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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.

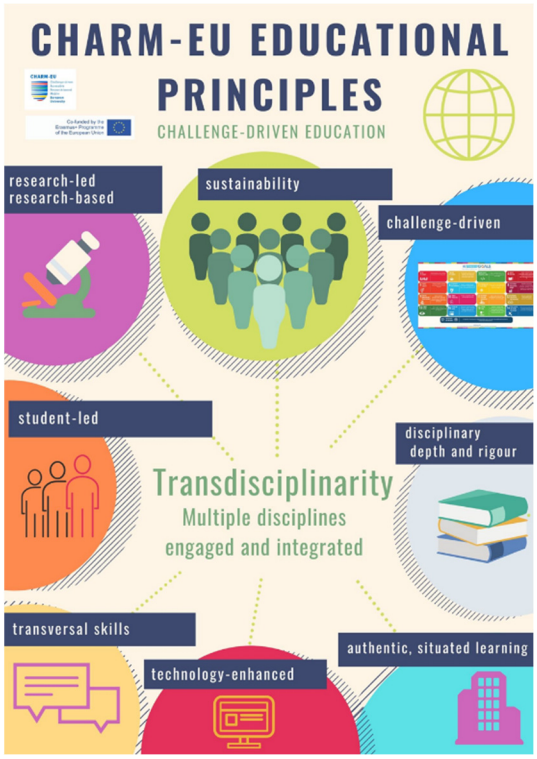

Figure 1. The CHARM-EU educational principles.

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).

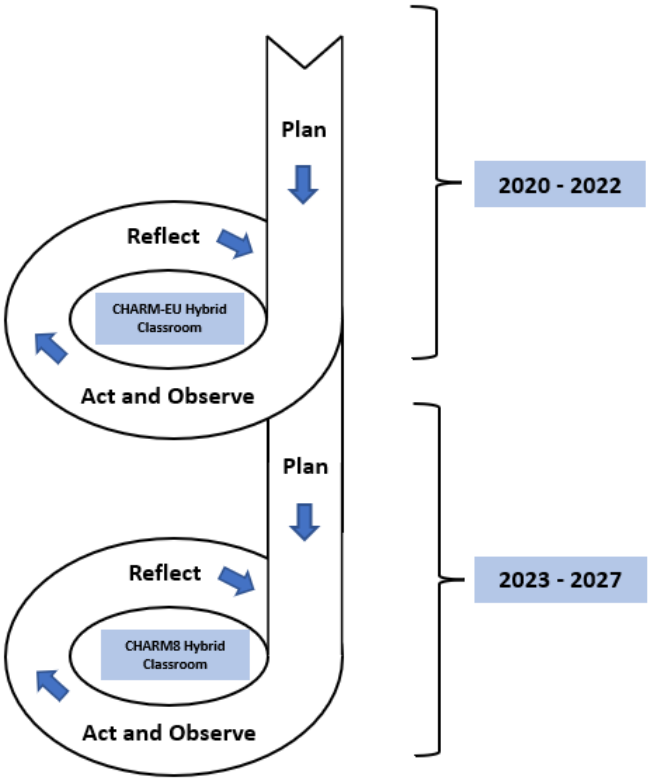

Figure 2. PAR cycles of Plan, Act & Observe and Reflect related to the CHARM-EU hybrid classroom.

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.

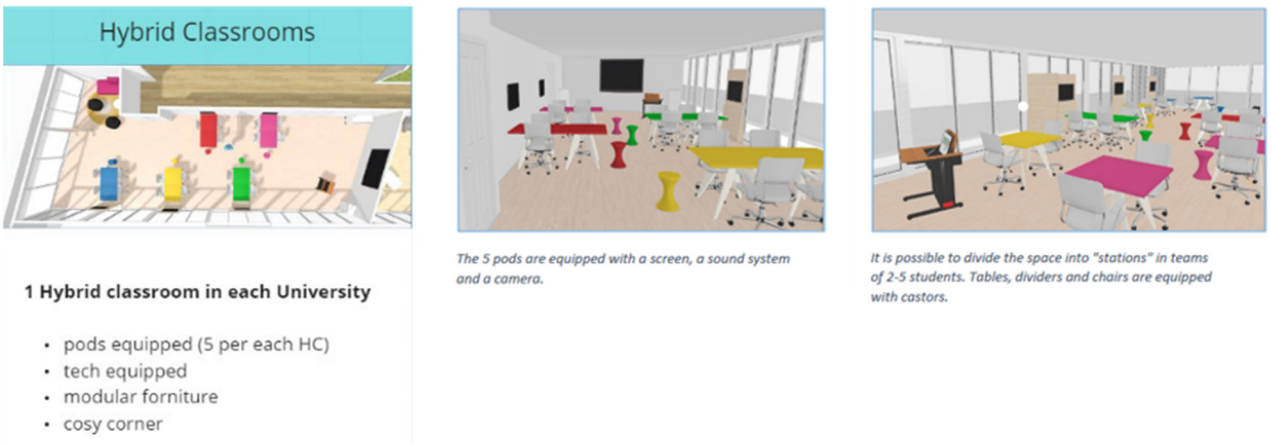

Figure 3. Hybrid classroom proposed layouts.

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.

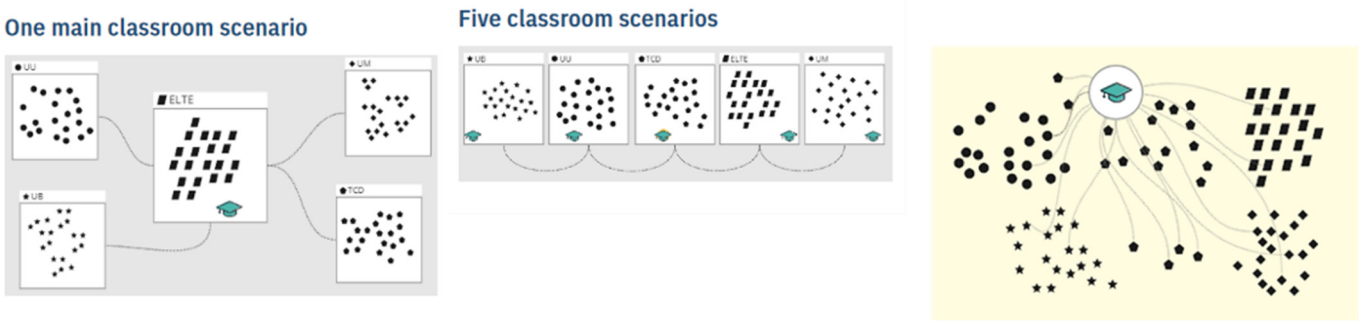

Figure 4. Teaching scenario example diagrams.

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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