were collected in the form of field notes during focus group sessions, interviews and digital and face-to-face conversations. We did not collect any audio-visual recordings in these meetings as this would have impeded the organic and natural context of the conversations. Participants in all activities were informed of the strategic as well as the exploratory nature of the study, as well as its duration over several months.

In the Analysis and Exploration phase, the main aim was to gain a deeper understanding of the specific context of KU Leuven, the policy-level aspirations regarding online mobility of its strategic actors and the practical consequences of mainstream implementation, in order to identify needs for intervention. Qualitative data were collected in three ways: Firstly, the perceptions, vision, priorities and attitudes of several actors in the university were collected through a dialogic approach, in which we engaged with a total of 54 people in 11 faculties and departments within the university and with 20 people of external institutional partner networks. Concretely, the following activities were conducted:

a. Dialogue with faculties (vice-deans of education and internationalisation, faculty educational support staff and liaisons internationalisation);
b. Dialogue with the Educational Development Unit;
c. Dialogue with Teaching and Learning Processes;
d. Dialogue with vice-rectors and the International Office;
e. Dialogue and check with external strategic partners (Una Europa Mobility cluster, LERU Virtual Exchange group).

Secondly, we inventorised relevant existing support instruments and materials in use and in development at the university through scouring the KU Leuven Learning Lab website and through targeted conversions with educational support staff. For example, the internal courses and modules on didactic formats and blended course design offered by the KU Leuven Learning Lab were identified of relevance for online mobility. The inventory was deemed necessary to understand how online mobility differs from other blended/online learning and which aspects of support were still lacking. Moreover, through this exercise, we gained an insight into what types of needs existed across the university that could benefit from extra support instruments made in the context of online mobility (e.g., on intercultural learning or managing intercultural groups). Thirdly, in order to identify further relevant existing support instruments, we also conducted a scoped literature study on virtual mobility, starting from the outputs of previous projects (e.g., VM-BASE, EU-VIP, IEREST, etc.) and with backward snowballing and citation tracking. We kept track of relevant publications on mainstreaming online mobility at European universities through our existing partner network. We have not reported extensively on the results of the literature study here, as this would have led us too far from the main objective of this article (i.e., the focus on the organisational design of support for mainstreaming online mobility).

The lead researchers analysed and triangulated the collected qualitative data in this phase to come to a common understanding of the problem setting, identify pressing needs for the large-scale implementation of online mobility and define interventions that would support the implementation in the following phase.

In the Design and Construction phase, four interventions were created to facilitate a mutual understanding between diverse actors at the university and to bring forward the conversation on online mobility at the university:

- KU Leuven terminology for online mobility activities: four types of online mobility formats were defined to create a shared vocabulary;
- Outline of the possible training flow within the university: the educational support flows at the university were mapped to define an appropriate approach for support for online mobility (with content and form of first-line support and second line support);

- A workshop series and staged approach were designed and trialled to support international teacher teams around a Blended Intensive Programme (BIP);
- Existing teaching and learning processes were mapped and extended to include support of online mobility.

In the Evaluation and Reflection phase, several activities were conducted to align the interpretations, interventions and outcomes to the actual needs. Qualitative data were collected at all these activities in the form of meeting notes:

- Focus group (in December 2021) with OpenU project partners Universidad Complutense de Madrid (UCM; n = 5) and Freie Universität Berlin (FUB; n = 6) to discuss and check the extent to which the KU Leuven strategy and approach was generic;
- Roll-out of two cases, BIP Teacher Education in a European Perspective and BIP Human Rights: these teacher teams were aware that they were pilots for the implementation of the educational support strategy. Reflective talks with the academic leads (n = 2) were planned after every workshop, to obtain feedback on the strengths and weaknesses of the workshops and eventual additional support needs;
- Continuous reflective talks with the leadership of the Educational Development Unit;
- Continuous reflective talks with university policy makers on education and internationalisation.

3. Results

In this Results section, we will first elaborate on the results of each phase to attempt to answer the research questions posed.

The results of the Analysis and Exploration were the following. Overall, the dialogic approach and literature exploration elucidated the complexity of mainstreaming an educational innovation such as online mobility. It was clear that mainstreaming online mobility would require specific support for teachers on very diverse topics such as digital pedagogies, teaching in an international context, as well as organisational issues such as existing international exchange agreements and student registration processes. Moreover, it also became apparent that several support departments in the university would be affected by this educational innovation, most notably, the educational development unit, the international office and student administration. Moreover, it brought up the issue of the most efficient and effective new organisational processes that would be needed to facilitate this educational innovation. Concretely, we identified several needs from teachers. The first identified need was the need for a common terminology and language around online mobility across all KU Leuven actors. Early on in this endeavour, we discovered that there was confusion with the use of different terms regarding online mobility (e.g., telecollaboration, Collaborative Online International Learning (COIL), virtual mobility, etc.). Teachers mentioned often how they became confused by the different terminologies used, and how this confusion acted as an obstacle for the uptake of online mobility. A second identified need was the need for a clear strategic direction. This resulted in the creation of a shared vision that was noted down into a formal policy note, perpetuated in the strategic policy plan and supported by all faculties. A third identified need was the need for better insight into the range of internationalisation possibilities for one course, and how aspects of internationalisation could be made tangible for the students. A fourth identified need was that teachers were unfamiliar with the instructional design options for online mobility, such as blended learning, teaching in an international context and assessment online. This has resulted in the creation of guidelines in the design of online mobility (e.g., include intercultural focus through instructional design choices). A final outcome was the identification of expertise in online mobility across the university.

Overall, the Analysis and Exploration activities showed that support for online mobility at KU Leuven needs to fit into the existing organisational processes used by KU Leuven Learning Lab [26]. This means that the main target group for newly created support interventions are the faculty educational developers. They will, in their turn, be supporting

the teaching staff. In addition, the internationalisation staff also play a unique role in this support. Materials that are created have to support both roles.

The Design and Construction phase brought to the fore several results. As mentioned earlier, a shared terminology at KU Leuven was developed on the forms of online mobility and published in the educational glossary of KU Leuven [27]. In order to avoid a delay in the project due to a possible semantic discussion, KU Leuven decided in December 2020 to use the term "online mobility" to refer to "all formats of cross-border online formal education, based on the exchange between two or more institutions for higher education". KU Leuven recognised in this rather pragmatic approach the common definitions of virtual exchange and collaborative online international learning [28,29]. The design conjecture behind this intervention was that common terminology would clear up confusion for teachers and create clear precedent models of online mobility, which will ultimately facilitate teachers in creating new online mobility courses [30].

We narrowed down the diversity of concepts to indicate the different online mobility formats that were closest to the university's teaching needs.

Online mobility for study is defined as cross-border online formal education based on the exchange between two or more institutions for higher education. We distinguished four different formats:

a. Online exchange courses

KU Leuven students can take online courses at another university and students at partner universities can do the same at KU Leuven. They count for at least three ECTS and include a formal assessment. The administrative processes are the same as for physical exchange students;

b. Blended mobility

Blended mobility is a combination of physical and online mobility. In this case, the period of physical mobility is usually short(er). The role of the online mobility activities is to prepare, follow-up and/or reinforce the physical mobility experience;

c. Joint International Formats

These are learning activities or courses developed in collaboration with teaching staff/didactic teams at a partner institution. The aim of these activities is to stimulate interaction and collaboration between students with a different national and/or cultural background;

d. Virtual or blended international internships

Work placements or internships involve three different stakeholders: the student, the higher education institution and the receiving company or organisation. During a work placement these three stakeholders ideally interact with each other on a regular basis. When the interaction between student and company is mainly ICT-supported, we talk about a virtual work placement or internship. When part of the interaction between the two stakeholders takes place face-to-face, we talk about a blended work placement or internship.

Different formats can also be combined.

A second design outcome was the outline of the possible training flow within the university. Following the organisation of the KU Leuven Learning Lab, first-line support for teachers has been situated within the faculties with the educational support staff and internationalisation staff at the faculty taking up a role for the immediate support. This involved the creation of new working methods and collaborations within the faculties. As second-line support, central support units design and develop new material and formats on instructional design specifically for online mobility. Educational and internationalisation support staff will work in duo in addressing questions about online mobility within the faculties. Support materials that will be created will also be integrated within the existing educational support strategies/model, and the ongoing efforts regarding internationalisation of curricula at the university.

As stated in 2006 by Mishra and Koehler, teachers often face difficulties when implementing educational technology. They do not only need content (what) and pedagogical knowledge (how) to design their learning activities and courses, but also technological knowledge (using what tools) for successful edtech integration. Since it is not always possible to find these types of knowledge within one person, the KU Leuven Learning Lab already uses a *design team* approach for educational support [21]. In every design team all three types of knowledge are represented [31]. Designing international online learning activities also appeals to international and intercultural literacy, thus shifting from the TPACK model towards the TPACK-I model (Figure 2).

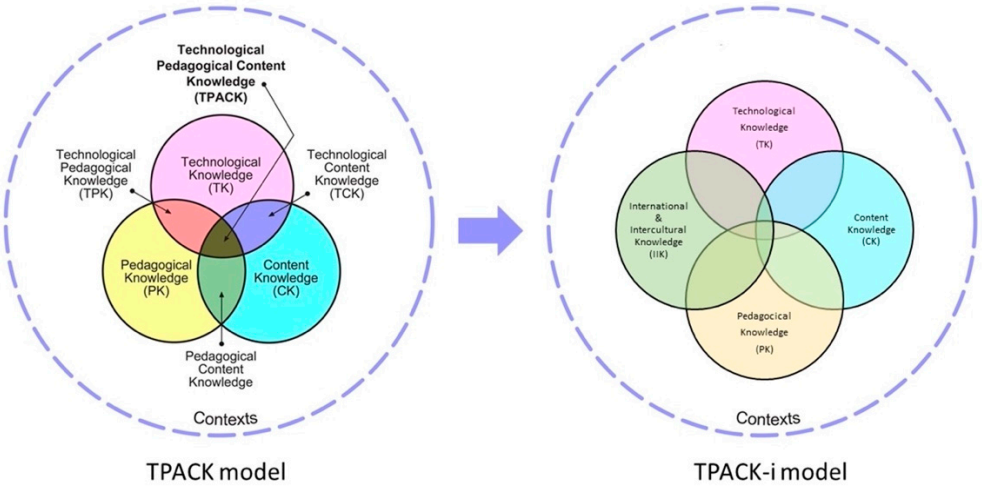

Figure 2. TPACK to TPACK-I.

To support online international learning activities, a design team will be composed in such a way that international knowledge is sufficiently present as well.

The guide for the blended course design we currently use at KU Leuven is based on the ABC Learning Design method [32,33]. During the experiment we also looked into the ACAD framework [34], which offers a practical approach to analysing complex learning situations, such as virtual or blended mobility activities/courses. The design conjecture behind this intervention is to provide micro-level support to teachers by the colleagues best placed to support them (namely educational support staff and international liaisons in faculties) with appropriate pedagogical, technical and organisational support [30].

A third concrete intervention was the design of a workshop series and staged approach to support international teacher teams around a Blended Intensive Programme. The aim of this workshop series (and the design conjecture behind it) was to develop standardised methods for facilitating the design of BIPs that encompass the pedagogical, technological, content and internationalisation aspects in a cohesive and complete way. We started from existing support materials such as the OpenVM Design Guide [35] and Learner Skills in Mobility [8].

A fourth and final concrete intervention was the creation of appropriate teaching and learning administrative processes to support online mobility activities. KU Leuven has in this way chosen consistent ways to use learning contracts such as in Erasmus mobility and the monitoring of incoming and outgoing students in different forms of online mobility. The design conjecture behind this intervention was to align online mobility with other forms of mobility in the institution, with the aim to increase familiarity for teachers who can see this innovative form of mobility in the same way as other mobilities.

In the ongoing Evaluation and Reflection phase, the created interventions were implemented and tested in real situations through the facilitation of three Blended Intensive Programmes at three different faculties at KU Leuven that were supported or organised. The design of these programmes was initiated in the period of November 2021–June 2022, and this is a sign of the positive uptake of this form of educational innovation by faculties

at the institution. The Faculty of Engineering Technology organised in spring 2022 a BIP on Sustainable Energy in an Internet-of-Things World. The BIP included lectures on state-of-the-art technologies, sharing of methodologies and best practices, discussions between professors, researchers and students and team-based project work. The virtual part was based on self-study prior to the physical week and finalizing the prototype of their output and a group report afterwards.

Two other BIPs at the Faculty of Law and Criminology and the Faculty of Economics and Business are being designed for launch in February and March 2023, respectively. These BIPs are being supported in a workshop series with the use of existing materials. The facilitation is held in a reflective and dialogic manner to identify structural needs and sequences in the design.

Ongoing reflective dialogue has also ensued with the educational support staff at the Educational Development Unit/KU Leuven Learning Lab to discuss how the complex support for online/blended mobility activities can be organised and how to integrate the developed support materials and instruments within the KU Leuven Learning Lab portal.

With this background, we can now attempt to answer the research questions.

In answer to the first research question: "What are the support needs of teachers and educational support staff in the creation and implementation of online mobility activities?", we can state that results of the pilots showed that support for online mobility is quite similar to other support needs for educational innovation such as for online learning, group work and blended learning, but that there is an added complexity of working in an international context. This added complexity is apparent in several practical issues such as the positioning of the BIP in the curriculum, the workload/ECTS credits associated with a BIP and the use of common online platforms within an international teacher and student team.

Teachers need a structured process in the design of online mobility, so that they can foresee the complexity and address it early on in discussions with partners. We have explored several educational design models and are in the process of developing a design support instrument that can deal with this complexity.

In answer to the second research question: "*What can a blueprint of an ideal support programme and instrument look like, within the context of KU Leuven?*", the exploration of the KU Leuven organisational structure gave us insights into (i) where support needs to be positioned, (ii) who offers front-line support and (iii) what the long-term, mid-term and short-term needs are regarding support. This exploration has allowed us to develop a plan for a phased support approach where teaching teams can use and adapt templates of instructional design for virtual mobility and reach out to central support teams for more bespoke support when needed. It has become clear that specific support and good practice will need to be developed on topics of intercultural learning and online assessment among others.

Regarding the research objectives posed, this study has shown that mainstreaming online mobility at a higher education institution requires the involvement of several departments at the university concerned with pedagogical support, internationalisation and student administration. Micro-level support for teachers is also needed to guide them in the design of these innovative educational forms. Simple interventions such as shared terminology and guided support from multiple perspectives have already been very effective in facilitating the uptake of online mobility as an educational innovation.

4. Discussion

Like other institutions, KU Leuven has recognised that virtual and blended mobility can provide authentic international learning experiences and has thereby reinforced its commitment to develop and register online and hybrid formats of international mobility, building on the experiences gained during the pandemic. Below, we discuss the findings on the organisational, pedagogical and policy aspects.

Regarding organisation, adequate monitoring of online mobility will be necessary to follow-up and evaluate the strategic goals of KU Leuven. Student registration is also vital in order to acknowledge the learning objectives the student has acquired. However, despite effective and efficient process flows for online mobility put in place in dialogue with the Teaching and Learning Processes unit that have maximised the registration/reporting of incoming and outgoing online student mobility, not all types of online mobility are currently fully registered. For example, participation in online courses or Blended Intensive Programmes are registered in the administrative systems and are mentioned on the diploma supplement. Other types of online mobility, such as joint innovative formats where online learning activities, developed or organised in collaboration with partner institutions, are integrated into existing courses, have not yet been fully grasped by the administrative systems. This raises questions on when a course can be defined as being an "international course". Is, for example, a course that includes a few online guest lectures from international experts an international mobility experience? Should this be registered as online mobility? How do you make these kinds of activities visible in your educational offer and course catalogue and ultimately in the student's individual educational programme? How can you integrate this in the processes and make an accurate registration of this type of internationalisation possible? Monitoring online mobility through registration in individual student portfolios is an important step in creating interest with the students and faculty for investing time and effort in these kinds of innovative formats.

Adequate monitoring of acquired competences is equally important. Online mobility activities offer unique international learning environments where several skills or competences can be developed. In the OpenVM project, seven learner competence areas that can be (but need not always be) addressed through online mobility were identified. These include intercultural skills, interactive and collaborative learning, autonomy-driven learning, networked learning, media and digital literacy, active self-regulated learning and open-mindedness [8]. Depending on the design of the activity, students will have more or fewer opportunities to develop specific skills. These skills are recognised widely as competences that will help students becoming professionals to better navigate their career in the modern workplace. Students that have engaged in online mobility activities and have acquired such competences must therefore be rewarded for this. During the Design and Construction phase, it was clear that it was important to address these transversal competences explicitly as intended learning outcomes. A clear vision on the learning goals as well as teacher support for designing appropriate learning environments, including the assessment of this kind of experiential learning, will be crucial. More clarity in relation to which competences are developed through online mobility creates more opportunities to create interest with teachers to invest time in developing these new formats in effective ways.

Important to mention here is the fact that in the whole trajectory we have not yet spoken to students. This is an area where further dialogue is recommended.

From a pedagogical perspective, the KU Leuven definition of online mobility is broader than only virtual exchange and collaborative online international learning. Although in the literature [28,29] much emphasis has been placed on the importance of collaborative international learning, KU Leuven includes online exchange courses in their definition even if these courses do not address intercultural or international competence development. In our opinion these courses can have an added value for students and/or teachers. These online exchange courses enable students to customise their individual study programme by following (niche) courses at partner universities that are not offered at the home university, or at times when no courses are offered at the home university. It enables lecturers to attract additional students for niche subjects, or to attract a diverse(er) group of students.

Regarding policy, in this study we tried to balance between implementing top-down decisions and fostering bottom-up initiatives. At the policy level, the strategy can be laid out but, in the end, it will be up to the faculties to take the initiative to set up online mobility activities. In this study we brought together the domains of education and

internationalisation and aligned all processes with the Teaching and Learning Processes unit. This was highly appreciated by all the people involved at KU Leuven.

Within the framework of the OpenU project, intensive support could be offered to faculties on the central level but in the longer term, this support will be translated in processes that are embedded and consolidated into the regular support structures. Responsibility for providing support to teachers and teacher teams will then also be put more with the faculties. To reach this in a sustainable way, it became clear during the dialogues with different departments at KU Leuven that the support offer for online mobility needed to be embedded in the already existing structures and directly linked to the strategic plan. Administrative and organisational support will follow as much as possible the already existing flows from the Teaching and Learning Processes unit and will be adapted where necessary. By explicitly and continuously referring to the strategic goals, commitment to the different units can be guaranteed and collaboration can be enforced. The networked approach also ensures a shared responsibility to work together towards the realisation of these goals.

5. Conclusions

As indicated earlier, at KU Leuven online mobility has grown into a strategically important topic. As a first step, a strategy formulation for online mobility was presented and approved by the university-wide international Policy Council in December 2021 in which the potential of online mobility to become complementary to physical mobility was confirmed. As may be clear, our journey towards the mainstreaming of online mobility at KU Leuven has not reached the final destination. However, some take home messages can be concluded:

1. Put continuous effort into balancing top-down and bottom-up approaches. In this study it appeared necessary to work at both all the time;
2. Bringing together the domain education and internationalisation was a much appreciated action. It smoothed the way for further actions in this project. What was also very important was that mobility as well as teaching and learning processes are taken into account when developing online mobility. Central support units such as an international office or a teaching and learning processes unit can alleviate the work of academics by putting in place clear efficient process flows for, e.g., the enrollment of students for online mobility and the recognition of credits;
3. Registration and the reporting of online mobility are important not only for the benefit of the student to make their efforts to take part in online mobility visible on their diploma supplements and so adding to their employability, but also to be able to monitor online mobility on a policy level and allow data driven policy making;
4. Foster networks, including networks within your organisation, with partners and beyond. Online mobility is a subject you cannot master alone.

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Informed Consent Statement: All participants involved in this study were informed of the Informed consent was obtained from all strategic as well as the exploratory nature of the study, as well as its duration over several months. They gave their verbal consent to participate anonymously in the study.

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education sciences

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Project Report

ENCODE4OpenU and the Preparation and Delivery of an International Collaborative MOOC: A Preliminary Analysis of its Pedagogical and Technical Implementation

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Abstract: Among the potential intellectual outputs of the ENCODE project is the production of a MOOC that introduces teaching staff and scientific experts to the digital transition in the field of ancient writing cultures. The basis for this MOOC is the need to foster awareness of the importance of digital competences and to use a structured framework to introduce people to the available innovative teaching and learning materials and opportunities for organizing (self-)training in this field of research. For specialists in the humanities, there is often an unexpected reluctance to go beyond simply using digital tools and to deepen their understanding of the implications of the digital transitions of research fields, as well as considering the readiness of young graduates to acquire digital competences. This MOOC, which is easily accessible, affordable, sustainable, and flexible, may achieve the initial aim of the project, namely, bridging the gap between the highly specialized competences in the humanities and the innovative digital skills needed in open science practices. The main methodological issue concerns the design and adaptation of cooperative tools in order to implement a common pedagogical approach and to produce MOOC content that integrates the different competences and insights of the project participants. This report on the experiment provides useful insights into the differing expectations of academic staff as content producers, issues surrounding MOOC-cooperative design between universities in different countries, the usability of the tested platform and of the different features provided, and sustainability, as guaranteed through the connection with digital infrastructures. In the concluding section, the originality of the MOOC at a more general scale is emphasized. The ways in which the MOOC can facilitate and support the digital transition are assessed according to the FAIR principles in Higher Education Institutions. Moreover, the MOOC offers models for hands-on experiences of digital training and the evaluation of learning outcomes according to shared European frameworks; it demonstrates the importance of being connected with larger projects and digital infrastructures.

Keywords: MOOC; digital competences; ancient written documents; digital epigraphy; digital papyrology

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1. Introduction

The present research takes place within the context of the Erasmus+ Strategic Partnership project, ENCODE. It addresses digital transformations in the cultural-heritage sector and within the OpenU project, which fosters cooperation, innovation, and sustainability in European higher education by creating a digital infrastructure for higher education policy experimentation through blended learning, mobility, and networking.

This paper is concerned with a specialized field of study in the humanities, as will be explained below. However, the approach to the present analysis, as well as the challenges we faced when developing our specific methodologies, may be of more general interest, especially in relation to the following issues:

(1) The project identified and described learning outcomes related to the new digital competences that are required to transition to open science, namely, the active participation of scholars in specific fields of the humanities in international digital infrastructures and in producing and sharing FAIR open data. We approached this issue by combining and adapting to the specific needs of two different competence and assessment frameworks, such as the CALOHEE assessment framework for history and the DigComp 2.1 and 2.2 Frameworks for digital competences. We suggest that this approach is also applicable to other subject areas.
(2) This research addressed the matter of how to design a MOOC for academics, teaching staff, and experts. The main issues addressed in the research include the transnational design of the tool for this specific target group and the choice of the relevant to other subject areas on a larger scale. More specifically, this paper considers the tensions that arise when integrating MOOCs into specific strategies of Higher Education Institutions or Networks of Institutions, such as UNA-EUROPA; we also consider the opportunities offered by International Digital Infrastructures. These opportunities include clustering scientific communities and fostering collaboration not only in the specific research area but also in training that is geared towards open science practices within the specialized communities and their interdisciplinary networks.

Specialized disciplines in the humanities that deal with ancient written artefacts, such as papyrology, epigraphy, and paleography, have embraced digital change by developing tools for new forms of participatory research and collaborative publishing. These innovations require new competences and training for graduate students and researchers in the rapidly evolving field of Digital Humanities and AI. Such training is necessary to prepare new professionals to contribute to preserving and giving access to the intercultural heritage of ancient texts in multiple ancient languages and writing systems.

ENCODE is a three-year (1 September 2020–31 August 2023) Erasmus+ KA2 strategic partnership for higher education. It is funded by the EU and aims to bridge the existing gap in the teaching/learning domain of ancient writing cultures between highly specific humanistic training and the digital competences now required for study, research, and employment. It brings together six partners: Alma Mater Studiorum Università di Bologna, Julius Maximilian Universität Würzburg, KU Leuven, Università degli studi di Parma, Universität Hamburg, and Universitetet I Oslo. Three objectives, which consider societal, educational, and institutional needs, were established for the project:

- To promote collaborative, participatory, and intercultural digital approaches to ancient written heritage through new professional profiles and the focused training of skilled graduates;
- To meet the learning needs of graduates who apply highly specialized digital skills to the study of ancient writing media in old European, Asian, and African languages, through innovative teaching modules;
- To strengthen the crucial cooperative connections between higher education and cultural heritage institutions, with the latter supplying materials for teaching and self-training to academics and providing stakeholders with support services.

The project foresees the teaching modules being implemented through seven transnational events. First, open international workshops and intensive training events for members of the project will be organized. These will train up to 80 international graduate students and academics and up to 51 graduate students and academics from university partners. In addition, international multiplier events, connected to the aforementioned workshops and supported by a concerted dissemination effort, will involve up to 210 international graduate students, researchers, and stakeholders/employers. By the end of the project, the modules will be available online to be used, implemented, and customized according to different European contexts and teaching/learning needs. From a methodological point of view, these modules will achieve the following:

- Be based on an internationally shared definition of learning outcomes, taking into account the relevant European frameworks;
- Use innovative pedagogies, enabling mutual learning among trainees and teachers, lifelong learning for both (being designed as trainee-centered modules), and research-based learning (being conceived as modules that foster problem-based learning, creative planning, and hands-on work, which replicates the forms of knowledge creation and dissemination used in professional contexts);
- Enable modular integration into courses according to training needs and contexts, and be amenable to future development and implementation according to the evolution of technologies and training practices;
- Foster the inclusion of the training sets inside the university study curricula, increasing appeal through ICT-enriched learning and real-world applications.

ENCODE foresees six intellectual outputs. The MOOC/Introduction to the teaching staff (including both academic staff and experts in cultural heritage institutions) is thus connected with five other outputs: a survey on digital competences; learning outcomes and best practices in teaching and learning; a description of and resources for teaching modules at a basic level, and at an advanced level; guidelines for teaching academic staff; and a platform for the alumni community and stakeholders/employers, which will be connected with the GoTriple infrastructure. The strongly interconnected nature of the project outputs has the aim of producing a coherent package, which is based on a shared definition of the required digital competences of graduate students in programs focusing on written cultural heritage. This provides a foundation for transnational training activities and constitutes the basis both for the implementation of a specific platform for employers and employable graduates and for improving cooperation between higher education institutions and stakeholders. The design and testing of innovative and customizable teaching modules (basic and advanced), which improves participatory and intercultural approaches to heritage, as well as educational initiatives aimed at fostering intercultural dialogue, are accompanied by a full guide to the teaching modules, including the MOOC; these materials convey the importance of innovative digital training and digital applications in the academic and professional environments. For literature that focuses on teaching and learning practices in the field of digital competences applied to ancient written cultures, see [1–4].

The production of a MOOC within the ENCODE Project should therefore introduce teaching staff and scientific experts in the field of ancient written cultural heritage (papyri, inscriptions, manuscripts, and other objects from different cultural contexts that contain writing in different languages and scripts) to the digital transition and new open science practices. As a consequence, the MOOC is designed as a strategic tool within the more general context of the ENCODE project, which is aimed at enhancing digital competences in the aforementioned specific scientific areas and interdisciplinary fields. In particular, it should encourage informal self-training and participation in structured training as part of a process of life-long learning through a set of training modules and examples collected through the same project.

We note that in academia in general, and in our specific field, which is concerned with the study of ancient written objects, there is often an unexpected reluctance among teachers to engage fully in the incorporation of digital tools and methods into different domains of study; moreover, awareness of the developments and practices of open science is still lacking. At the same time, young graduates are willing to acquire digital competences in their research fields. Having noted that the platforms for MOOC delivery that are currently available in universities are too rigid for the expectations of a cooperative endeavor targeted at teachers, experts, and academic staff, we felt the need to open up to an international and interdisciplinary audience the useful tools that have been produced in an international context and specifically designed for collaborative implementation. For these reasons, the ENCODE MOOC needs to be a tool that is easily accessible, affordable, sustainable, and flexible. Moreover, since the MOOC is a product of transnational cooperation between different universities, the platform should accommodate different pedagogical approaches

and communication strategies. This experiment analyzed the challenges that can be encountered during the preparation of an international collaborative MOOC, specifically in relation to the platform used to deliver such pedagogical formats.

The design of a cooperative MOOC by a group of scholars from different universities required as a first step the choice of a MOOC model from among the many different formats that have been developed in the last 20 years. The four key characteristics of MOOCs are as follows: (1) their massive scale, (2) the open and free involvement of participants, (3) their online dimension and digital nature, and (4) they have the structure of a 'course', namely, a learning path with specific learning outcomes and assessments. Considering these characteristics, we decided that, in our context, we should consider the training needs of the specific target group to whom we plan to offer the MOOC. This means that the MOOC model, spread by the courses offered through special platforms such as Coursera, Udacity, and edX, in which the core teaching is delivered through online recorded lectures combined with computer testing, would not be the most appropriate for our research. Regarding the main elements of a MOOC explained above (massive, online, open, course), the focus group discussion helped us to understand that, in our case, 'massive' would not mean reaching out to a potentially huge number of participants, but rather a vast targeted audience; meanwhile, for the 'open' and 'online' dimensions, we decided to put a strong emphasis on a deeper awareness of open science practices in the wider sense, namely, introducing FAIR principles both into the content and into the design of the object. Finally, although we plan multiple entry points to our material, we contend that organizing our materials into a 'course' is extremely important and offers an example of pedagogical design, even considering the fact that our target audience will use the course material in very different and flexible ways, through multiple entry points and combinations. For this reason, when organizing the learning material and choosing a platform, we made decisions that would allow us to go beyond the classical models of MOOCs and move towards other models that emphasize a stronger openness in terms of content, activities, and ways to use the teaching material. As such, we can focus on the autonomy of the learner, in terms of learners choosing what content or skills they wish to acquire, and on diversity, imagining participants with different knowledge levels and different interests. Our MOOC, however, will not be able to offer the interactivity that is needed in terms of cooperative learning, nor will it offer communication between participants within the MOOC framework itself. However, in order to achieve our aims of allowing new knowledge to emerge and be shared, we take advantage of the ENCODE community and activity on the GoTriple Platform, as well as that of other practice-based communities in the field, such as the EpiDoc community, and the opportunities of training that are constantly being organized. On the characteristics and pedagogy of MOOCs, see [5–7].

The starting point for the development of the course structure and content is based on the programs and content of the ENCODE Multiplier and Training events, which also represent the main fields of expertise of the partner universities. In this way, we attempted to cover as comprehensively as possible the topic of the use of digital technologies for the study and research of ancient writing cultures. For this reason, the MOOC is divided into four units: "Digital Greek and Latin Epigraphy" (coordinator: the University of Bologna), "Linked Open Data for written artefacts" (coordinator: the University of Hamburg until 02/2022, and the University of Leuven), "Multilingual-Multicultural Digital Infrastructures" (coordinator: the University of Leuven and the University of Oslo), and "Crowdsourcing and Greek and Latin Papyri" (coordinator: the University of Würzburg and the University of Parma). To our knowledge, there are no extant MOOCs that focus on a similar subject: one experiment that focuses on the digital encoding of texts transmitted by the manuscript tradition is the MOOC created by Marjorie Burghart and Elena Pierazzo, titled "Digital Scholarly Editions: Manuscripts, Texts and TEI Encoding", which is hosted by the #dariahTeach platform; our MOOC aims to relate to this other course, but with a different approach. On #dariahTeach as a platform for open educational resources that are engaged in the promotion of MOOCs, see [8].

This research is important because there are currently no tools that present the different applications of digital technologies to the study and research of ancient writing cultures to a non-expert (but potentially interested) audience. On the other hand, this MOOC, conceived as an accessible and stimulating tool, aims to win over the scholars who are reluctant to engage with the digital aspects of the study fields in which they are involved and to raise awareness of the importance of standards and linked open data for scientific cooperation in international digital infrastructures. Indeed, the addressees are primarily teachers and experts who want to understand more about and introduce innovative teaching and training methodologies, digital resources, and tools in their traditional teaching or actively participate in digital infrastructures. From an educational point of view, this MOOC is part of an effort to integrate digital tools into the traditional teaching of disciplines linked to ancient cultural heritage, focusing on digital approaches to problems and project-based learning, as well as on the personalization of flexible learning paths. At the same time, the medium through which the contents are delivered both allows the users to become familiar with digital tools and also helps designers to realize some of the MOOC's features, such as its ability to reach a vast targeted audience, its openness and its learner-centered activities.

2. Materials and Methods

Undertaking this research in the context of the OpenU project provided us with the opportunity to deepen our understanding of the cooperative dimensions of our endeavor. Additionally, it allowed us to explore the specific implications of building a MOOC that will be offered transnationally with the following aims: (1) to improve the digital skills of the target group (teachers, experts, and academic staff); (2) to create a more general awareness of the digital transition and of open science practices, and to facilitate appreciation of its implications for research and innovation in teaching and learning; (3) to describe challenges and best practices in designing digital training resources for students in terms of learning outcomes and effective pedagogies; (4) to offer structured access to training and self-training materials; (5) to offer opportunities for participants to join active practice-based communities in the field of digital humanities within and beyond the specific areas of study. The objective of this specific segment of our research was twofold: first, there was the challenge of defining the specific learning needs and, more specifically, the learning outcomes for the MOOC through shared frameworks, which could transcend the specific educational contexts of each institution and promote the transnational dimension. The second challenge, which is connected to the first, is that we wanted to design and deliver the MOOC through a platform that has the ability to emphasize and demonstrate, within the learning experience, the features of working within a digital infrastructure, and to address implications in the design of training related to the digital transition.

Two of the main outputs of the ENCODE project are definitions of (1) the learning outcomes and (2) the digital competences required by scholars in disciplines related to ancient written cultures, both of which served as key building blocks for the development of the MOOC. On this, see [9]. In order to identify these learning outcomes and competences, questionnaires were administered to teachers and students involved in the workshops and training events of the ENCODE project. Survey participants were asked to describe and evaluate their transnational training experiences with digital competences applied to ancient written cultures, both within the ENCODE project and beyond. Moreover, they were asked to share and discuss the best teaching and learning practices. The sample comprised 142 participants: 36 teachers and 106 students. The detailed survey results are presented in a report on 'Digital Competences, Learning Outcomes and Best Practices in Teaching' [10] and a report on 'Learning and Hands-on Workshops' [11], both also available through the ENCODE project's website.

The survey results formed the basis for the development of a framework of digital competences that distinguishes four levels of proficiency (basic, intermediate, focused, and advanced). Such a framework for digital competences applied to ancient written cultural heritage disciplines was lacking. However, to be able to advance and improve

education and training in this domain, a framework is highly needed, both for students and teachers. In addition to the survey results, two international reference frameworks, CALOHEE [12] (for humanistic competences) and DigComp 2.1 [13], updated recently to v. 2.2 [14] (for digital competences), were used as input and inspiration for the development of the framework of digital competences, particularly for the field of ancient written culture disciplines.

The definition and identification of learning outcomes and digital competences added value to the Multiplier Events and training activities organized within the context of the ENCODE project. Moreover, the learning outcomes and competences were used as the basis for the development of the unit and chapter structures of the MOOC. By identifying teaching and training needs, the specific topics of the MOOC were selected, and decisions were made regarding their place in the unit and chapter flow. In the MOOC structure, the learning outcomes are clarified at the beginning of each of the individual units. A self-assessment test at the end assesses the achievement of the learning outcomes, but it also gives further feedback on the digital competences that may be further fostered. The incorporation of a form of evaluation is useful in stimulating users to reflect on the digital (re)sources addressed in the course and invites them to explore different digital tools in the domain of ancient written texts, following the flexible structure of the SunoikisisDC teaching program. On the design of MOOCs based on the definition of learning outcomes, see [15].

This structure classification by learning outcomes and competences is also at the basis of the teaching modules included in the ENCODE Database, to which the individual chapters of the MOOC refer and through which, alongside other external resources, users can deepen their knowledge of the individual topics. In this sense, the MOOC is, in fact, not only a course for acquiring digital competences, but it represents an ideal pathway through which users can become aware of opportunities for digital training in the field of ancient written cultures. It offers them a structured introduction to the available training and self-training materials, which can be used both for improving the user's own competences and to design and deliver training courses for students. As far as the digital platform is concerned, the team explored several possibilities before selecting the preferred platform.

The first platforms we explored were the ones offered by the University of Bologna and the University of Leuven. Both universities offer the opportunity to develop MOOC courses; however, they are conceived primarily as synchronous courses with some opportunity for social interaction among the participants and/or instructors. This implies that every MOOC has to be delivered at fixed times; participation can be free and the participants who complete the course obtain a final badge/certificate. However, even if there is the possibility of navigating parts of the MOOC units (predominantly those that comprise videos from YouTube) beyond the fixed periods of delivery, the educational context would be missing. Another issue that discouraged us from using one of these platforms concerns the fixed framework for planning and implementing the course and videos; this limitation made it difficult to design the course in conjunction with the responsibility being distributed among the international partners. To broaden our scope, we explored the platform of the EC in which all Erasmus+ projects upload information about project goals, strategies, and results.

From this exploration, we identified some interesting experiences and selected one as a noteworthy example: a project called "YouTrain", aimed at producing video tutorials for instructors engaging in non-formal education. This project was instructive on three different levels:

- First, it produced a MOOC, which is extremely simple: it is a web page structured in seven sections/steps. Each step includes a short text introduction and one or more videos. That model—even if it appears overly basic—responds to one of the main needs we identified: the motivation of our colleagues and staff, who are using the MOOC on a voluntary basis, and who may only use single parts and skip others as they do not want to be forced to learn within a rigid structure;
- The second interesting aspect of the project is the content. The MOOC produced by the project "YouTrain" deals with issues related to non-formal education, so it gave us

good ideas for the units that deal with pedagogy, especially since the modules we will be promoting are targeted not only to staff members operating in formal educational contexts but also towards (self-)training by graduates and specialists. Some videos offer excellent examples of this approach as they are short and simple but, at the same time, informative and stimulating, and include high-quality info-graphics;
- Third, it offers some tutorials which can be useful in designing a MOOC for non-formal education.

The need for an open environment that enables a more distributed approach to the design and implementation of the MOOC led us to explore options offered by free platforms. Google Education, for instance, provides a good guide and open technology for MOOCs and online courses with great flexibility. Another option that we explored was the platform of #dariahTeach, developed within the Digital Research Infrastructure for the Arts and Humanities (DARIAH) initiative, which is an important Digital Research Infrastructure established as a European Research Infrastructure Consortium (ERIC) in August 2014. This special project offers a platform for open educational resources (OER) for Digital Arts and Humanities educators and students, with a specific focus on the digital transformation of program content and learning methods. The #dariahTeach objectives and design are strongly in line with our goals since they are aimed at innovating learning and teaching materials related to the digital transition in the humanities through flexible models of publishing and accessing courses. For the MOOC design, see [16].

3. Results

The research allowed us to find sustainable solutions for the design and delivery of a MOOC targeted to a diverse audience of teachers and professionals in the field of written cultural heritage. This MOOC will be aimed at motivating participants to improve their understanding and awareness of the implications of the digital transition in their field in relation both to research and to teaching.

3.1. Design

We realized that the design of a transnational educational resource related to important transformations which affect the disciplinary field needs to connect to and can benefit from developments carried out by larger communities. Our specific project was informed by three processes that affect the larger field of the humanities, the field of digital competences in general and the Digital Humanities as a specific disciplinary field. We had the opportunity to embed the innovations carried out by larger projects and to incorporate them into the actual teaching and learning design and practice of our MOOC.

First, we based our understanding and definition of competences and learning outcomes on the methodology developed by the Tuning Academy within the CALOHEE project. Our conceptual model relates to the competence framework developed for the Humanities (history subject area), especially for sub-dimension 2, which is related to "texts and contexts"; this appeared particularly valuable for the area of written cultural heritage. At the same time, however, we were faced with the specialized disciplines in the humanities that deal with ancient written artefacts, such as papyrology, epigraphy, and paleography, which have embraced digital change and recognized the need to develop tools for new forms of participatory research and collaborative publishing. These innovations require new competences and training both for graduate students and for researchers in the rapidly evolving field of Digital Humanities and AI. These competences are essential in preparing new professionals to contribute to preserving and giving access to the intercultural heritage of ancient texts written in multiple ancient languages and using different writing systems.

For this reason, we implemented a second framework: the Digital Competence Framework for Citizens (DigComp). This framework addresses digital transformation and was developed with the aim of defining what digital competence is. It, therefore, provides a shared basis for educational innovation, taking into account the labor market and societal changes. DigComp, as the EU-wide framework for developing and measuring digital

competences in March 2022, has been published in its 2.2 version, which takes into account developments in the field of AI as well. When designing the learning outcomes of our training activities (which were also connected to the MOOC), we faced the challenge of combining in our approach both the methodologies developed by Tuning and CALOHEE, which has an explicit focus on the formal context of higher education and DigComp 2.2, which is considered a wider reference framework for citizens' competences. Notwithstanding this important and foundational difference, it was possible to work with the two frameworks since both share common features, such as being articulated in 'dimensions' according to competence area. While CALOHEE formulates reference learning outcomes relative to levels 6 and 7 of the Higher Education Qualification Framework (integrating both the descriptors of EQF and the QF-EHEA), the DigComp conceptual model was used to develop a matrix of five dimensions (information and data literacy; communication and collaboration; digital content creation; safety; problem-solving) with four progressive overall levels (foundation, intermediate, advanced, and highly specialized), articulated in eight granular levels. This matrix is independent of qualifications, and levels are built on three main areas of mastery: (1) complexity of tasks, (2) autonomy, and (3) cognitive domain (remembering, understanding, applying, evaluating, and creating).

Third, through the surveys offered to participants at the end of the teaching activities, which were analyzed in a dedicated report (see above), we could see that the way we combined the two frameworks in order to formulate the learning outcomes and competences in our training activities helped the learners to focus on these competences in the disciplinary field of the humanities. In fact, they achieved mastery before the training activity, and at the same time understood how the digital training improved their knowledge, awareness, and skills within their specific field of study, and not just as a separate competence. Building on this result, we designed our MOOC by sharing this experience with future trainers and offering them a methodology to work with different competence frameworks; in addition, we offer a specific introduction to digital content and the basic knowledge and skills that will enable participants to develop from being users of digital content to creators of digital transformation when planning their own self-training or training activities for their students.

3.2. Delivery

The analysis of the different MOOC models and platforms and the choice of the #dariahTeach platform further confirmed the advantages of connecting to wider initiatives and exploiting the results and outputs of other Erasmus+ projects. In our specific case, the added value of working within #dariahTeach is not limited to the easy sharing of a dedicated platform but primarily concerns the ability to connect to a community engaged with the different facets of the digital transition in the humanities, especially with the much-needed training in open science practices, production, and the dissemination of FAIR research data. Lastly, the #dariahTeach platform offers the necessary flexibility both to the contributors and to the participants in the course, allowing for the development of a flexible and personalized course (with some basic tools to evaluate the learning process). These well-structured courses are divided into units, with further subdivision into lessons and pages (equivalent to book chapters, sections, and pages). This design allows instructors to utilize the entire course or to select only those units and sections that are relevant to their own course objectives and learning goals. To this extent, the choice of the #dariahTeach platform is strategic (especially with regards to the sustainability of the infrastructure) and it is combined with the use of the GoTriple platform and its add-on for hosting activities of the community of participants (trainers and trainees) of the ENCODE workshops and training events, and of the MOOC.

4. Discussion

The development of a MOOC of this kind, which was intended as an open, free, and stimulating tool that allows users to understand the importance of acquiring digital

competences in the field of ancient writing cultures, fills a gap in the field. Few European universities offer curricular courses on this topic, and opportunities to learn digital skills in the study of epigraphy, papyrology, and other related disciplines are limited to occasional workshops and training activities. These activities, moreover, mainly attract students and scholars who are already (somewhat) familiar with the tools presented or are already interested in acquiring such competences. On the other hand, in the context of such workshops and training activities, communities of scholars linked to digital infrastructures and projects often produce freely reusable and continuously updated materials. The goal of this MOOC is, therefore, twofold. First, it aims to capture the attention of users unfamiliar with these topics and to encourage them to go digital. Second, it aims to collect the available online resources in such a way that users can independently undertake an initial self-education and/or reuse them in teaching. ENCODE thus offers a systematization of the various materials produced by consortia, such as the aforementioned SunoikisisDC, and communities, such as EpiDoc, for the digital encoding of ancient sources; moreover, it integrates these materials with those produced by the project's own intensive training activities, in such a way that they can also be reused in future workshops or incorporated into traditional teaching. This is also possible thanks to the connection of the MOOC with a network created by the ENCODE project, which ensures constant and dynamic contact among different actors, such as employers, institutions concerned with digital curation, professionals active in museums and libraries, alumni, prospective students who want to start their studies in the area of ancient history, and academics working in languages and cultures who design curricula and training modules. The future network will rely on the European infrastructure GoTriple and on the connected social network Trust Building System; for further details, see [17]. In the meantime, ENCODE will gradually gather a community through its mailing list, which is used to disseminate information on upcoming events and professional positions.

5. Conclusions

This effort to produce a cooperative MOOC targeted at potential trainers (teachers, academic staff, and staff at cultural heritage institutions) generated the following insights on policy issues, which may be useful if shared within the wider community of Higher Education Institutions (HEI):

1. Within specific disciplinary fields (in our case, disciplines concerned with ancient written cultural heritage), an increasingly rapid digital transition is underway; this transition is connected with a wider awareness of the need to implement open science practices. Researchers (in our field as in many others) are urged to produce, manage, and share FAIR data, coordinate efforts within digital infrastructures in order to integrate research data and publications and connect with other researchers and projects to build a critical mass of searchable data across disciplinary fields. Academics and teachers, as well as researchers working in cultural heritage institutions, are not always adequately prepared to keep their knowledge up-to-date and to transfer these research competences into their daily teaching or training activities. Our research builds on the assumption that it is necessary to support teachers and academics by providing simple, easily accessible, and reusable teaching and learning materials, information about past training events (to consider as possible models), and future training events in which they can participate. The present effort, however, responds to the fundamental need to encourage academic staff to innovate in teaching and learning. Through focus groups among participants at the training workshops, we learned that international practice-based communities within fields of scientific research are the resource academics and researchers will most likely look to for support; it is, therefore, important to keep this link and to build motivation by offering training (in our case, a MOOC) which uses the infrastructures, platforms, and tools that are more directly connected with the scientific area. Through this MOOC, participants will be introduced to developments in the field and models and materials for in-

novative training formats and practices. This may, however, be challenging for the institutions that intend to develop and structure policies, infrastructures, and facilities for improving the digital transition in education and support opportunities for the professional development of staff, either at the level of a single HEI or at the level of a network of institutions. Our recommendation is that HEI institutions should develop policies that account for the different strategies and opportunities for professional development that are designed and implemented in scientific fields. New institutional infrastructures and facilities should be as flexible as possible to interoperate and communicate with a multiplicity of initiatives developed within the different disciplines or within interdisciplinary research communities since the wide movement towards open science have now reached a consensus on many common standards; this can be observed in the European Open Science Cloud Portal and Marketplace.

2. From our experience, one of the most promising training models that might be used to bridge the gap between highly specialized humanistic competences and the digital skills needed to participate in international digital infrastructures are short intensive training activities in which trainees can practice hands-on digital encoding and review their work within the training group.
   Our experience with short intensive training (either in person, online, or blended) has shown that the most effective and motivating approaches include international groups and a research setting that can produce results to be published and shared on digital infrastructures; this is also confirmed by literature on the format of training activities related to digital competences in the field of ancient writing cultures [18]. These formats might benefit from further developments within the Erasmus+ Blended Intensive Programs scheme, where groups of students or staff undertake a short-term placement abroad, as well as participating in a compulsory virtual component that facilitates collaborative online learning exchanges and teamwork; such formats could play a role in the development of HEI policies for blended learning (see [19]). In this regard, we again suggest that there should be a strong effort to connect with the open science initiatives that are developing within international digital infrastructures.

3. We note that, when designing training activities in an international setting, it is helpful to refer to common reference points that can help to overcome the barriers created by local and national contexts. Within the ENCODE project, as illustrated in this article, we have experimented with ways to design learning outcomes for short intensive training and to deliver micro-credentials that can fit into shared European frameworks, namely, CALOHEE and DigComp 2.2. This experience is incorporated into the MOOC in order to offer a tool to teachers who are facilitating the design of trainee-centered modules, which can be shared in an international environment.

4. Training for the digital transition within disciplines is best organized at an international level in order to take advantage of project-based work within international digital infrastructures. Connections with larger projects and infrastructures enable us to constantly update training needs and training resources according to the evolution of technologies and practices. In this context, we should also note that this approach allows for the design of research-based learning, fostering problem-based learning, creative planning, and hands-on work that replicates the forms of knowledge creation and dissemination seen in professional contexts. The reciprocal learning among trainees and teachers in the same research training environment is also beneficial and relies on an recognition of the efficacy of cascade training dynamics: the digital training of graduates fosters the subsequent implementation of teachers' awareness, digital self-training, and engagement. On the cascade effect in self-education and project-based learning, see [20].

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Article

Exploratory Study on the Blended Learning of Research and Language Skills in EFL and Interinstitutional Assessment

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Abstract: Blended learning is receiving more and more attention due to social changes, technological advances, and the increasing internationality of studies, and research needs to be carried out to explore the possibilities this instruction modality offers to university students. This project aimed to test the feasibility and success of a blended course on research and EFL skills and to determine whether there is an internationally shared criterion when assessing students' scientific work. To do so, a short module on research skills was designed and implemented with 30 students from the BSc in Optics and Optometry from the Complutense University of Madrid, whose final project, the production of a scientific poster, was assessed by three instructors from different universities. The results show that the content and modality of the teaching were successful in the increase in students' research and language skills. The assessment of the posters showed heterogeneous evaluations regarding the quality of their visual features and their contents. Therefore, more research is needed on international perspectives about the presentation of results in the academic and scientific genre to pursue the creation and dissemination of homogeneous criteria, and therefore improve students' performance with an international value.

Keywords: blended learning; course design; EFL; interinstitutional assessment; research skills; scientific posters

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1. Introduction

Over the past years, blended learning has emerged as a popular alternative to progress effectively in the transition from a traditional learning model to a model that integrates electronic environments and resources [1]. The meaning of the term "blended learning" has, however, been used ambiguously. As Ref. [2] points out, there are two definitions which are the most common definitions that can be found in the literature. On the one hand, Ref. [3] (p. 5) indicates that blended learning is based on the combination of "face-to-face instruction with computer-mediated instruction". On the other hand, Ref. [4] (p. 96) is more specific and indicates that blended learning combines "face-to-face learning experiences with online learning experiences". Therefore, it can be concluded that for learning and teaching to be commonly considered blended, it must include face-to-face and online instruction. However, there are different ways to implement and combine face-to-face and online instruction. For example, teaching and learning may occur in real time either having students both online and on-site during the same session—with online students attending from a classroom in a different campus or connected individually through a videoconference with their own devices—or having fully on-site sessions alternated with completely remote sessions [5–7].

Additionally, some other parameters have also been considered in the definitions of blended learning, apart from students' location and the use of technology. For example,

the use of different groupings (individual vs. group work) and mode (synchronous vs. asynchronous work and activities) may also play a role in blended learning [8]. Therefore, blended learning may actually involve the combination of options regarding space (students and instructor's location, this being either on-site or online), time (synchronous meetings and activities or asynchronous work and materials), and the degree of cooperation among students (individual and group work).

Previous work on blended learning usually combines some but not all of the options for those parameters. For example, studies may deal with online asynchronous instruction but not online synchronous instruction [9–12], they may analyse online instruction but not on-site instruction [13–15], or they may focus on individual on-site and online work but not on group on-site and online work [16,17]. Therefore, studies testing the implementation of courses combining all options are still scarce.

Blended learning has received special attention in the higher education context [18,19]. Due to its specific features, presented above, it is a very suitable methodology for courses that aim to have national and international students. By attending online, students can easily take courses that are taught at international universities without leaving their local institutions. This way, students can integrate a course from an international university as part of their ordinary instruction. As a result, degrees can be designed with a more international view, combining courses from different universities.

However, some issues may arise that deter students from doing so. For example, students may have pedagogical adjustment difficulties due to teaching methods and styles, or they may think that expectations from international universities may be different from those they are accustomed to Refs. [20–23]. They may also avoid participating in class due to a lack of confidence in their competency in the foreign language used [24,25]. There may also be curricular concerns related to a cultural bias in curricula [26] and assessment procedures may not be equally adequate for some international students' learning styles [23].

Conducting research and research skills cannot be separated from university instruction. These skills are not only necessary for academic life, but they are also important for students' professional life after their university period [27–29]. Research skills have already been seen as a cross-disciplinary subject and introduced into the curriculum [30]. However, in order to promote students' internationalisation and their success beyond their home university, it is important to provide students with common, internationally validated knowledge on how to conduct research and communicate their research results, but progress on this issue still needs to be made.

Thus, research skills and foreign language (English) skills are ideal content to implement blended learning since they are key skills for university students to develop. The teaching of these skills makes it possible to virtually target any student at any university and, consequently, a blended course on how to conduct research and communicate research results in English may thus exploit the possibilities that blended instruction offers, as well as make it accessible to international students.

More specifically, such a blended course could include a theoretical part and a more practical part where students put the new concepts into practice while working in a foreign language. This can be carried out by asking students to conduct research and present their results in a scientific poster, since the design and creation of this type of poster has already been shown to have several benefits for students, including the improvement of effective communication [31], content understanding [32], and literacy and writing skills [33].

1.1. Objectives

For the reasons presented above, the aim of the exploratory study presented in this paper was to test the feasibility and success of a blended course on research and EFL skills that might be implemented with students from different universities at the same time and receive an internationally valid assessment. To do so, some more specific aims were

designed: firstly, to design and create a short module addressing the specific skills to be developed; secondly, to test the implementation of such a module, including synchronous and asynchronous, group and individual, and online and on-site work; thirdly, to test whether taking the module may have a positive influence on students' perspectives on internationalisation and their confidence on their research and foreign language skills; and fourthly, to determine whether there are internationally shared criteria when assessing students' scientific work. Thus, the study addresses blended learning from a comprehensive point of view, and it contributes to the teaching of research skills and the international understanding of these skills.

1.2. Research Questions

The present study tries to answer the following research questions regarding the design and implementation stages of the short module:

- Can a discussion group with instructors from international universities be used to design a module avoiding in-house perspectives? If so, what issues may arise in the design of the module and the implementation of the group?
- Can blended learning courses combine synchronous and asynchronous, group and individual, and online and on-site work? If so, what issues may arise in their implementation?

With respect to the outcomes and success of the module concerning its contents, two questions are posed:

- What perspectives do students have about internationalisation? Can this view be changed by taking a short module with internationalisation aims?
- Are research and foreign language skills important to students at university? If so, can these skills be improved by taking a short module?

Finally, shared instructors' views on students' performance are also a key issue in the success of a module that comprises national and international students. In relation to this, one research question is asked:

- Do instructors share common criteria internationally when assessing students' work in a common field of higher education, such as conducting research and presenting their results?

Answering these questions through this exploratory study will highlight some specific current needs that instruction may deal with when trying to be opened to international students. Additionally, the description of the design and implementation of the module can be used as an orientation for future similar educational content and practices.

2. Materials and Methods

This section presents the participants, materials, and procedure followed to carry out the study. It must be noted that the participation in this project was limited, both in the number of students and instructors, due to its exploratory nature.

2.1. Participants

The participants included students and instructors. With respect to the former, 30 students from the Complutense University of Madrid participated in the study. They were all students from the BSc in Optics and Optometry who were taking the optional course in *English applied to Optics and Optometry* and, although most of them were 19 years old, and thus in their 2nd year, there were also some students in their 3rd and 4th years. Their English level was around B2, as checked in an entry test taken on the first day of the course.

Regarding instructors, a total of five took part in the study, all of them having research experience and fluent in English. These five instructors include the two authors of

this paper, together with an instructor from Paris 1 Panthéon-Sorbonne University, the University of Rennes 1, and the University of Trento.

2.2. Resources

Since instruction and collaboration were done either on-site or online, the key resources and materials used in the study include a classroom, online communication tools, questionnaires, and a Learning Management System (LMS).

The classroom was equipped with the following items: a digital board connected to a computer, whose screen could be shared through a videoconference session; a microphone, so that students attending online could hear the instructor; speakers, to hear online students' oral contributions; a camera, for online students to see the room, their classmates, and the board; and chairs and hexagonal tables, which were better suited for collaborative work. Since students attending on-site needed an electronic device (either their smartphones, a laptop, or a tablet) to work with students attending online, they were asked to bring their own devices. However, the classroom was also equipped with some tablets at the groups' disposal in case any members of the group had not brought one. Additionally, on-site students were recommended to bring their own headphones with microphones to be able to communicate with their online group members more conveniently.

Online communication tools (Google Meet, Google Drive) were used to enable collaboration among instructors from the different universities involved. Microsoft Teams was used for online sessions with students.

Some questionnaires were designed with Google Forms and used to collect data. First, feedback about the initial design of materials for the short module was obtained through the questionnaire in Appendix A. Posteriorly, students filled in a total of four questionnaires. These questionnaires included a pre-test and a post-test on internationalisation views (Appendices B and C, respectively), and a pre-test and a post-test on research and language skills (Appendices D and E). The pre-tests were taken at the beginning of the first session and the post-tests were taken at the end of the second session. Finally, instructors assessed students' work with a rubric designed in the form of a questionnaire addressing several aspects of the scientific posters (Appendix F), including layout, visual appearance, graphics, content, and English (the foreign language used). Instructors filled in this questionnaire in July 2022.

2.3. Procedure

The experimentation was divided into two phases. The first phase consisted of the planning, design, and creation of a short module in English targeted at university students on what research is and how to present research results through a scientific poster. It had the specific purpose of dealing with any issues involved in the design of a blended activity that involves instructors and students from different universities.

The second phase consisted of the implementation of the educational content created in the first phase and involved the teaching of the contents, the design of a scientific poster in English by students and the assessment of students' work by instructors from different universities. It had the specific purpose of testing the materials previously created and comparing international criteria regarding students' work.

In the first phase, the authors of this paper planned and prepared the contents and materials for the short module to be posteriorly implemented. A discussion group was formed together with the instructor from Paris 1 Panthéon-Sorbonne University; the materials were agreed on, revised, and corrected to promote and guarantee an international view on the topics dealt with and avoid in-house preferences.

In the second phase, the authors implemented the sessions with the students. Students attended a total of two two-hour synchronous sessions, one in each of the last two weeks of April 2022. Before that, they were asked to check the materials prepared in the first phase about conducting research and writing scientific posters, which added up to a

total of about an half an hour long. This task was done asynchronously and individually, and the materials had been uploaded to the virtual course created specifically for this experiment, inside the university's learning management system (Moodle).

Half the students were asked to attend the synchronous sessions online (an online session was created in Microsoft Teams), while the other half attended on-site (but they also joined the online session to be able to interact with online students). During these sessions, students were divided into groups of 5 (a total of 6 groups) which combined on-site and online students. Each of the groups chose one of the given topics for research, which were not subject-specific, but dealt with general issues such as social media, fake news, and educational resources. Apart from working on their posters, students also produced an oral explanation for them, but this was not assessed as part of the study, since the focus here was on the written poster itself. While students were allowed to continue their research outside the class between the two sessions in case they wanted to use specific materials, instruments, or facilities, they were not allowed to continue working on their posters. Their research was expected to be simple, since the focus was on following a scientific procedure and communicating their findings, and not on obtaining revealing results.

For the assessment process regarding students' work, three instructors were involved: one of the authors of this paper together with the instructors from the University of Rennes 1 and the University of Trento.

3. Results

This section presents the results obtained from the study. They are divided into categories matching the specific aspects analysed. Due to the exploratory nature of the project, as mentioned above, the results shown in this section and discussed in the following one must always be considered within their limits, and generalisations beyond the participants' profiles cannot be made at this point. More extensive participation would be needed to establish general patterns across Europe. However, the results may well be seen as indicators of the need for further research following this same line.

3.1. Material Design and Creation

The first phase of the study involved the design and creation of the materials that would be posteriorly used as the theoretical base for the short module on conducting research and designing scientific posters. They were created with the purpose of being equally useful and valid for national (Spanish) and international European students, so, apart from being created in English, it was necessary to avoid an in-house perspective on the topic. For this reason, a discussion group was created with the collaboration of an instructor from a university based in a different European country from the authors. This external instructor participated in the general discussion of the feasibility of implementing such a module internationally as well as in the revision of the materials and provided some feedback during an online discussion session and through a questionnaire (Appendix A). Below are presented the final components of the module and the answers to the questionnaire.

The short module comprised two units which were recorded in videos consisting of a PowerPoint presentation with oral explanations. The first unit was titled "Scientific research" and explained the following topics: concepts, types, and elements. These contents were divided into three videos. The second unit was titled "The scientific poster" and covered the differences between posters and papers, the characteristics and contents of posters, and some examples. It was divided into four videos. A more detailed distribution of the contents and the length of the videos can be seen in Table 1.

Table 1. Distribution of contents and length for the short module videos.

Unit	Contents	Length
1.1. Concepts	What is scientific research	2′30″
1.2. Types	Traditional Basic, applied, documentary, field, mixed Exploratory, descriptive and correlational, explanatory Experimental vs. Non-experimental Diachronic and synchronic Field vs. laboratory	14′
1.3. Elements	Introduction, rationale, studied issue, research questions, objectives, hypotheses, theoretical framework, methodology, results, discussion, conclusions, references	5′
2.1. The poster vs. The paper	Definition, comparison	1′40″
2.2. Characteristics of the poster	Format, structure, oral presentation	3′
2.3. Contents of the poster	Introduction and objectives, methodology, results, conclusions, other information	1′30″
2.4. Examples	Incorrect, correct	3′

It was also agreed that two synchronous two-hour sessions would be devoted to students' work. Prior to the first of them, students would need to have watched the videos asynchronously. The videos were uploaded to the university LMS in a course created specifically for this module, which would also be used by students to upload their work. In the first session, students would create groups and start working on their research. In the second session, students would continue and finish their work. The number of groups and members might vary depending on the number of students participating in the activity.

With respect to the feedback obtained, the results were highly positive. Regarding the first part of the questionnaire, involving the collaboration process, collaboration was seen as very good (Question 1) and communication means were considered adequate (Question 2). In the benefits that had been obtained out of the collaboration (Question 3), the sharing of working methods was mentioned as a difficulty in the collaboration (Question 4), and the time distribution for the tasks was pointed out, since they were close to the Christmas break in December 2021. Consequently, organisation and collaboration dates were regarded as an aspect for future improvement (Question 5). Regarding the second part of the questionnaire, about the module design, the topic was considered to be highly relevant, since university students need to communicate their research results in a synthetic way to a diverse public (Question 6). The materials were seen as informative enough for the task, taking into account international students' different research backgrounds (Question 7). The videos recorded were positively perceived (Question 8). Finally, the participant indicated as a general suggestion for further improvement the creation of a list of the skills that students are expected to develop and explaining them (Question 9).

Finally, during the discussion session, important issues arouse, including students' knowledge about LMSs and schedule (in)compatibilities among universities.

3.2. Internationalisation in the University Environment

Since, among other topics, this paper deals with having an international perspective on conducting research, students were asked about their views on internationalisation in the university environment. The topic was also mentioned in the first of the two synchronous sessions, since the purpose of the module was to improve their research and language skills to conduct research internationally. The following statements summarise the results obtained in the pre- and post-tests (Appendices B and C) completed by the 30 students who participated in the study.

- 70% of the students had not studied abroad but they would like to (90% out of the 70%)—or they had and would like to again (78% out of the 30%);
- 90% of the students would prefer to go physically to a foreign university rather than take their courses online from their home university (10%);
- 73% of the students had not cooperated with international students for academic purposes, but they would like to (90% out of the 73%);
- 63% of the students thought that academic expectations of universities regarding students differ internationally;
- 92% of the students thought that working with international students for their assignments would increase their interest in internationalisation;
- 92% of the students thought that if they had an international classmate attending their classes online, they would be more likely to do the same.

3.3. Research and Language Skills

Another issue involved in this study was students' research skills and their EFL skills. The contents and materials of the module were designed address the former, while they were created in English and students' work had to be completed in that same language to address the latter. Students' views were collected through two questionnaires, a pre- and a post-test (Appendices D and E). The following results summarise students' answers:

- 91% of the students had not studied at a foreign university;
- 91% of the students thought that conducting research is important in their degree;
- 100% of the students thought that conducting research is important for national and international students;
- 82% of the students had been asked to conduct research at some point in their degree;
- 70% of the students had not had any specific training on how to conduct research in their degree;
- 52% of the students did not think that they were prepared to carry out research, but 87% of the students thought they were prepared after the module was over;
- 87% of the students thought their knowledge about research and scientific communication has improved after the sessions;
- 87% of the students thought that working with research material and producing a poster and an oral explanation in a foreign language has helped them improve their linguistic skills.

3.4. Students' Posters Assessment

As mentioned above, this part of the study was possible thanks to the contribution made by three instructors from the Complutense University of Madrid, the University of Trento, and the University of Rennes 1. All these instructors hold a PhD, although in different fields (health, linguistics, computer science education), were fluent in English, and had shared their research via different academic means. They assessed the posters created by the six groups of students according to five parameters: layout, visual appearance, graphics, content, and English. For each of these, instructors had to choose among four levels of performance and could provide additional comments. Additionally, at the end of the assessment, it was possible to provide final comments on any aspects of the posters.

With respect to the first aspect, layout, the options for the assessment were the following, from 1 (worst) to 4 (best): "1. Poster structure is difficult to follow", "2. The poster shows some organisation", "3. The poster is organised and the flow of information is appropriate", and "4. The poster is organised, the flow of information is appropriate, and prominent space is given to most important information". The answers can be found in Figure 1.

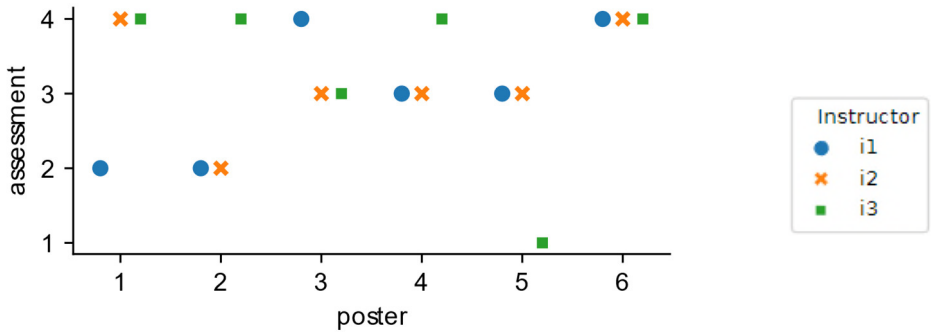

Figure 1. Layout assessment.

The answers show some disagreement in the quality of the layout in posters 1 to 5. In posters 1 and 5, the disagreeing mark falls on a lower option, while the opposite happens in posters 2, 3, and 4, where the disagreeing assessment has a more positive evaluation than the other two. There is complete agreement, however, in poster 6, with the highest possible rating.

Regarding visual appearance, the options were "1. Font style, font size, spacing, colours and design style are not adequate", "2. 1–2 items among font style, font size, spacing, colours and design style are adequate", "3. 3–4 items among font style, font size, spacing, colours and design style are adequate", and "4. Font style, font size, spacing colours and design style are adequate." The assessment is presented in Figure 2.

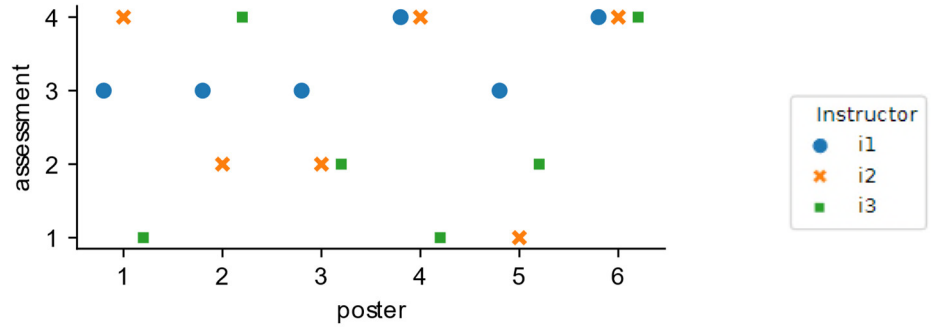

Figure 2. Visual appearance assessment.

Instructors show a higher degree of disagreement in their assessment of this item. In this case, posters 1, 2 and 5 have three different ratings, while two instructors agreed in their assessment of posters 3 and 4. As for the previous item, all instructors agree in giving poster 6 the highest possible rating.

With respect to graphics, instructors could choose from "1. Graphics do not contribute to understanding the poster", "2. Some graphics are related to the topic and make it easier to understand", "3. Graphics are related to the topic and make it easier to understand" and "4. Graphics are related to the topic, make it easier to understand and are presented in adequate places and sizes." The results are shown in Figure 3.

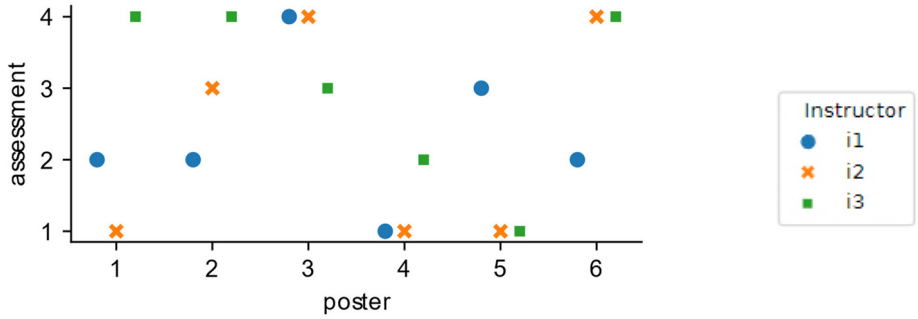

Figure 3. Graphics assessment.

Similarly to the previous item, three different ratings can be found in some posters (1 and 2), while partial agreement is observed in others (posters 3, 4, 5 and 6). Sometimes, instructors agree on a higher mark (posters 3 and 6), but in the other cases (posters 4 and 5) they agree on a lower one. Unlike in the two previous assessed items, here there is no total agreement for any of the posters.

When assessing content, the following performance options were given: "1. The poster cannot be considered a scientific poster because it does not include any sections nor information expected in a scientific poster", "2. The poster does not include all the sections expected nor they are informative enough", "3. The poster includes all the sections expected in a scientific poster, but they are not informative enough", and "4. The poster includes all the sections and information expected in a poster." Figure 4 shows the results for this item.

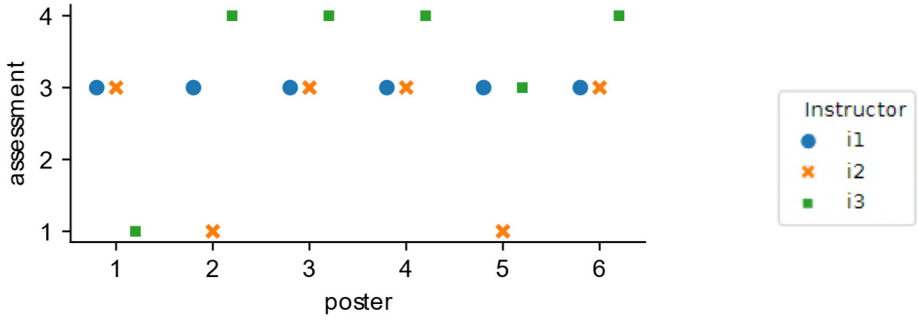

Figure 4. Content assessment.

Partial disagreement is found for all posters but poster 2, where there are three different ratings. It is especially noteworthy that these include the lowest and highest possible ratings, which means that while one instructor considers that, with respect to its content, the poster cannot be considered a scientific poster, another instructor thinks that it includes all the sections and information that could be expected in this genre. Agreement is found in the higher mark in posters 1 and 5, while instructors agreed on giving a lower mark in posters 3, 4 and 6.

Finally, the assessment involved English expression. The options were "1. The message cannot be understood", "2. The message is understood, but the style is not adequate and there are grammar and vocabulary mistakes", "3. The message is understood, but the style is not adequate or there are grammar and vocabulary mistakes", and "4. The message is understood, the style is adequate and there are no grammar or vocabulary mistakes." The answers are presented in Figure 5.

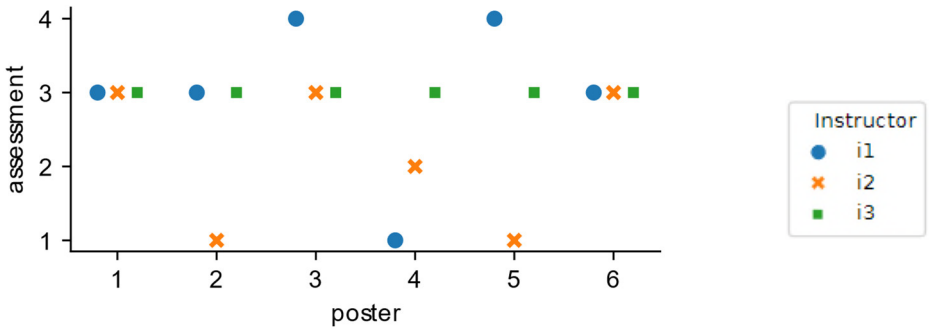

Figure 5. English assessment.

Some agreement can be found in posters 2 and 3, while three different ratings were given to posters 4 and 5. However, instructors showed total agreement in posters 1 and 6.

4. Discussion

This section presents some comments on possible reasons behind the results and connections to previous research in the field. The section is organised in the same fashion as the previous one.

4.1. Material Design and Creation

Regarding results from the discussion group formed to evaluate the materials designed and created, it can be said that they were highly favourable. The module created is short enough to be compatible with school calendars and students' schedules, but it is informative and useful enough to produce positive results in students' performance.

Additionally, during the online discussion session, it was observed that international students do probably share some basic common knowledge about the use of online educative platforms, which makes it easy to design digital materials that can be accessed and used by students later. Students may also feel comfortable when understanding how a course may work, what they may be expected to do, and how to manage the resources of which the course makes use. Additionally, they are usually familiar with synchronous and asynchronous online teaching.

The most difficult part in designing such an activity is scheduling it; that is, finding a specific, adequate, and convenient schedule for synchronous sessions with students from different institutions. In this case, the module designed requires two online sessions which are preceded by online, individual, asynchronous work, and are interwoven with optional group asynchronous work. That means that students must devote time to the activity over several weeks and, if needed, find a time to meet with the other members of their groups, as well as be available for the synchronous sessions. Since the first and second terms do not start and end at the same time in every institution, if this module were to be implemented with international students, they might find it difficult to enroll if the schedule does not suit their ordinary classes.

To finish, it must be said that some typos were observed in the materials during their implementation, so they will be revised before further use.

4.2. Internationalisation

As mentioned in Section 2, most students participating in the study were in their second year of the degree. However, students usually go to study abroad in their third or fourth years, so it was expected that most of them had no previous experience studying abroad or cooperating with foreign students. Those who had some mostly referred to summer camps or exchange experiences in their high school years. Since they were taking the optional course "English applied to Optics and Optometry", students were also expected to have an interest in languages or value the importance of speaking a foreign

language in their personal and professional lives. Additionally, some foreign students actually visit these students' university, so they might have also had previous experiences with international students in their own university.

Despite the convenience of attending courses from foreign universities online, most students preferred to attend those courses on-site, which means travelling to a foreign country and living there for at least a semester. This may be related to students' interest in English as a foreign language and thus indicate that they would like to be really immersed in a foreign culture as a personal experience and as a way to improve their language skills. However, students thought that they would be more willing to take online foreign courses if they had a classmate participating in their courses that way, so their initial reticence to do so may be due to their current unfamiliarity with the procedure, since this practice had not been carried out previously in their degree.

Students' feeling that universities have different expectations regarding them may be based on their previous international experiences. However, the most important point in this question is that students' thinking so may have an influence on their self-confidence regarding their performance in a foreign university or on their choices when deciding which university or country to visit if taking a semester or a year abroad.

4.3. Research and Language Skills

Students agree on the importance they give to research nationally and internationally and in their degree, and they had actually been asked to conduct research during their university studies. However, it is important to highlight that most of them had not had any previous training in conducting research. That means that students are asked to do something they have not been properly trained to do, and this may have an impact on their performance.

This point and the one discussed in the previous section regarding students' thoughts on institutions having different expectations about students show the need for the creation of homogeneous training on how to conduct research at university. Regarding the success of this pilot experience, it can be said that, taking into account that the study carried out here involved half an hour of theoretical, video-based training and a total of 4 h of in-class work, the improvement in students' confidence regarding how prepared they were to conduct research and communicate their results is noteworthy: an increase from 52% to 87%. This means that this type of training may be suitable for university students and that it can be carried out in a context combining on-site and online students and including a workload of asynchronous and synchronous tasks.

4.4. Students' Posters Assessment

The evaluation has shown a high degree of disagreement in the instructors' criteria. For most assessment items and posters, instructors did not meet in a unified rating (which was only observed 4 times), but they usually provided two different ratings (18 times) and even three different ratings (8 times). Therefore, partial agreement is the most common result. There was no particular trend observed in the matching of the criteria; that is, when partial agreement was found, it was not always between the two same instructors. This seems to point to very different criteria in instructors' assessment, which indicates that further investigation is needed to confirm whether this lack of consistency may be common among different institutions or occasionally found in this specific case.

To finish with the discussion of the results, it must be noted that the resources needed to carry out the experiment, as mentioned in Section 2, included a learning management system. To provide support for this experiment, it would be necessary that this system allows the implementation of the activities described, including presentation and storage of audio-visual materials, integrated activities for individual and group synchronous and asynchronous work (e.g., forums, tests or quizzes, live chats and videoconference sessions among students, etc.), online synchronous sessions with the instructor for the class sessions, and assessment of students' assignments by multiple instructors.

5. Conclusions

This study has dealt with the possibilities that blended learning offers in the context of higher education instruction open to international students due to its flexibility regarding the location of the instructors and students, synchronous and asynchronous teaching and learning time, and the grouping of students (individual and group work). As key aspects in the use of blended learning with internationalisation purposes, educational materials and courses should be designed with shared international perspectives; in addition, it is necessary to cover topics and skills that international students can benefit from; and finally, it is also important that students' work is assessed with shared criteria that ensure an internationally accepted level of performance.

For these reasons, this paper has presented an experiment based on the planning, design, creation, and implementation of some basic training organised in a short module on how to conduct research and how to make a scientific poster targeting 30 students mostly in their 2nd year, but also in their 3rd or 4th, from the BSc in Optics and Optometry from the Complutense University of Madrid. Inter-university cooperation was received for the first phase of the study, consisting of the design of the materials and the module, as well as for part of the second phase (the implementation of the module), specifically in the assessment of students' work to compare instructors' criteria in their evaluations.

The design of the module as consisting of a set of videos about scientific research and scientific posters with a total length of about half an hour can be evaluated as good and adequate for international use, since the results regarding the quality and usefulness of the contents were entirely positive. In order to have wider cooperation of instructors and students from other universities, it would be necessary to cope with making the implementation compatible with other instructors' ordinary duties, finding a place for these activities inside an existing course or designing it as a stand-alone module with official recognition, and institutions' calendars.

Additionally, the results revealed that students would be more likely to join online courses from foreign universities if they were already familiar with that option, for example with the online attendance of visiting students to their courses. Therefore, more promotion would be necessary to increase students' willingness to enroll and participate.

Since this exploratory study required students to work individually and in groups, synchronously and asynchronously, and online and on-site, it can be said that blended learning was successfully tested to a great extent. However, the training can be enriched with additional activities and materials to improve it pedagogically, as well as with additional or different procedures to ensure the suitability for larger groups of students (such as peer evaluation or number of members per group).

The experiment also involved the sharing of international views on conducting research at the bachelor level, thanks to the cooperation of contributor partners in the assessment of students' work. They had to mark five parameters of the posters according to four performance levels each. In their evaluations, instructors tended to disagree more often than not. This points to very heterogeneous criteria in their assessment and shows the importance of further research and work on this issue.

Bearing in mind that conducting research can be considered key, cross-disciplinary knowledge to university studies and that research is largely shared internationally, the design of a series of brief courses addressing key issues about conducting research at higher education institutions can be proposed. These series would be offered by European institutions after being approved to ensure that all students receive similar instruction and therefore their research meets international criteria. In addition, the use of an internationally shared learning management system that meets the needs of the instruction designed should be considered as well. In light of the results and conclusions presented here, it can be said that future education guidelines should benefit from addressing issues such as the compatibility of calendars among universities and institutions, the promotion and visibility of common assessment criteria, and students' duties to make students more confident

regarding their performance to study internationally, and to increase students' awareness of international educational options and enrolment in educational activities.

It must be remembered that this study was only exploratory in nature. For this reason, the number of participants, including both instructors and students, was limited. Consequently, the results, although promising, cannot be generalised and applied to other contexts and profiles different from those specifically dealt with here until a wider sample is analysed. However, they point to an interesting research line that deserves closer attention and should be further studied to find general patterns across Europe that lead to possible improvements in higher education at an international level.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Feedback on Short Module Design

Regarding the collaboration for the design of the module

1. What is your general evaluation of the collaboration?

	1	2	3	4	5	
Very bad						Very good

2. Were the communication means adequate? (E-mail, Google Meet meeting, online questionnaire, files shared through Google Drive)

   □ Yes
   □ No

   2.1. If you said No, why? (open answer)
3. What benefits were obtained through the collaboration? (open answer)
4. What difficulties were found in the collaboration? (open answer)
5. What aspects can be improved in the future? (open answer)

Regarding the design of the module

6. Is the topic (research skills and the use of English as a foreign language) interesting in the context of university students in your opinion? (open answer)
7. Do you think the materials created provide enough information to do the task (carry out some research and design a scientific poster), taking into account the different background students have at different universities?

   □ Yes
   □ No

7.1. If you said No, why? (open answer)
8. Can you provide some feedback about the videos? (open answer)
9. Do you have any additional comments to improve the proposal? (open answer)

Appendix B. Pre-Test on Internationalisation

1. How old are you?

   18/19/20/21/22/23/24/25+
2. In which year of you degree are you?

   1st year / 2nd year / 3rd year / 4th year / 5th+ year
3. Have you ever studied abroad?

   □ Yes, official education at university.
   □ Yes, official education in high school.
   □ Yes, private courses in the summer.
   □ Yes, other.
   □ No.

   3.1. (If the answer was No) Would you like to study abroad?
   3.2. (If the answer was Yes) Why did you do it?
   3.3. (If the answer was Yes) Would you like to do it again?
4. What do you think the benefits of studying abroad are?
5. What do you think the challenges of studying abroad are?
6. Think of the possibility of studying some courses of your degree abroad. What would you prefer: to go to a foreign country to study there or to take courses from a foreign university but staying in your own country (i.e., taking the courses online)?

   □ Go abroad and attend the foreign university courses on-site.
   □ Stay in my country and attend the foreign university courses online.
7. Have you cooperated with international students before with academic purposes (e.g., visiting students in your degree)?

   □ Yes
   □ No

   7.1. (if the answer was No) Would you like to cooperate with international students for academic purposes?

   □ Yes
   □ No
8. Do you think that what universities expect from students in foreign universities is different from what your university expects from you, academically speaking?

   □ Yes
   □ No

   8.1. (if the answer was Yes) In which ways is it different? (open answer)

Appendix C. Post-Test on Internationalisation

1. How old are you?

   18/19/20/21/22/23/24/ 25+
2. In which year of you degree are you?

   1st year / 2nd year / 3rd year / 4th year / 5th+ year
3. Do you think that working with international students for your university assignments increases your interest in internationalisation?

   □ Yes
   □ No

4. Imagine some of your classmates are foreign students who attend courses from your degree online. Would you be more likely to take a course from that university if you have contact with these students (e.g., they can tell you about the courses you are interested in, the teachers, the assignments, etc.)?

   □ Yes
   □ No

Appendix D. Pre-Test on Research and EFL Skills

1. How old are you?

   18/19/20/21/22/23/24/25+

2. In which year of you degree are you?

   1st year / 2nd year / 3rd year / 4th year / 5th+ year

3. Have you studied at a foreign university?

   □ Yes
   □ No

4. Do you think that doing research is important as a student in your degree?

   □ Yes
   □ No

5. Do you think that doing research is important for university students in general (in national and international universities)?

   □ Yes
   □ No

6. Have you been asked to do research at any point during your studies in the degree?

   □ Yes
   □ No

7. Have you had any specific training on how to do research during your degree?

   □ Yes
   □ No

8. Imagine you are taking a course from a foreign university, and they ask you to do some assignment that requires doing research. Do you think that you are prepared to carry out the research and communicate your results?

   □ Yes
   □ No

9. Do you know what research is, what the types of research are and what the elements in research are?

   □ Yes
   □ No

10. Do you know how to design and write a scientific poster?

    □ Yes
    □ No

Appendix E. Post-Test on Research and EFL Skills

1. How old are you?

   18/19/20/21/22/23/24/25+

2. In which year of you degree are you?

   1st year / 2nd year / 3rd year / 4th year / 5th+ year

3. Do you know what research is, what the types of research are and what the elements in research are?

□ Yes
□ No

4. Do you know how to design and write a scientific poster?

□ Yes
□ No

5. Do you think your knowledge about research and scientific communication has improved after completing the project?

□ Yes
□ No

6. Imagine you are taking a course from a foreign university, and they ask you to do some assignment that requires doing research. Do you think that you are prepared to carry out the research and communicate your results?

□ Yes
□ No

7. Do you think that working with research material in a foreign language and producing a poster and a presentation in that language has helped you improve your foreign language linguistic skills?

□ Yes
□ No

Appendix F. Rubric for the Assessment of Students' Scientific Posters

1. Layout

	Poster structure is...	The poster shows ...	The poster is orga...	The poster is orga...
Poster 01	○	○	○	○
Poster 02	○	○	○	○
Poster 03	○	○	○	○
Poster 04	○	○	○	○
Poster 05	○	○	○	○
Poster 06	○	○	○	○

2. Further comments on Layout. Please indicate the number of the poster if you want to refer to any of them specifically. (open question)
3. Visual appearance

	Font style, font siz...	1-2 items among f...	3-4 items among f...	Font style, font siz...
Poster 01	○	○	○	○
Poster 02	○	○	○	○
Poster 03	○	○	○	○
Poster 04	○	○	○	○
Poster 05	○	○	○	○
Poster 06	○	○	○	○

4. Further comments on Visual appearance. Please indicate the number of the poster if you want to refer to any of them specifically. (open question)
5. Graphics

	Graphics do not co...	Some graphics are...	Graphics are relate...	Graphics are relate...
Poster 01	○	○	○	○
Poster 02	○	○	○	○
Poster 03	○	○	○	○
Poster 04	○	○	○	○
Poster 05	○	○	○	○
Poster 06	○	○	○	○

6. Further comments on Graphics. Please indicate the number of the poster if you want to refer to any of them specifically. (open question)
7. Content

	The poster cannot ...	The poster does n...	The poster include...	The poster include...
Poster 01	○	○	○	○
Poster 02	○	○	○	○
Poster 03	○	○	○	○
Poster 04	○	○	○	○
Poster 05	○	○	○	○
Poster 06	○	○	○	○

8. Further comments on Content. Please indicate the number of the poster if you want to refer to any of them specifically. (open question)
9. English

	The message can...	The message is un...	The message is un...	The message is un...
Poster 01	○	○	○	○
Poster 02	○	○	○	○
Poster 03	○	○	○	○
Poster 04	○	○	○	○
Poster 05	○	○	○	○
Poster 06	○	○	○	○

10. Further comments on English. Please indicate the number of the poster if you want to refer to any of them specifically. (open question)
11. Further comments on the posters. You may mention any issues that you think are relevant but have not been addressed in the previous questions. (open question)

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