Challenge-Based Learning and Online Micro credentialed Courses on digital education sustainability

Erasmus+ KA2 C-FLEX Result 3

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Book Introduction:

Introduction

In the context of evolving higher education practices, the C-Flex project aims to explore sustainable approaches to digital education, addressing the challenges faced by institutions in developing adaptable and forward-looking learning models as described in Result 1. The C-Flex project's Result 3 addresses these challenges by adopting them as requirements for a comprehensive framework for Challenge-Based Learning (CBL) into a CBL template and micro-credentialing, designed to meet the demands of its Summer School and education in general.

Recommendations

As discussed in Result 1, the decision-making in higher education today must consider multiple dimensions next to the economical: technological advancements, environmental sustainability, pedagogical effectiveness, and social factors including legal and administrative considerations. Based on the analysis of Result 1 we have drafted a number of recommendations (See: Appendix A: Recommendations for Sustainable Education) These interconnected aspects necessitate an approach that prepares students for real-world complexities while stimulating innovation and adaptability.

CBL Approach

Challenge Based Learning (CBL) emerges as a powerful tool to satisfy these needs. CBL is an innovative pedagogical approach that engages students in solving authentic, open-ended problems. It emphasizes interdisciplinary collaboration, self-directed learning, and the application of knowledge to real-world scenarios. By its nature, CBL addresses the multi-faceted considerations facing higher education, preparing students for the complexities of modern professional environments. This document is written from the perspective of Eindhoven University of Technology, where CBL is widely applied at all Bachelor Programs.

More information about CBL, and how you might start to adopt CBL, can be found in another of the C-FLEX handbooks, R4b.

Micro credentialed Online courses

Complementing the CBL approach, micro-credentialing addresses the growing need for flexible, targeted skill recognition in today's rapidly changing job market. By offering micro-credentials for specific competencies developed through CBL experiences, universities can provide learners with tangible, recognized qualifications that align closely with industry needs. This approach supports lifelong learning and allows for more granular recognition of skills acquired during educational experiences. On a European level microcredentialling has received quite some attention and supports national initiatives, like the Surf initiative stimulating all Dutch Universities and educational institutes

CBL Template

To implement CBL and microcredentialling effectively, the C-Flex project developed a robust CBL template. This template, based on extensive requirements analysis and use cases, integrates the C-Flex' four key dimensions: pedagogy, technology, social aspects, and environmental factors. For instance, a blended course within this framework might focus on sustainable urban development, where students from various disciplines collaborate to address issues like renewable energy integration and smart city planning. The template guides teachers through the entire process, from the initial introduction to the challenge, through team formation and development, to engagement with mentoring teachers.

Validation in Summer Schools

The CBL template was validated in two Summers School projects on sustainable education executed by the partner universities offering online courses aligned with the four dimensions, ensuring diversity, equity, and inclusion for all students. These courses were designed to be suitable for micro-credentialing, providing students with stackable, recognized qualifications. Additionally, students were given access to a curated selection of external online courses, supporting the Just-in-Time (JIT) learning philosophy central to CBL. During the Summer Schools, a CBL approach challenged the students to provide solutions for sustainability issues in education. Providing the online lessons afterwards helped ongoing lifelong learning.

Conclusion

This practical application of the CBL template not only validated its effectiveness but also demonstrated how it can be used to address complex, real-world issues while providing students with valuable, recognized credentials and fostering a commitment to ongoing learning.

Chapter 1: Sustainable Education Recommendations

Introduction

This chapter presents recommendations for a blended summer school focused on sustainable education. These recommendations are the result of a comprehensive analysis and synthesis process, rooted in the findings from Result 1 of the C-Flex project/

1.1 Introduction

The analysis of Result 1 serves as the foundation for the general recommendations outlined in Appendix 2 (See Appendix 2: Recommendations for Sustainable Education). These general recommendations, in turn, have informed and shaped the specific recommendations detailed in the following text.

Our approach recognizes the importance of modularisation as a foundational strategy that can benefit both Challenge Based Learning (CBL) and micro-credentialing.

The recommendations that follow are structured around the C-Flex framework's four dimensions: Pedagogy, Environmental, Technology, and Social considerations. Each set of recommendations has been carefully derived from the general requirements, ensuring a comprehensive and coherent approach to sustainable education.

By presenting these recommendations, we aim to provide a practical guide for implementing a blended summer school that not only teaches about sustainability but also embodies sustainable practices in its design and execution. This document serves as a bridge between our research findings and their practical application in educational settings.

1.2 Recommendations for a Blended Summer School

As higher education institutions increasingly embrace sustainable practices and digital technologies, the concept of a blended summer school on sustainable education emerges as an innovative approach to teaching these crucial concepts. Such a program combines the benefits of online learning with face-to-face interactions, while focusing on sustainability in both content and delivery methods.

The C-Flex framework, with its four dimensions of Pedagogy, Environmental, Technology, and Social considerations, provides an excellent structure for designing and implementing such a summer school. By applying these dimensions, we can create a program that not only teaches about sustainability but also embodies sustainable practices in its very execution.

Here are detailed recommendations for each dimension, tailored specifically for a blended summer school on sustainable education:

PEDAGOGY

1. Adopt a holistic approach to sustainability in the curriculum: This involves covering environmental, social, technological, and economic aspects of sustainability. The curriculum should interconnect these dimensions, showing how they influence each other in real-world scenarios.

2. Balance online and face-to-face components: Leverage the strengths of each modality. Use online components for theoretical content, discussions, and individual work. Reserve face-to-face sessions for hands-on activities, group projects, and experiences that benefit from physical presence.

3. Incorporate practical projects: Include projects where participants evaluate and select sustainable DETs for hypothetical educational scenarios. This hands-on approach allows students to apply theoretical knowledge to practical situations.

4. Use diverse teaching methods: Employ a variety of teaching strategies to cater to different learning styles and demonstrate various sustainable educational approaches. This could include virtual simulations, case studies, peer teaching, and collaborative problem-solving sessions.

ENVIRONMENTAL

1. Implement "Remote Interactive Exercises" for some practical sessions: Utilize virtual or remote experiences to reduce travel-related emissions while still providing hands-on learning opportunities.

2. Calculate and communicate the carbon footprint: Measure and transparently share the carbon footprint of both online and face-to-face components of the summer school. Use this as a teaching tool and to identify areas for improvement.

3. Demonstrate e-waste reduction strategies: Showcase practical methods for reducing e-waste in educational settings. This could include repair workshops, discussions on circular economy principles, and demonstrations of e-waste recycling processes.

Technology

1. Select and showcase sustainable DETs: Choose technologies for the summer school that align with sustainability principles. Explain the selection process to participants as a real-world example of sustainable decision-making.

2. Demonstrate integration of open-source and proprietary solutions: Show how both types of solutions can be used in a sustainable educational context. Discuss the pros and cons of each approach.

3. Provide hands-on experience with sustainable technologies: Give participants opportunities to use and evaluate various sustainable educational technologies throughout the program.

4. Discuss long-term viability and scalability: Include sessions on how to evaluate the long-term sustainability and scalability of educational technologies. This could involve case studies of successful (and unsuccessful) technology implementations in education.

Social (Ethical/Legal/Administrative)

1. Ensure accessibility and inclusivity: Make all components of the summer school, both digital and face-to-face, accessible to participants with diverse needs. Use this as a teaching opportunity to discuss inclusive design in education.

2. Clearly communicate data protection policies: Be transparent about how participant data is collected, used, and protected during the summer school. Use this as a case study for discussing data protection in educational settings.

3. Include case studies on ethical considerations: Explore real-world examples of ethical dilemmas in sustainable education and technology use. Engage participants in discussions and decision-making exercises.

4. Facilitate networking and collaboration: Create opportunities for participants to connect and collaborate on sustainable education projects. This could include group assignments, a project showcase, or a virtual collaboration platform.

5. Gather and incorporate participant feedback: Continuously collect feedback from participants and demonstrate how it's used to improve the program. This models good practice in iterative, user-centered design of educational experiences.

Summer School approach

Considering several recommendations we see the contours of the design of the Summer School on Sustainable Education. Many of the recommendations do not contradict or even align well with CBL principles, emphasizing practical, real-world learning experiences and interdisciplinary approaches. Pedagogy recommendation 3 clearly steers toward a method that involves both practical projects that challenges students while keeping them in control.

While the recommendations do not explicitly mention micro-credentials, several of them support the principles of micro-credentialing. These include the focus on specific, measurable outcomes, the balance of online and face-to-face learning (which supports flexibility), and the emphasis on transparency and continuous improvement.

Modularisation of education as such is the foundational approach that both Challenge Based Learning and micro-credentialing can benefit from, with particular emphasis on just-in-time learning and flexible learning paths. Motivating the main points:

1. For CBL, modularisation primarily supports just-in-time learning. This allows students to access specific knowledge or skills exactly when needed to solve parts of their challenge. It aligns well with CBL's focus on real-world problem-solving and iterative learning.
2. For micro-credentialing, modularisation enables flexible learning paths. Learners can choose which modules to take and in what order, earning micro-credentials that suit their individual needs or interests. This supports personalized learning journeys and the accumulation of stackable credentials.
3. When combined, these approaches create a synergy that allows for a highly adaptable learning experience. Students can tackle challenges using just-in-time learning modules, while simultaneously earning micro-credentials that recognize their growing competencies.

By implementing these recommendations, a blended summer school can not only teach about sustainable education but also exemplify it in practice. This approach provides participants with a rich, multifaceted learning experience that they can draw upon to implement sustainable practices in their own educational contexts.

Chapter 2: Challenge Based Learning

Summary

In this chapter, we analyze the key aspects of Challenge-Based Learning (CBL) including its focus on real-world challenges, interdisciplinary teamwork, self-directed learning, and collaboration with stakeholders. We also examine common pitfalls, such as student frustration and overly broad challenges.

2.1 Introduction

Challenge Based Learning (CBL) represents an evolution in experiential learning approaches, building upon and extending concepts such as Project Based Learning, Problem Based Learning, and Design Based Learning. These related methodologies fall under the umbrella term "XBL," where "X" denotes the specific approach.

CBL distinguishes itself by emphasizing real-world challenges and student-driven solutions. It encourages learners to identify, investigate, and tackle authentic, complex problems, often with global or local significance. This approach not only fosters deep learning of subject matter but also develops crucial 21st-century skills such as critical thinking, collaboration, and communication.

Authentic and Active Learning	1. **Emphasis on real-world relevance and authenticity,** 2. **Active engagement of students in inquiry, exploration, and problem-solving,** 3. **Application of knowledge and skills in practical contexts.**
Autonomy, Ownership, and Critical Thinking	4. **Provision of autonomy and ownership over learning,** 5. **Encouragement of reflection, iteration, and metacognition,** 6. **Development of critical thinking skills and problem-solving abilities.**
Collaboration and Interdisciplinary Integration	7. **Promotion of communication and collaboration among students,** 8. **Integration of multiple disciplines or subject areas.**

At the core of XBL methodologies lies exploratory learning. However, as De Bruyckere, Kirschner, and Hulshof (2015) point out, exploratory learning is not inherently effective. Its true potential is realized when learners have acquired the right knowledge framework before engaging with the material. Under these conditions, exploratory learning can lead to a deeper, more meaningful learning experience.

Challenge Based Learning (CBL) takes this concept further, expanding the possibilities of XBL by introducing more open-ended challenges. This approach supports students in dealing with uncertainties and gathering information at the right time (Just-In-Time) while working in interdisciplinary project teams. Due to its complexity, CBL is considered one of the more advanced pedagogical methods.

In a CBL environment, students engage with challenges often provided by external stakeholders or teachers. What sets CBL apart is that it empowers students to determine the scope of these challenges and set their own goals independently. This approach is particularly popular in engineering education, where it cultivates essential skills such as teamwork, communication, critical thinking, and problem-solving.

The primary aim of CBL goes beyond mere problem-solving. It equips students with the ability to navigate and manage uncertainty, fostering resilience and determination - qualities often referred to as "grit." Ultimately, CBL teaches students to generate knowledge independently, a crucial skill in today's rapidly evolving world.

Result 3 of the C-Flex project successfully established the foundation for implementing Challenge Based Learning (CBL) in micro-credentialed online courses. This achievement bridges the gap between the requirements identified in Result 1 and the benchmarking insights, leading to practical applications in Result 4. The collaborative efforts and methodological approaches employed have yielded a holistic and adaptable framework, paving the way for future educational initiatives. By promoting innovative, inclusive, and sustainable education practices through CBL, the project is shaping the future of higher education. This approach not only prepares students for the challenges of tomorrow but also equips them with the skills and mindset needed to thrive in an increasingly complex and uncertain world.

2.2. Characteristics (Principles of CBL)

The main learning outcomes or competencies of Challenge Based Learning (CBL) can be summarized on an abstract level as follows.

Key Competencies

Attitude	Resilience, determination, grit, being able to cope with uncertainty
Skills	Agile teamwork, communication, critical thinking, problem-solving
Knowledge	Interdisciplinary, just-in-time, independently generated knowledge

The Compass tool[1] at Eindhoven University of Technology analyses existing courses on their level of Challenge-Based Learning (CBL) through various characteristics. The following sections provide a description of these characteristics.

Real-life, open-ended challenges, societal impact

Challenges in Challenge-Based Learning (CBL) are characterized by their authenticity, being open-ended, complex, and interdisciplinary. They aim to address real-world problems, transforming conventional practices, and fostering societal impact by raising awareness and trust among stakeholders.

Collaboration with stakeholders

CBL emphasizes collaboration with various stakeholders including academia, industry, government, and culture. This collaboration is essential for tackling multifaceted challenges effectively and often involves diverse perspectives and expertise.

T-shaped engineers

In CBL, learning activities promote the development of "T-shaped engineers" who possess both deep disciplinary knowledge and a broader understanding across disciplines. Students engage in critical and creative thinking, problem formulation, and design, while also acquiring skills in self-directed learning and navigating uncertainty.

Self-directed learning

CBL fosters self-directed learning by providing opportunities for learners to acquire and apply knowledge and skills in relevant contexts. It supports the development of

[1] https://www.datamonitor.nl/compass/

meta-cognitive skills and self-regulatory abilities, empowering learners to take ownership of their learning journey and effectively deal with uncertainty.

Assessment

Assessment in CBL is balanced, focusing on both the product and process, individual and team learning, and encompassing both formative and summative assessment methods. This ensures a comprehensive evaluation of students' learning outcomes and progress.

Teaching

Teachers in CBL play a crucial role in supporting students' learning through coaching, scaffolding, and finding a balance between providing guidance and fostering openness. They also act as co-learners and co-creators, actively engaging in the learning process alongside their students.

Collaborative learning

CBL encourages collaborative learning through activities that enable cycles of divergent and convergent reasoning. Students engage in peer learning, sharing ideas, perspectives, and solutions, which enhances their understanding and problem-solving skills.

Interdisciplinarity

Interdisciplinarity is a key aspect of CBL, where challenges require interdisciplinary teamwork and the integration of diverse perspectives and skills. Learning activities support the development of interdisciplinary professional skills, preparing students for complex, real-world challenges.

Learning Technology

CBL leverages educational technologies creatively to enhance learning experiences. It allows for innovative use of technology in learning activities and utilizes learning analytics to improve teaching and learning effectiveness.

Facilities support

Adequate facilities in CBL provide the necessary resources, materials, spaces, and tools, including ICT tools, to support students' learning and project work effectively.

Teacher support

Teacher support structures in CBL offer assistance in course design and pedagogical strategies, as well as coaching skills development. This ensures that teachers are equipped to facilitate effective learning experiences and provide valuable guidance to students throughout their learning journey.

2.3 CBL Pitfalls

Despite its benefits, the limited and not well-established research on CBL poses challenges for its widespread adoption. Exploratory learning, such as CBL, is particularly inefficient, especially when students lack a framework or cognitive schemas in a specific domain. Student frustration is a common issue, especially at the beginning of CBL courses, with identified difficulties including understanding course expectations, narrowing down broad challenges, applying content knowledge, dividing tasks among group members, managing time, and handling group processes. The pitfalls also arise when challenges are either too large, leading to endless searching for solutions, or too small, resulting in routine processing without meaningful learning.

To address these challenges, Result 3 has proposed a CBL Framework aiming to enhance providing the creation of the students' framework, scalability, manageability, and adaptability to varying student motivations. The goal is to create a replicable process that maintains the essence of CBL while addressing common difficulties and ensuring a more positive and productive learning experience.

Exploratory Learning	Without framework or cognitive schema, students will learn very slowly
Challenge level	The level of the challenge should stimulate students to explore efficiently
Frustration	Needless frustration in not understanding CBL must be avoided

Chapter 3: Micro-credentialing

Summary

This chapter explores micro-credentialing as a flexible approach to education, offering small, assessed units of learning that align with labor market needs. Initiatives like SURF's badges and the European Digital Credentials for Learning highlight their role in enhancing employability and lifelong learning. At the same time, we also highlight how challenges such as standardization and equitable access must be addressed for broader adoption.

3.1 Introduction

Micro-credentialing has emerged as a significant trend in education and professional development, offering bite-sized qualifications that represent specific skills, knowledge, or competencies. These flexible, targeted credentials are designed to meet the demands of a rapidly changing job market, supporting lifelong learning and continuous professional development.

Unlike traditional degrees, micro-credentials focus on smaller units of learning that can be completed in shorter timeframes, often through online or blended approaches. They provide learners with opportunities to acquire and demonstrate specific competencies, while offering employers a way to verify skills in potential hires or current employees.

As we explore micro-credentialing, we'll examine various initiatives, standards, and platforms shaping this educational innovation across Europe and beyond, highlighting its growing role in bridging education and employment in the 21st century.

3.2 Definition

The European Commission decided in 2022 to stimulate micro-credentialing and provided the following definition:

'Micro-credential' means the record of the learning outcomes that a learner has acquired following a small volume of learning. These learning outcomes will have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity.

From a knowledge economy perspective, micro-credentials are vital for reskilling and upskilling to meet the fast-evolving demands of the labor market. Research by Brown, Mhichil, Beirne, and Lochlainn (2021) emphasizes that "increasing employability" is a dominant driver, with 63% of publications identifying this as a core factor. Governments also highlight that micro-credentials are pivotal in revitalizing job markets post-COVID-19. Economic and competitive interests are at the heart of this movement, with HolonIQ projecting the global online degree and micro-credential market to reach €108 billion by 2025.

3.3 Supporting Lifelong Learning

Higher Education Institutes (HEIs) are recognizing a new market in potential learners, including alumni and those who have engaged in MOOCs (Massive Open Online Courses) and various online offerings. This shift presents an opportunity for HEIs to enhance enrolment and revenue while aligning academic learning with industry-required skills.

Europe's HEIs have an edge due to the European Credits Transfer System (ECTS), acknowledged across Europe. Despite this potential, the true value of European Credits (ECs) in terms of education level and program context has been challenging to establish. Diplomas are typically awarded based on the coherence of a program, rather than just accumulated ECs. To address this, new initiatives aim to leverage ECs as a foundation to overcome these difficulties.

3.3 Specific initiatives

On a national level, the Netherlands' SURF organization has implemented a system using open badges. These badges underpin learning outcomes and levels, potentially valued differently across programs. SURF is preparing future services based on this technique, with institutions like Fontys Hogescholen participating in a proof-of-concept.

The SURF whitepaper on open badges and micro-credentials outlines several key aspects:

1. Three scenarios for using badges in Dutch higher education:
    - Micro-credentials (accredited education, externally visible)
    - Badges for extra-curricular further training (non-accredited education, externally visible)
    - Badges as game elements (internal motivation tool)
2. Technical considerations:
    - Online proof and trust
    - Storage of badges
    - Personal data protection and access
    - Ecosystem for digital badges
    - Open Badge Standard

Key issues for discussion:

- Breaking study programs into smaller, recognizable units
- Quality assurance for badge-based education
- Validation and authentication of badges
- Administrative impact on institutions
- Standards for badge criteria and issuer identification

The whitepaper calls for coordinated experiments to gain practical experience with digital badges for micro-credentials in Dutch education.

3.4 Microcredentials and Open Badges

Pioneering Digital Credentialing

The Open Badges initiative, over a decade old, is now being applied in Dutch higher education. The unique proposal combines these badges with European Credits (ECs), suggesting a 'level' to indicate where the badge might be useful. Educational programs still require approval (e.g., by university exam committees).

An exemplary pilot at Utrecht University, Edubadges Unveiled: From Design to Application, highlights the journey of digital credentialing via the national SURF platform. Key insights include:

- Aligning global aspirations with local goals
- Concrete use of edubadges in Utrecht's courses
- Mapping existing badge successes and potential courses
- Anticipating cross-border badge-sharing collaborations

3.5 European Digital Credentials for Learning (ELM)

Part of the European Learning Model (ELM), the European Digital Credentials for Learning initiative offers students a live digital record of their skills development. Benefits include enhanced employability and continuous professional development.

This platform allows organizations to issue tamper-proof digital credentials, verified and recognized across Europe. Key features:

- Free credential issuing and hosting
- Instant verification for employers and institutions
- Integration with HR software and student information systems
- Support for various credential types (diplomas, certificates, badges, etc.)
- Compliance with EU regulations and standards

The platform aims to modernize credential management, enhance mobility and transparency in education and employment, and bolster micro-credentials in Europe.

3.6 Analysis of Research on Micro-Credentialing

Micro-credentialing is a burgeoning innovation in education and professional development, offering a flexible and targeted approach to skill acquisition. Here's a synthesis of findings from recent research:

- Definition and Characteristics: Micro-credentials are digital records of learning outcomes, assessed against clear criteria, and verified by trusted bodies. They can be stacked or combined with other qualifications for a modular education approach.
- Applications and Benefits: Used in various fields like teaching, telecommunications, and pharmacy practice, micro-credentials validate skills and promote professional growth. For instance, teachers document their learning via work samples and videos, while pharmacists in New Zealand prefer micro-credential programs for career advancement.
- Impact on Learners and Employers: Micro-credentials enhance knowledge, skills, and career prospects. Studies show they positively affect learners' professional practices and can even lead to career changes. They also reduce employer uncertainty and boost worker earnings by signaling verified skills in online labor markets.
- Challenges: A universal definition of micro-credentials is lacking, leading to variations in assessment and perceived value. Employer unfamiliarity and concerns about equitable access and education commodification pose additional hurdles.
- Future Directions: Increased interest from higher education institutions suggests a growing role for micro-credentials. Empirical research is needed to explore implementation, sustainability, and relevance to practical contexts.
- In summary, micro-credentials offer a promising, flexible approach to learning. Addressing challenges related to definition, recognition, and equity will be crucial for their broader adoption and impact.

In summary, micro-credentials offer a promising, flexible approach to learning. Addressing challenges related to definition, recognition, and equity will be crucial for their broader adoption and impact.

3.7 Future of Micro-credentials in Europe

The future of micro-credentials in Europe looks promising, driven by the European Commission's efforts to establish a common framework. As the job market evolves, micro-credentials are set to play a crucial role in workforce development. Integration with emerging technologies like AI and blockchain could enhance credential verification and management. European higher education institutions are likely to create flexible pathways combining traditional degrees with stackable micro-credentials, revolutionizing lifelong learning. While challenges persist, the momentum suggests micro-credentials will become integral to the educational and professional landscape. As the system matures, we can expect improved quality assurance, wider recognition, and innovative applications, leading to a more flexible, personalized, and responsive learning environment across Europe.

Chapter 4: CBL Template

Summary

In this chapter, we present a CBL framework for integrating micro-credentialing during the pre-summer school 2023, along with its subsequent development and optimization for the 2024 edition.

4.1 CBL Framework using Micro-credentialling

Setting the circumstances

Considering both the strengths and pitfalls of CBL, we've identified the conditions to leverage its strengths and avoid its pitfalls. Subsequently, we have developed a framework for CBL. This was tested out in the Summer School 2023, evaluated and improved for the second summer school. In the table below, you can find the layout of the online pre-summer school designed to facilitate an ideal CBL course.

🔑 Goals	🐾 Steps
Legend: Face-to-face, Online knowledge, Attitude & skills (online)	
Providing trust and comfort **🕓 15 minutes**	Provide each participant a personal online introduction
Assess level & personality **🕓 1 hour**	Take an online test from each participant
Allocation to teams (similar level, different personalities)	
Team building – provide material **🕓 30 minutes**	Each participant provides material on central platform (Bio, photographs, video, music preferences, etc.)
Team building – intro to team **🕓 1 hour**	Team members introduce themselves in their team
Team building – Establish role **🕓 1 hour**	Per team, team members establish their dominant roles

Online skills training

📚 Material: Live online skills training

Communication – Conflicts 🕓 **2 hours**	Per team a Deep Democracy training is provided (different viewpoints, resistance line, role fluidity)
Communication – Reflection 🕓 **2 hours**	Each team learns how to reflect (Deep Democracy) (guided)

Provide the knowledge framework

📚 Material: Live online courses in sustainable education

Create Environmental Framework 🕓 **2 hours**	All teams engage in course on Environmental dimension
🕓 **½ hour (Retention)**	Team reflection on the Environmental Course (independent)
Create Pedagogical Framework 🕓 **2 hours**	All teams engage in course on Pedagogical dimension
🕓 **½ hour (Retention)**	Team reflection on the Pedagogical Course (independent)
Create Social Framework 🕓 **2 hours**	All teams engage in course on Social dimension
🕓 **½ hour (Retention)**	Team reflection on the Social Course (independent)
Create Technological Framework 🕓 **2 hours**	All teams engage in course on Technological dimension
🕓 **½ hour (Retention)**	Team reflection on the Technological Course (independent)

Team building

Team (group) building 🕓 **2 hours**	All members of all teams meet each other

Formative Assessment

Retention cognitive schemas 🕓 **2 hours**	All teams engage in a pub quiz on all topics against each other

Challenge Choice

Select Challenge (Level) 🕓 **2 hours**	All teams chose their challenge from a list of challenges

Summer school

📚 Setting: Physical Place

Explore problem space 🕓 **4 days**	Each team explores the problem space of their challenge
Explore solution space and develop presentation 🕓 **4 days**	Each team develops a solution and presents this in a final presentation to the group.

Lifelong Learning

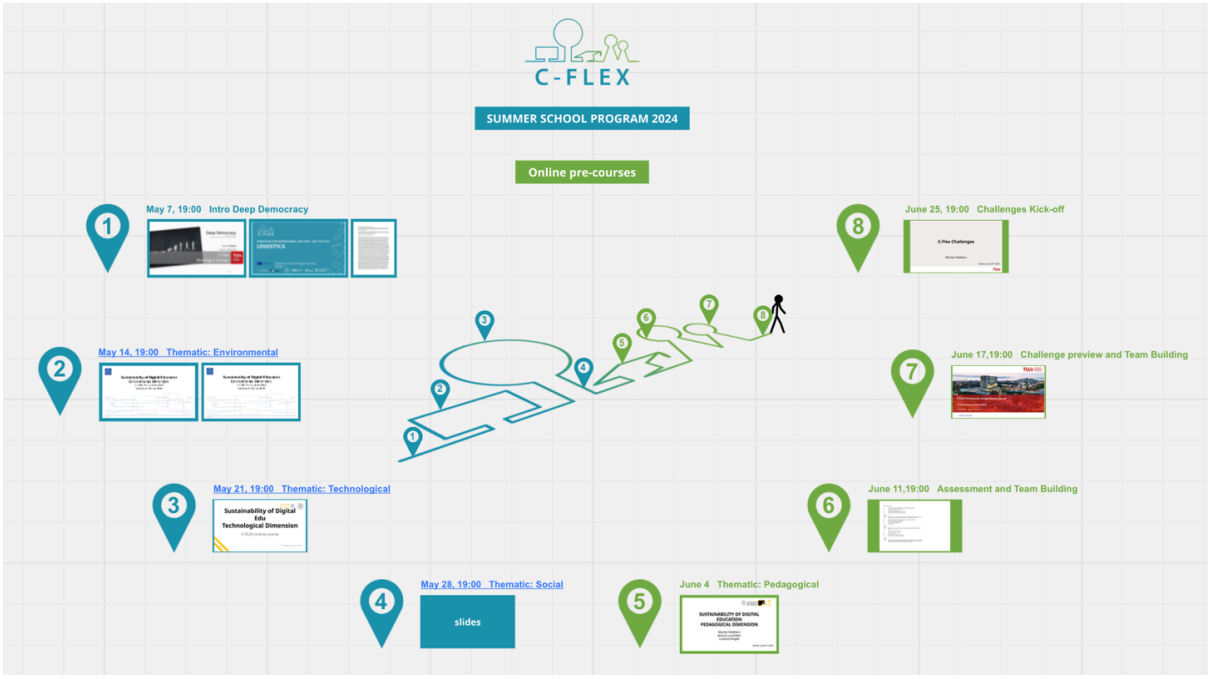
📚 Setting: Online

Recollection, reflection, and deepening of knowledge 🕓 **2 hours**	All members have access to the online learning material (developed for this summer school and external) for further personal exploration and development.

For details on the face-to-face Summer School see Result 4.

Appendices

Appendix 1: Experiences of the Summer School



Appendix 2: Recommendations for Sustainable Education

General

In the rapidly evolving landscape of higher education, institutions are increasingly turning to Digital Education Technologies (DETs) to enhance learning experiences, improve accessibility, and adapt to changing educational needs. DETs encompass a wide range of tools and platforms, from learning management systems and virtual classrooms to AI-powered tutoring tools and digital assessment platforms. However, the selection and implementation of these technologies is far from straightforward, requiring careful consideration of multiple factors to ensure sustainability and effectiveness.

The C-Flex framework provides a comprehensive lens through which to view DET decision-making, focusing on four interconnected dimensions: Pedagogy, Environmental, Technology, and Social (encompassing ethical, legal, and administrative aspects). This multifaceted approach recognizes that sustainable digital education is not just about adopting the latest technologies, but about creating a balanced ecosystem that supports learning outcomes while considering broader impacts.

While economic considerations are important, we've chosen not to include them as an explicit dimension in our approach. This decision allows us, but also educational institutions, to consider innovative solutions that, although potentially costly in the short term, may become more efficient and affordable as demand grows. We believe that many universities share similar needs and preferences, potentially forming a significant customer base for certain solutions. This approach encourages a forward-thinking perspective, focusing on long-term sustainability and effectiveness rather than immediate cost concerns.

PEDAGOGY

When it comes to pedagogy, decision-makers are encouraged to look beyond immediate needs and consider the long-term implications of their choices. This means evaluating how DETs can support diverse learning styles, enhance collaborative experiences, and foster digital literacy skills. It's about finding the sweet spot between innovation and practicality, ensuring that the technologies adopted truly serve the educational mission of the institution.

To achieve this, the following recommendations could be drawn from the earlier analysis:

1. Adopt a holistic approach to DET sustainability that considers educational outcomes alongside other factors.
2. Balance immediate pedagogical needs with long-term sustainability goals when selecting DETs.
3. Evaluate DETs based on their ability to support diverse learning styles and pedagogical approaches.
4. Consider the potential of DETs to enhance collaborative and interactive learning experiences.
5. Assess how DETs can support the development of digital literacy skills among students and staff.

Environmental

The environmental dimension of DET decision-making has gained increasing prominence in recent years. As institutions strive to reduce their carbon footprint, they must consider the lifecycle impact of the technologies they adopt. This goes beyond energy consumption to include considerations of e-waste, the potential for remote learning to reduce travel-related emissions, and innovative solutions that can provide hands-on learning experiences with a lower environmental impact. The following recommendations apply:

1. Prioritize the collection and consideration of environmental impact data for DETs.
2. Implement e-waste reduction strategies for hardware used in educational settings.
3. Consider the carbon footprint of DETs, including energy consumption and potential for reducing travel.
4. Explore options like "Remote Labs" to reduce emissions associated with on-campus activities.
5. Evaluate the lifecycle environmental impact of DETs, from production to disposal.

Technology

From a technological standpoint, the challenge lies in balancing functionality with simplicity, openness, and ownership while considering the growing trend of outsourcing digital infrastructure. Decision-makers must navigate a complex landscape, weighing the benefits and drawbacks of various solutions.

Simplicity refers to the ease of use and implementation of DETs. It's crucial for both end-users and IT staff. Simple tools are more likely to be adopted widely and used effectively, reducing the need for extensive training and support. However, simplicity shouldn't come at the cost of necessary functionality.

Openness relates to the use of open standards and open-source solutions. Open technologies often offer greater flexibility, customization options, and community support. They can also promote interoperability between different systems. However, open solutions may require more in-house expertise to maintain and customize.

Ownership concerns the level of control an institution has over its digital tools and data. With the increasing trend towards outsourcing and cloud-based solutions, universities are facing decisions about how much of their digital infrastructure to manage in-house versus entrusting to external providers. While outsourcing can offer cost savings and access to cutting-edge technologies, it may also lead to decreased control and potential data sovereignty issues.

Balancing these factors is crucial. It's not just about choosing the most advanced technology, but about finding solutions that fit seamlessly into the existing infrastructure, can adapt to future needs, and align with the institution's goals and values.

Consider the following recommendations:

1. Balance functionality with simplicity when choosing digital tools, ensuring they are user-friendly while meeting necessary requirements.
2. Consider the integration capabilities of new DETs with existing infrastructure, including both in-house and outsourced systems.
3. Evaluate the trade-offs between open-source and proprietary solutions, considering factors such as customization needs, available support, and long-term sustainability.
4. Assess the long-term viability and scalability of selected technologies, particularly in light of the rapid pace of technological change.
5. Consider the potential for customization and adaptation of DETs to meet specific institutional needs, whether through in-house development or vendor partnerships.
6. Evaluate the security features and data protection capabilities of DETs, especially when considering outsourced or cloud-based solutions.
7. Carefully weigh the benefits and drawbacks of outsourcing digital infrastructure, considering factors such as cost, expertise requirements, and desired level of control.

By carefully considering these aspects, institutions can make more informed decisions about their technological infrastructure, striking a balance between leveraging external expertise and maintaining necessary control over their digital ecosystem.

Social (Ethical/Legal/Administrative)

The social aspect of DET decision-making encompasses crucial ethical, legal, and administrative considerations. It focuses on ensuring inclusivity and accessibility for all learners, protecting privacy and data in compliance with regulations like GDPR, clarifying content ownership, addressing potential biases in AI-driven tools, and mitigating "technology fatigue." Successfully navigating these issues is essential for creating a fair, responsible, and effective digital learning environment.

To navigate these complex issues, consider the following recommendations:

1. Ensure all selected DETs meet high standards of inclusivity and accessibility.
2. Prioritize robust privacy protection and GDPR compliance in all technology decisions.
3. Develop comprehensive policies on data ownership, usage, and sovereignty. Clearly define who owns what data and how it can be used or shared.
4. Implement strong data governance practices to protect sensitive information and maintain user trust.
5. Consider the administrative workload associated with managing and maintaining DETs.
6. Critically evaluate AI-driven tools for potential biases and ethical implications.
7. Develop strategies to combat technology fatigue, such as phased implementations and ongoing user support.
8. Adopt a multi-disciplinary approach to DET selection, involving diverse stakeholders in the decision-making process.
9. Consider flexible contracts or trial periods for new technologies to allow for adjustments.
10. Balance in-house expertise with outsourced support to ensure efficient management of DETs.
11. Establish clear channels for gathering and acting on user feedback to continually improve DET implementation.

By addressing these social aspects thoughtfully, universities can create a digital learning environment that is not only technologically advanced but also ethical, inclusive, and respectful of individual rights. This approach ensures that DETs enhance the educational experience for all members of the academic community.

Conclusion

By considering the interplay between these four dimensions - pedagogy, environmental impact, technological capabilities, and social factors - institutions can make more informed decisions that not only meet immediate needs but also contribute to long-term sustainability goals. This holistic approach encourages a comprehensive view of sustainability in digital education, helping to create more resilient, effective, and ethically sound learning environments. Economic considerations are not included, since we have chosen not to include them as an explicit dimension in our approach. This decision allows us and, we think, educational institutions as well, to consider innovative solutions that, although potentially costly in the short term, may become more efficient and affordable as demand grows.

As we move forward in this digital age, the decisions we make about educational technologies will shape the future of learning. By adopting this thoughtful, multifaceted approach to DET selection and implementation, higher education institutions can create learning ecosystems that truly serve the needs of all stakeholders while contributing to broader sustainability objectives.