CiC NEXTBOOK

Co-created Interactive Courseware

Project No: 2019-1-UK01-KA203-061669

IO1 _ Pedagogical Framework

June 2021

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Co-funded by the Erasmus+ Programme of the European Union

This communication has been produced with the support of the Erasmus+ Programme of the European Union. The contents of this communication are the sole responsibility of the CiC Consortium and can in no way be taken to reflect the views of the NA and the Commission.

Document version – Control table

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Ana Barata (P.Porto)	2021-02-04	V01
Tinne De Laet (KU Leuven)	2021-03-08	V03
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Tatjana Welzer (UM)	2021-03-09	V04
Tatjana Welzer (UM)	2021-03-24	V05
Ana Barata (P.Porto)	2021-03-30	V06
Ana Barata (P.Porto)	2021-04-01	V07
Ana Barata (P.Porto)	2021-04-15	V08
Ana Barata (P.Porto)	2021-04-28	V09
Ana Barata (P.Porto)	2021-07-15	V10

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1. Introduction

At the very beginning of the Co-created Interactive Courseware (CiC) project, in December 2019, there was already a clear perception as for the essential role Educational technology (edtech) plays on the quick and ever evolving landscapes of Education. This rapidly evolving landscape has suffered an even larger shift when speedily called to develop strategies in response to the challenges created by the COVID-19 Pandemic that has struck the World since mid-March 2020. This worldwide reality impacted on everyone's life, reinforcing that digital tools and environments cannot be disregarded in any sector, especially in Education.

Nevertheless, and prior to the twist educational institutions have faced, the needs propelled by today's workplace demand students in higher education to excel not only in their field of study, but also in broad, 21st-century skills such as critical thinking, leadership, collaboration, active learning, and multidisciplinary collaboration. These are crucial skills in the present knowledge society, characterised by globalisation, internationalisation, digitalisation, and continuous change (International Bureau of Education, 2021), in line with "The strategic framework for European cooperation in education and training" (European Comission, 2020), which pursues, namely, to "improve quality and efficiency", and to "enhance creativity and innovation" at all levels of education and training (European Comission, 2020).

With shifting and more demanding expectations, new requirements for the tools that support the learning process are a reality in higher education as well. However, too often, technical solutions are either limited in flexibility, and thus are applicable only to narrowly defined types of content or come with a significant technical burden for the educator in terms of initial setup, configuration, management, and ease-of-use, especially for those lacking in digital literacy; and lack the necessary controls, leaving little room for creativity, inspiration, and research. Hence, difficult to use solutions are often a time sink, diminishing the promise of such technology, especially for large groups of students. Besides, challenges in this educational level also relate to the exceptionally high failure rate in the first year across many fields of study.

Although this multifaceted problem is unlikely to be solved by any single solution, the right direction from which to tackle it is to increase student engagement with the respective subject of study, and to shorten the feedback loop in the student support process. Several studies approach this concern (Cassidy et al., 2019; Kahu, 2013; Mercer-Mapstone & Bovill, 2020), providing enriching support to elaborate strategies from. Technology is an enabling force that can unlock an unseen potential in the digital-literate student population. Nonetheless, even with the increasing adoption of digital tools, the promise of a significant increase in study performance or effectiveness remains to be accomplished.

CiC project aims at establishing the pedagogical backdrop against which newly available tools such as Nextbook[1], an under-development framework built with collaboration in mind, could be implemented in future courses. Moreover, CiC aims to create a methodology around co-creation and learning analytics that could be applied to different contexts, and diverse educational levels. Dwelling with research and the involved partners' experience, expertise, and insights, the research within the

[1] Platform available at www.nextbook.io

project is propelled by the will to explore the opportunities and challenges of using a co-creation facilitator platform such as Nextbook.

The Co-created Interactive Courseware project takes, therefore, a holistic approach, proposing a solution that aims to increase student engagement by combining three solutions: (1) A social learning environment where students can help each other learn and track their own progress; (2) A fully automated publishing flow where authors can publish their existing (static) courseware and thus create interactive, co-creation-enabled textbooks with zero technical overhead; (3) A learning analytics engine offering the professor/teacher insight into the full learning trajectory of their students.

This document presents the desk research on co-creation, scaffolding the involved partners' experience and insights on these matters, and introduces the pedagogical framework aimed at providing teachers with a set of approaches on how to explore and integrate in their teaching scenarios the co-creation of knowledge to foster students' engagement and motivation, and simultaneously handling integration, improving communication between students as well as empowering them to enrich their courseware and, then, contribute to enlarge knowledge and their will to learn.

1.1. Objectives

This document introduces the pedagogical framework outlining approaches to provide teachers with strategies on how to incorporate co-creation of knowledge into their teaching scenarios. Based on the literature review and on the partners' experience on this matter, a unique student-centred approach framework is proposed in chapter 6.

1.2. Methodology

The pedagogical framework on co-creation was developed based on desk research, focusing on published papers and reports on the Educational area, informal interviews with teachers, professors, PhD researchers in the field, other academics, and on the expertise of the project partners.

This process also involved online surveys, and interviews with stakeholders, and it will still involve Delphi groups, conducted by the involved partner institutions, to pilot the proposed framework.

The main target group are higher education students, through their higher education institution and lecturers acting as gatekeepers, and IT teams and staff developers acting as support. Hence, the scope of the framework is primarily higher education, but it is intended to be adjusted to fit other Education levels from pre-school to high school levels as well as companies willing to engage their staff in the company development.

1.3. Structure

This document is divided into five chapters. It starts by providing an overall review of the literature referring to co-creation and student engagement in higher education, followed by an overview of recent pedagogical approaches (Chapter 2). Afterwards, in Chapter 3, the CiC partners' experiences are scaffolded, focusing on the respective institution's vision, strategies and facilities adopted to

involve students in the diverse facets of knowledge-building. Chapter 4 concerns an overall description of Nextbook platform, its features and perspectives for development, followed by the proposed pedagogical framework in Chapter 5. This document ends with a reference to future steps and a few conclusive remarks.

2. Co-creation of Courseware: Overview of the Literature

Higher Education is a fundamental ground for learning, research, experimentation, and growth, and the students are the core target characters on this landscape. Thus, teachers and researchers on Education focus their attention on how to engage students, as approached by (Bovill, 2019b; Kahu, 2013; Owens et al., 2020; Rengel et al., 2019), on developing further and more effective methodologies to motivate and enlarge learning, critical thinking, constructive argumentation, creative capabilities, among others, as explored by (Blau & Shamir-Inbal, 2017; Bovill, 2019b; Cattaneo, 2017), on devising strategies using EdTech to enable innovative, meaningful, and tailored learning and knowledge development like (Chootongchai & Songkram, 2018; Cesar Huerta-Guerrero et al., 2021) spotlight.

This chapter frames the background of the research within CiC project, centred on three core dimensions: (1) co-creation of courseware, its impact on students' engagement and motivation, the challenges and opportunities to higher education when embracing this approach (2.1.); (2) the pedagogical trends framing adopted approaches (2.2.); and (3) the settings in which these methodologies are applied (2.3.).

2.1. Understanding co-creation and engagement in learning scenarios

Co-creation

Collaboration, cooperation, active learning, co-creation are commonly used terms when discussing the design of learning scenarios that aim at students' engagement in the learning processes. Students' engagement is widely "recognised as an important influence on achievement and learning in higher education" (Kahu, 2013). What is more, being engaged in the learning activities also increases students' interest in participating more actively in the institution they are attending (Dollinger et al., 2018). This mutual motivation fuels the process of co-creation that as (Dollinger et al., 2018) point out "can allow for institutions and students to work together to improve the student experience and enhance students' ability to act as partners" (Dollinger et al., 2018, p.210).

Most studies focus mainly on projects involving "small groups of often already super-engaged or privileged students" as Bovill states (Bovill, 2019b), disregarding students' contribution to curriculum development, to social and cultural change, as well as the reality of whole and large classes of students. Nevertheless, few studies may be found, considering students' role in the governance of the respective higher education institution (Carey, 2013; Mercer-Mapstone & Bovill, 2020), and others exploring active learning approaches in large classes (Exetera et al., 2010).

On the one hand, this document discusses and aims to set what co-creation implies, perceiving the student as partner despite the complexities implied in this expression (Bovill, 2019b), embracing a holistic approach, and, on the other hand, it explores diverse levels of engagement and their implications on students', teachers', and on education institutions' expectations (Bovill, 2019b; Carey, 2013).

Following Bovill's research (2014; 2015; 2019; 2020), when analysing and referring to the potential of co-creating learning and teaching, we consider content development not only within a course's learning activities, but also as to diverse other fields and contributions students act upon, as follows: student representation in the Education institution governance system, students' contribution to course design and curricula as pointed out by Mihans et al. (2008) and Rock et al. (2015) (op. cit. Bovill 2019), students as collaborators on research projects with teachers and researchers as explored by Werder and Otis (2010) (op. cit. Bovill, 2019), and "acting as change agents" as spotlighted by Dunne and Zandstra (2011) (op. cit. Bovill, 2019), students as "representatives on committees for quality assurance and enhancement purposes", as highlighted by Luescher-Mamashela (2013) and Buckley (2014) (op. cit. Bovill, 2019), and as "consultants providing feedback on teaching observations", like Cook-Sather et al. (2014) and Huxham et al. (ccc) analysed (op. cit. Bovill, 2019). Knowledge sharing, i.e. the way institutions and students combine their knowledge and skills to improve themselves (Dollinger et al., 2018), is a key-element to co-creation. Deriving from the information gathered, when the term "co-creation" is used in this document, it embraces the pointed out myriad characteristics and features, also implied in the term "co-production" by (Dollinger et al., 2018)

Supported on the above-mentioned studies, CiC partners embrace co-creation as a process of student engagement that encourages students and staff members to become partners who have a voice and a stake in curriculum development.

Engagement

The rapid growth in the number of students enrolling in higher education degrees has deepened the awareness about diversity, which has led to greater demands and complexities in the processes of teaching and assessment, deriving on the need to analyse what student actual engagement means when large and heterogenous classes are every schoolyear a reality, namely in higher education. Literature argues that active learning approaches have the potential to promote student engagement with lectures, but this becomes an undeniable challenge when class sizes increase (Bovill, 2019b; Exetera et al., 2010; Kahu, 2013). By "large class" we consider a group of more than fifty students, which already imply active participation to be limited.

Exetera et. al.'s study, for instance, investigated student engagement from a teacher's perspective "to identify practices in teaching, learning and assessment designed to promote student engagement in courses with more than 1000 students" (2010). Large classes are often associated to limited interaction between students and lecturers in the classroom, to a high degree of student anonymity, and to courses where didactic teaching prevails (Exetera et al., 2010, p. 762). The authors spotlight that teaching large or small groups of students implies very similar teaching skills, as both scenarios require commitment as to "the need to motivate students, being systematic, organised and developing stimulating assessment tasks" (Exetera et al., 2010). Nonetheless, the larger the classes, the more challenging is to engage students with class activities and with the learning materials.

Owens et. al (2020) discuss students' resistance and motivation to active learning approaches, introducing several studies that state that active learning enhances "students' motivation and attitudes" on the one hand, while others indicate "that students resist to active learning and censure them on evaluation" (Owens et al., 2020). The authors argue that this apparent paradox and "disparity is a result of variation in the active learning instruction that was implemented" (Owens et. al, 2020), i.e., it is not the concept of being active in learning that hinders student involvement, but the way it is

implemented that may lead to negative reactions. Using a "qualitative analysis of open response questionnaires and interviews", Owens et al. (2020) identified sources of resistance to active learning, namely students not being familiar with the essential practices involved, having to struggle with uncertainty, and the "extra effort required to actively construct knowledge as compared to learning via traditional, teacher-centred instruction" (Owens et al., 2020). For students to get actively involved, and motivated it is essential to structure clear instructions and that they are aware of what is expected from them and the purpose of the activity.

When analysing and discussing student engagement, "the time, energy and resources spent on the activities designed to enhance learning" (Owens et al., 2020) must be contemplated. Engagement is "an evolving construct" (Kahu, 2013) that comprises institutional practices and students' behaviours, related to their level of satisfaction and achievement, including the time spent on the task, social and academic integration, and teaching practices (Kahu, 2013). Kahu underlines the importance of acknowledging the student and the institution as well as the influence of their socio-cultural context to devise a conceptual framework targeted at fostering engagement. Following this author's research, these questions should be considered to identify student engagement: (1) How do students perceive a novel active-learning environment to affect their learning experience? (2) To what sources do students attribute their positive and negative affective responses to active learning? (3) What learning gains, if any, result from participation in the active-learning intervention? (Kahu, 2013).

Furthermore, student engagement may be analysed according to four dominant research perspectives: (1) the behavioural perspective, centred on student behaviour and institutional practice; (2) the psychological perspective, which outlines engagement as an individual psycho-social process; (3) the socio-cultural perspective, which highpoints the fundamental role of the socio-political context; and (4) the holistic perspective, considering a broader view of engagement (Kahu, 2013). This broader view may be linked to the recent research on student engagement that points out "that one way to equalise access to learning within HEI may be to engage students in ways that position them as actors rather than objects in learning (Felten et al., 2019, op. cit. Mercer-Mapstone, 2020). It is this holistic broader view that CiC project embraces, and that underpins the pedagogical framework proposed in Chapter 6.

2.2. Pedagogical approaches in review

Throughout centuries, educationalists have been developing myriad theories and pedagogical models. Turning students into active participants in knowledge building has its roots in the "Socratic Dialogue", the first used terminology to refer to Socrates's pedagogical model, which implied the careful and clear formulation of questions so that students could instinctively answer and formulate questions back (Christie & de Graaff, 2017). As Owen (2016) recalls, "good science begins with good questions", consequently, student-generated questions may actually be "a starting point from which higher-order thinking and collaboration centered" practices may inform (Owens et al., 2020). Designing learning strategies and environments, embodied by active learning pedagogies is demanding as definitions are often contested and intertwined (Cattaneo, 2017). Still, research is clear in stating that "learner-centeredness is a primary goal of all pedagogies", despite their differences in theoretical and implementation backgrounds (Cattaneo, 2017; Christie & de Graaff, 2017). This perspective informs CiC proposed pedagogical framework as well.

When reviewing the pedagogical field, it is essential to consider philosophers, researchers, and pedagogical experts whose contributions are widely recognised as pillar in Education science. Hence, we turn to John Dewey (1859–1952) for the pedagogical philosophy; for research, we focus on Kurt Lewin (1890–1957); for learning theories, we refer to Vygotsky (1896–1934), and to Bruner (1915–2016). All these authors promoted what is known as the "constructivist theory of learning", which puts the learner on the center while the teacher becomes a guide, and a facilitator. Simply put, the constructivist learning theory sustains that learning takes place in problem solving situations where the learner draws on his or her own experience and existing knowledge to discover facts and relationships and new truths to be learned (Bruner, 1961). Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments. As a result, students may be more likely to remember concepts and knowledge discovered on their own (Bruner, 2009). Project-based learning, problem-based learning, inquiry-based, case-based, discovery-based, simulation-based, incidental learning are few of the active learning pedagogies embodied in the constructivist learning model.

Digital information technologies have a major impact on pedagogical approaches in context. They are not simply tools, they demand effective participation, what is more, they contribute to blur the boundaries between authors and audiences, creators and consumers, knowledge makers and knowledge users (Kalantzis, 2012) also in the sense of convergence (Jenkins, 2006). Moreover, the learning systems must be renovated to acknowledge the ever evolving and changing social needs which imply new demands and, consequently, changes in epistemologies and ways of being as (Kalantzis, 2012) highlights.

Media information literacy (MIL) and democratic participation are key in all Education levels at present. The ability to "access, retrieve, understand, evaluate and use, create, as well as share information and media content in all formats" (UNESCO, n.d. op. cit. Drotner, 2020) is central in higher education students, especially in the 21st Century. The widespread advances in technology brought new pedagogical approaches, the creation of outstanding learning environments, and innovative teaching-learning strategies. Education scenarios cannot be understood as limited to the Education institution grounds, they have overlapped the physical institutions.

Aligned with this landscape, the Institute of Education Technology has published a series of annual reports on innovations in teaching, learning and assessment "for the modern, technology-enabled world" (Kukulska-Hulme et al., 2020, 2021; Sharples et al., 2015, 2016). Table 1 presents the six themes identified by Sharples et al, 2015, and the respective pedagogies, which provide a clarifying framework to consider and refer to when devising active learning strategies.

Table 1. Pedagogy themes and associated pedagogies emerging from the Innovating Pedagogy reports (Sharples et al., 2015)

Themes	Pedagogies
Scale	Rhizomatic learning MOOCs Crowd learning Citizen inquiry Badges to accredit learning Massive open social learning
Connectivity	Seamless learning Flipped classroom Bring your own devices
Reflection	Assessment for learning Learning analytics Learning to learn Learning design informed by analytics Learning through argumentation
Extension	Geo-learning Learning from gaming Event-based learning Learning through storytelling Threshold concepts Computational thinking Context-based learning Incidental learning Learning by doing real science
Embodiment	Maker culture Bricolage Embodied learning
Personalisation	Personal inquiry learning Dynamic assessment Adaptive teaching Analytics of emotions Stealth assessment

Flexible pedagogies, embracing, applying, and challenging the "technology enabled world" (Sharples et al, 2015) are the focus of research in diverse levels and fields of study be it engineering specific (Christie & de Graff, 2017), culture awareness (Squire & Jenkins, 2011), computing (Baker et al., 2008; Rengel et al., 2019), directed to children (Drotner, 2020; Tu et al, 2019), or higher education students (Bates & Khasawneh, 2007; Urios, 2017; Teoh, 2006) to mention only a few. The diagram in

Figure 1 scaffolds the connections and variety of facets to consider when framing pedagogical approaches in the 21st century.

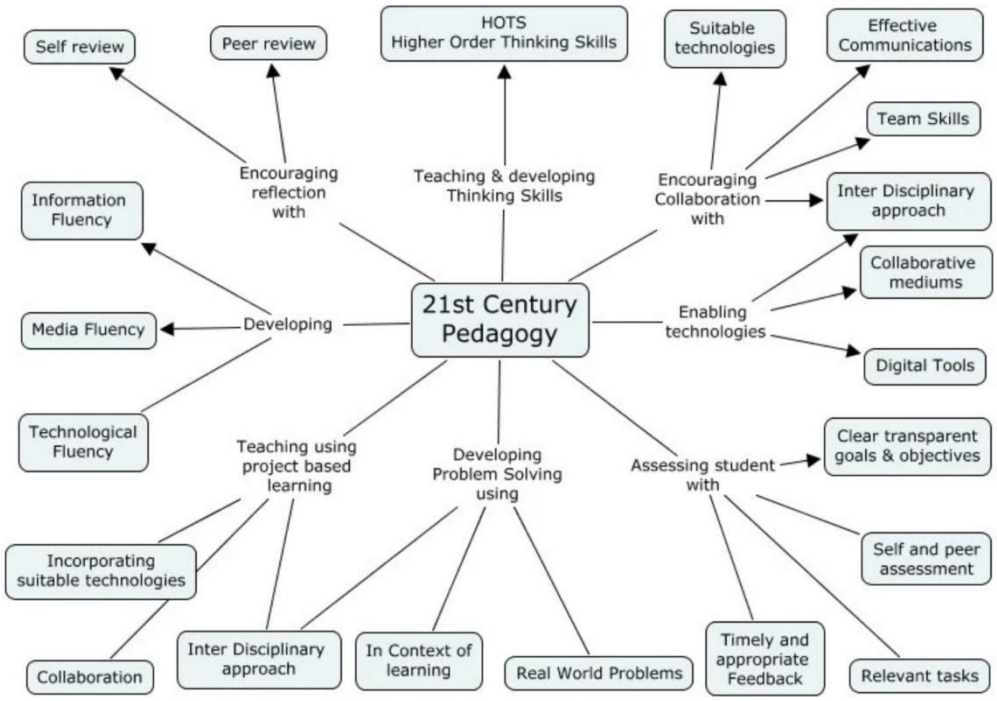

Figure 1. the 21st Century Pedagogy by TechThought Staff (TechThought Staff, 2018)

CiC project's proposed pedagogical framework has considered these approaches, as well as the insights provided in several other reports, namely (Kukulska-Hulme et al., 2020, 2021; Sharples et al., 2015, 2016).

Learning-teaching models (Sharples, et. al, 2015)

Crossover learning – learning in informal settings, linking educational content with issues with real-life applications that students may recognise and apply in their lives. "The crossover learning experiences exploit the strengths of both environments and provide learners with authentic and engaging opportunities for learning."

Context-based learning – learn from experience. Beyond the classroom learning

Argumentation – helps students attend to contrasting ideas; makes technical reasoning public, for all to learn; allows students to refine ideas with others and work together to establish and refute claims; teachers can encourage students to ask open-ended questions, re-state remarks in more scientific language, and develop and use models to construct explanations. Students learn how to listen actively, take turns, and respond constructively to others. (essential for the co-creation concepts with the use of tools such as Nextbook).

Incidental learning – unplanned or unintentional learning that may occur while carrying out an activity. Unlike formal education, incidental learning is not led by a teacher, nor does it follow a structured curriculum, or result in formal certification. However, it may trigger self-reflection, and this

could be used to encourage learners to reconceive what could otherwise be isolated learning fragments as part of more coherent and longer-term learning journeys.

M-learning – or "mobile learning", enabled by improvement in telecommunications and widespread use of mobile devices, or mobile-learning, a "learning modality supported by mobile technology to improve and reinforce learning processes." (César Huerta-Guerrero et al., 2021)

Flipped classroom (FC) – models in which direct instruction is delivered outside the classroom, using videos, while class time is used to deepen discussion on the topic, peer collaboration, personalised guidance (Blau, 2017).

Project-Laboratory teamwork – from (Gozalo, et al, 2017)

Concepts that inform pedagogical approaches and constructs

a) learner empowerment,
b) future-facing education,
c) decolonising education (Ferguson et al, 2019)
d) transformative capabilities,
e) crossing boundaries, and
f) social learning

Student Centred Pedagogical resources

10 Innovative Learning Strategies For Modern Pedagogy | (teachthought.com)

OECD iLibrary | Teaching for Global Competence in a Rapidly Changing World (oecd-ilibrary.org)

Lessons for education during the coronavirus crisis - OECD Education and Skills Today (oecdedutoday.com)

Schooling disrupted schooling rethought How the Covid-19 pandemic is changing education - OECD (oecd-ilibrary.org).

Teaching and Learning Toolkit (an accessible evidence on teaching 5-16 year old)

The-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf (oecd.org)

OECD iLibrary | Creativity and critical thinking in everyday teaching and learning (oecd-ilibrary.org), Fostering Students' Creativity and Critical Thinking.

How are young VET graduates faring in the digital transformation? – Skills and Work (wordpress.com)

Teaching and learning in VET: Providing effective practical training in school-based settings - OECD (oecd-ilibrary.org)

Pedagogy of the Twenty-First Century: Innovative Teaching Methods | IntechOpen

Education 4.0 ... the future of learning will be dramatically different, in school and throughout life. - GeniusWorks (thegeniusworks.com)

[PDF] The Futures of Learning 3 : what kind of pedagogies for the 21st century? | Semantic Scholar

What makes great pedagogy? Nine claims from research (publishing.service.gov.uk) (Children-focused)

Innovating-pedagogy-2017.pdf (open.ac.uk)

2.3. Conclusions

This chapter presented an overview of the literature on engagement, co-creation and pedagogical practices considered the most relevant for their innovative perspectives, and insights they provided for the CIC project. Diverse levels of engagement were researched as well as their implications on students, teachers, and on education institutions. Despite the differences in the diverse analysed pedagogical approaches, the main priority is the learner as the centre of the process.

3. Co-creation across CiC Partners: Experiences and Insights

This chapter comprises the partners' experiences and insights on co-creation, considering the "students as partners" (Mercer-Mapstone & Bovill, 2020) not only in content development, but also in the academic institutions' governance, learning strategies structuring, curricula development, and social engagement. These insights and experiences were collected having in mind the strategies adopted by each partner institution for engaging students in the learning processes and the diverse types of student engagement in the co-creation of knowledge as introduced and defined in Chapter 2.

The chapter is structured in three sections: the first presenting the core values and educational vison of the institutions, the second explores the partners' institution approaches considering the students' engagement in co-creation for learning purposes, comprising its several facets, and finally, in the third section, a list of the available tools and respective uses is included.

3.1. Partners' perspectives and experience on co-creation

University of Wolverhampton (UoW)

In the Faculty of Education, Health and Well-being at the **University of Wolverhampton (UoW),** there has been an emphasis on the **co-creation of knowledge and the social constructivist theories that underpin it** for more than a decade, particularly in the Institute of Education, but also at a wider level within the University, for example, in the College of Learning and Teaching (CoLT). A particular area of expertise in these areas is the initial teacher education (ITT) branch of the Institute.

Traditionally taught through a mix of centre-based subject lectures and in-school experience, teacher education has always sought to blend the theoretical and philosophical with the practical. In this way, taught sessions (including theoretical underpinnings and the direct influence of the tutors) combine with the practical experiences in school and college situations to help shape the pedagogical beliefs of student-teachers. As they negotiate the course, they construct their burgeoning understanding of their role as teachers (Smith 2017a), engaging and participating in authentic environments (Herrington and Herrington, 2006) through placements. It is in these authentic environments in practice-based school and college placements that 'situated learning' (Lave and Wenger, 1991), or learning that takes place in the same context in which it is applied, best takes place. These different values, taken together, have been understood as the 'signature pedagogies of the profession' (Shulman, 2004): a combination of knowledge of how students learn, knowledge of the subject matter they need to learn, and knowledge of the pedagogies to teach effectively.

UoW aims to teach in facilitative and student-centred ways, using "flexible pedagogies" (HEA, 2013, p5; p14) which focus on empowering learners through involving them in the **social co-creation of learning,** creating an educational focus towards **agency and competences**, not just knowledge; and developing cultures and environments for **learning outside of the formal curriculum,** using **collaborative activities** and new and **emergent pedagogies**.

KU Leuven's

A core concept in **KU Leuven's educational vision** is the "disciplinary future self", future selves students develop related to a scientific discipline, towards "Future-oriented Education". The development of such a disciplinary future self requires a student to actively engage in the learning process and in the learning community, consisting of other students, teachers, teaching assistants, professionals, etc., As a result, KU Leuven has been highlighting "student activation" as one of the key areas to work on. Recently, the policy "Going Digital @ KU Leuven" has been put forward, where educational technology is seen as a central tool to promote collaborative, multi-campus, and international education. Furthermore, student activation is one of the 8 quality characteristics that, in KU Leuven's vision, underlies a high-quality program: "The teaching and learning environment encourages students to play an active role in the learning process and contributes to a steady study progress".

KU Leuven is a large research-intensive and general university. It has more than 60.000 students in 49 academic bachelors, 127 initial masters, 40 master-after-masters, 47 postgraduates, and 50 programs for lifelong learning. KU Leuven aims at providing a central mission and related support while still fostering the diversity of the different faculties and educational programs and bottom-up initiatives, e.g., by funding educational innovation projects with open calls. As a result, a wide variety of educational practices exist at KU Leuven, of which the university does not have a full overview.

An exemplary approach for combining the top-down and bottom-up approach is the KU Leuven Learning Lab, with the slogan "united in education". KU Leuven Learning Lab is a network that brings together educational expertise in different faculties and departments, that relate to the Future-oriented Education and Going Digital policy projects.

Instituto Politécnico do Porto's (P.Porto)

Students and learning are the core pillars of a higher education institution's mission. Empowering students to comply with and answer to current and future challenges is the borderless learning approach of **Instituto Politécnico do Porto's (P.Porto**) philosophy that underpins all the eight schools under its umbrella. The largest polytechnic institution in Portugal, attended by approximately 19000 students, P.Porto stands out for its ability to educate young people to the job market, providing them with the fundamental principles and knowledge for contributing to economic growth, and development as well as endowing them with high sense of social responsibility.

P.Porto guarantees 56 degrees, 62 master's degrees and 56 postgraduate programs internationally recognised by the distinctive pedagogical model based on the central articulation between teaching and research, the dynamic interaction with the world of work, based on a knowledge-to do approach, where real-life learning environments are a strong and structuring element.[2] This model favours the development of transversal competences, entrepreneurship, and cultural enrichment, propelling both individual and collective growth and active citizenship. In this environment, students are called to actively participate in the learning processes, in the curricula revisions as well as in the institution's diverse initiatives. P.Porto targets at "training socially responsible citizens, who use their knowledge for the benefit of society, contributing to the construction of a better world"[3].

[2] Cf. https://www.ipp.pt

[3] Cf. https://www.ipp.pt

ISEP, the institution directly involved in the CiC project, is the School of Engineering of P.Porto. Besides the thirteen undergraduate degrees, fifteen master's degrees, a wide diversity of post-graduations, and other shorter training courses, ISEP holds eleven research units in diverse expertise of the Engineering field, which, being tightly connected to the learning processes, promote knowledge transfer and innovation, international cooperation, close relationship with industry and the world of work at large, contributing to ensure the quality in engineering education.

University of Maribor

At the **University of Maribor**, Faculty of Electrical Engineering and Computer Science, co-creative learning has been implemented on many levels. This has been especially useful during the COVID-19 pandemic period due to online teaching. Some collaborative tools were already part of the learning strategies, so the transition was not too hard for students nor teachers.

The entire University has decided to use the **Microsoft Teams** tool as a single communication platform for instant written and audio-visual communication. This decision paid off, as it avoided the confusion of using a multitude of different tools, among which both professors and students could get lost – this enabled the focus to be kept on the content. As both teachers and students were already familiar with Teams, it was possible to make a smooth transition from classroom lessons to distance learning in one weekend.

During the lectures, **Mentimeter** or similar tools are often used to engage students in creating content to debate and develop. We also use it to test the current knowledge of students and see if any more explanations are needed for the students to understand the topic. One of the well accepted tools is also when the lecturer gives students an option of **what they want to hear** at the next lecture on the topic within the course description. This gives students a powerful feeling that they are leading the course content and are also more engaged further on.

A good co-creation method was also an **analysis of the solutions** provided by the students. When students received some programming tasks, for example, they had to submit their assignments. After the review process was finished, examples of mistakes can be presented at the next lecture so that the students understand and hear the content of the course again and try to remember it well. It is also very important that the students have access to the material presented at the lectures immediately after the synchronous lecture. That is how they can easily remember what they were explained at the lectures and can make extra questions to the lecturer if anything on the material is not clear.

Moving into a virtual environment brings with it many limitations and requires many changes and adaptations. Still, it has also broadened horizons and illuminated some options and ways of working that were previously neglected or not used at all. One of the major challenges that arise here is the **active participation of students** in the pedagogical process. Teachers know the challenges they face in the classroom, how difficult it is to animate a crowd of students and convince them to participate in the classroom with answers to questions, self-initiative questions, comments, etc.. It turned out that in a virtual environment, such cooperation, which could also be described as a kind of co-creation of lessons, is a bit more demanding. Namely, students are hidden behind their screens, usually without microphones and cameras, and they respond to the questions asked by the lecturer with more restraint than in the classroom. Such a limited mode of interaction can negatively affect both lecturers and students and, therefore, requires adaptability and mitigation. It has been shown that students

respond much better to methods of interaction that do not include audio and video, e.g. the aforementioned Mentimeter, so we want to accelerate the use of such methods in the future.

Methods that are closer to the current generation of students include **instant messaging**, as communication via email seems outdated to most. We have noticed that many students talk via private messages without much hesitation, perhaps even easier than live. The method of communication without hesitation can be an **important element in co-creating study material**, as in this way, pedagogical staff can get a direct and unencumbered response, either in the form of questions or comments, through which they can adapt or supplement the study material.

An approach that ensures a more dynamic involvement of students in the pedagogical process is also the **granulation of obligations** and the associated assessment methods. This means that the final grade of the course consists of several components: participation in laboratory work, solving short quizzes, seminar assignments, presentations, projects, and at the end of the course the written exam. Although such a course implementation requires much more commitment from the lecturer and the teaching assistant(s), there are many pedagogical advantages: the assessment is more objective, as it covers the whole semester and the effort put in during all this time as opposed to the assessment, which would be concentrated on one day. Assessment is also performed with several different methods, thus removing the bias of individual methods that could be close to individual students. After all, an **assessment that takes place throughout the semester** can also indicate potential problems live, which can then also be resolved quickly, as there is no need to wait for a change in the entire generation. Therefore, this makes it possible for the students to co-create the course path.

Another useful direction is also office hours or lately also 24/7 availability via MS Teams. Students can easily contact the lecturer to discuss some topics that were not clear to during the lecture and the lecturer can do an evaluation of the comments and explain the content in a way that makes it easier for students to understand in the next lecture.

After passing the exam for a particular subject, it is the practice at the university to conduct **surveys** for students where they are asked about their satisfaction with the subject and the lecturers. With the help of these surveys, students can shape the future of the study program as they can point out potential shortcomings and praise the strengths. Also, part of the survey is intended to assess whether they were burdened as much as provided in the curriculum during the course, or whether there were any deviations. This offers lecturers a good view of the student's workload and enthusiasm on the course subject.

If we summarise all the mentioned elements, we can conclude that at the University of Maribor, students are involved in various ways in co-creating the study process, but there could probably be more ways of involving students in co-creation.

Student engagement in the co-creation of content for learning purposes

UoW provides the following pathways for their teaching staff to engage students in the co-creation for learning purposes.

Co-creation of the curriculum:

- **Student representation**: At UoW, students are represented in almost all levels of educational decision making and quality control, making them partners in the co-creation of the curriculum. They are represented in the Program Advisory Boards, the Faculty Program

Advisory Board, and in our Quality Assurance processes. The recognition of student-voice enables students to influence certain aspects, such as what they would like more or less of in our provision.

- **Feedback from students:** UoW uses the Rate My Module approach, where all students individually evaluate the modules on their courses, and more widely on their whole course, and this is also tracked nationally through the published National Student Surveys.

Co-creation in modules: Many programs, depending on the learning outcomes, contain some form of project work or problem-based learning (PBL), where students work, often collaboratively, on researching or designing a solution to realistic problems. We also expect presentations (screencasts, live presentation, poster sessions etc.) as part of many modules, and these are assessed by both peers and tutors. On teacher education modules, such as Politics, Policy and Practice, students have complete autonomy to follow a brief and research any policy and classroom-based practice in the context of their placement. This allows for a student-centred approach that enables specialism in a particular area, with students choosing their own materials, how they present their research and the mode of assessment.

Co-creation of the learning experience: UoW uses a plethora of ideas to allow co-creation of the learning experience such as in-session whole-group, small group, and partner discussions, PBL, *jigsawing*, *snowballing*, *envoying* and *rainbow groups*, paired or group student presentations, etc. Two particular approaches are to let students co-decide or co-design the teaching or assessment used, and to use an approach of learning by inquiry where students create their learning experience and content, with tutors acting as facilitators rather than didactic teachers. This is particularly prevalent in UG research dissertation modules, in PG assignments and on all of the taught master's programmes. There is also an expectation for students to engage in discussion on pre- and post-session content, using the *Flipped Learning* approach (Smith & Gurton, 2020).

Co-creation of course content: Within particular courses and modules, students create course content through video, audio, podcasts, wikis, and blogs. There is a specific emphasis on collaborative work in all of these. On modules such as an Access to HE 'inclusive education' module, the community of students quite literally becomes the curriculum itself in a Rhizomatic approach (Cormier, 2015) as we shape each session's content around free writing that the students do each week. Elements of that writing, which draws closely from students' own life experiences of their education, are weaved directly into the subsequent week's sessions to explain and illuminate educational theories in a continual spiral praxis (Scott and Bennett, 2021). The students are inducted to HE as curriculum writers.

Co-creation of research outputs: we should note that the Institute hosts taught courses and research programmes. These are not two distinct and separate activities but rather for different students are blended in different ways in different proportions. At one extreme are postgraduate research programmes, including PhD programmes composed of only individual and unique research but also EdD programmes where a smaller volume of individual research is combined with a significant proportion of taught courses. At the other extreme are entry-level undergraduate taught programmes but even these contain individual courses of increasing scope as undergraduates progress through their degrees. These observations serve to problematise the understanding of co-creation, both in terms of pedagogy and in terms management and administration. For postgraduate programmes, there is the increasing expectation that research students will co-author research papers with their

research supervisors. This is normally seen in the context of progressively developing intellectual independence and academic writing skills but is nevertheless co-creation and when successful feeds content into the wider academic community. Reconsidering these activities in the context as co-creation could be pedagogically fruitful.

KU Leuven provides the following pathways for their teaching staff to engage students in the co-creation for learning purposes.

- **Co-creation of the curriculum:**
    - **Student representation**: At KU Leuven students are represented in almost all levels of educational decision making and quality control, making them partners in the co-creation of the curriculum. They are for instance represented in the Program Advisory Boards, the Faculty Program Advisory Board, and are important partners in the quality assurance process (COBRA- Cooperation, Reflection, and Action with attention for Checks & Balances) that leads to the institutional review for accreditation.
    - **Feedback from students:** KU Leuven uses the "student evaluation of teaching" where students individually evaluate course/teacher combinations. The Program Advisory determines the evaluation schedule such that each course/teacher combination is evaluated at least once every three years.
- **Co-creation in project work, design sessions:** Many programs, depending on the learning outcomes, contain some form of project work or design sessions, where students work, often collaboratively, on researching or designing a solution to a realistic problem. In this process they create designs, prototypes, products, maquettes, etc. Project work and design sessions are often combined with student presentations (video, live presentation, poster session, …) attended by peers and teaching and support staff.
- **Co-creation of learning experience:** Many ways exist to co-create the learning experience such as class-room discussions, project work and design sessions (see previous bullet point), student presentations, etc.. Two particular approaches are to let students co-decide or co-design the teaching or assessment used, and to use an approach of learning by inquiry where students create their learning experience (and often learning content) by the process of inquiry.
- **Co-creation of course content:** Within a particular course, students can be invited to create course artefacts or content. KU Leuven offers support and tools for students creating content through video, audio, podcasts, wiki's, and blogs.
- **Social interaction:** As learning is strengthened by social interaction, the interaction between students and by students and teaching staff can also be seen as a co-creation effort. KU Leuven provides discussion fora natively on their learning platform. Additionally, an integration of Perusall, a social annotation platform, and the LMS is provided. Perusall allows students to "socially" annotate and to discuss directly on the course material, rather than on a separate discussion forum disconnected from the actual learning material.

The following are only a few examples of some contexts in which students are engaged in the process of co-creation, considering not only the direct learning environment involving their degree work, but also their involvement in the social, and management issues of the Institution.

Co-creation of the curriculum, institution's governance and social interaction:

- **General Council Board** (P.Porto)
- **Social Assistance Offices and Boards** (P.Porto)
- **Degree Representatives** (intervenção e parecer sobre documentos reguladores dos momentos de avaliação)
- **Pedagogical Council Board** (ISEP)
- **ISEP Ambassadors:** students embrace the institutions' mission and values and play as mediators and disseminators in the community helping other students to integrate.

Co-creation of within Project work:

- **Project Work Course Units:** Engage students in collaborative learning environments, making use of teamwork to develop a transversal project comprising all the course units of a semester. Students are called to solve a problem by proposing a software solution, combining the hard skills acquired throughout the semester while also applying teambuilding and project management strategies.
- **Learning in context scenarios:** projects engaging students in active and in-context learning such as "Math Outside", or "Math After Hours", "Problem-Based Learning" multidisciplinary projects, involving Companies with recognized influence in the community, and in which students are called to develop projects that aim at contributing to improve a specific aspect with impact on a community.
- **Other initiatives:** Hands-On sessions (involving alumni, teachers, companies, and current students) **ArdLab** (remote laboratory to program microcontrollers – it started being devised as a student internship project and was enlarged to embrace current demands)

Co-creation in research, curriculum development and strategic partnerships:

- **International projects** where students have an active role as contributors and partners: Blended-AIM, ATHENA's Colloquial Talks, Praxis (these involve contribution to curriculum development, knowledge transfer, students as partners when providing feedback (questionnaires, surveys) to improve approaches and strategies).

Approaches and strategies for student engagement in the learning process

The approaches and strategies elaborated below cannot be interpreted as a complete list of all engagement and co-creation practices, but rather serve as inspiring examples.[4]

The approaches/strategies to promote student engagement depend on the underlying pedagogical strategy: learning by listening/watching, learning by finding out, learning by doing, learning by discussing, learning by creating or learning through collaboration (https://www.kuleuven.be/english/education/leuvenlearninglab/academic-year-2020-2021/blended-learning/didactic-formats). The "big picture" of student activation, and strategies to obtain activations, as presented to teaching staff at KU Leuven is summarized in Table 2 that follows.

[4] KU Leuven

Table 2. Student activation and strategies to obtain activations at KU Lueven.

Students think along	Students work along		
	Individual action	**Group action**	**Actions specific for outside in-class interaction moments**
Concept Map, Make Thinking Process Explicit, Demonstrations, Rhetorical Questions, Examples, Invited Speakers	Concept Map, Asking questions, Triggle Reflection, Classroom Assessment, Portfolio	JigSaw exercise, Peer instruction, Discussion, Student presentations, Case studies, Peer Assisted Learning, Group work, (interdisciplinary) Project work, Roll play, Simulations	Flipped classroom, Company visit or excursion, Preparation for interaction moment

All engineering degrees and respective course units have their specific characteristics which imply that a diverse set of strategies and methodologies may be used. The following are only some examples of the most common, considering, first, those integrated within the Moodle.ISEP (the Learning Management System used at ISEP), and Microsoft Teams, and second, general pedagogical approaches that may be brought from a F2F context into an online, at a distance, learning environment, being in line with (Bovill, 2019b; Owens et al., 2020; Sasao et al., 2017; Weisberg, 2006). (list is similar to KU Leuven).

Available Tools:

UoW utilises technologies that can support these ideals. Below is a non-exhaustive list of tools that are supported at the central level and/or used by colleagues, especially in the light of the pandemic and its disruption to 'service as normal'.

- **Canvas** is the university's learning platform or learning management system (LMS), also known as a Virtual Learning Environment (VLE). It is a generic industry-standard system that has been customized and extended by the IT services of the university. Our Canvas platform has been optimized for learning modules, assessment rubrics, portfolios, discussion fora, an internal collaborative platform called BigBlueButton (BBB) (with presentation and breakout facilities), quizzes and the uploading of student material in multiple file formats.
- **Online real-time video interaction:** BigBlueButton (integrated in the LMS), Microsoft Teams, and Skype for Business.
- **Online real-time T&L interaction:** Mentimeter, Kahoot, etc.
- **Asking questions during interactions:** Poll everywhere, Polly (in MS Teams), Padlet, message boards on BBB or MS Teams
- **Co-creation of content:** joint/shared portfolio tasks, presentations, responses to tasks on Google Docs, Flipgrid, etc.

For each of the strategies (**Table 2**)[5] for activation support, material for teachers is available on the intranet.

KU Leuven provides educational technology that can support the above activation. Below you find a non-exhaustive list of tools that are supported at the central level.

- **Toledo** is the university's learning platform or learning management system (LMS). It is a blackboard-based system that is customized and extended by the IT and didactic services of the university. Besides the functionality that is readily available in any LMS, Toledo has support for discussion fora, self- and peer assessment, learning modules, rubrics for feedback and assessment, and portfolios.
- **Kaltura** is the video platform of the university, which is connected to the LMS such that student activity can be monitored and tracked.
- **Online real-time video interaction:** Blackboard Collaborate (integrated in the LMS), Microsoft Teams, and Skype for Business.
- **Asking questions during interactions:** Poll everywhere
- **Co-creation of content:** wiki and blogs
- **Social annotation tool:** Perusall, a social annotation tool, also allowing for annotation assignments, is available at KU Leuven and fully integrated with the LMS. See also Miller et al. (2018) and Suhre et al. (2019).
- **Learning Dashboards:** Since 2018 KU Leuven is investing in so-called Learning Dashboards that provide students with feedback on their learning and study progress based on educational data that is available within the institute.

The Learning Management System used at ISEP (and at P.Porto's schools in general) is Moodle. Moodle comprises a set of tools that enable the creation of dynamic learning materials, and activities where students may be called to collaborate, discuss, and develop content collaboratively. The following are only few examples of the most used. It is relevant to point out that due to the COVID 19 Pandemic, which has led the classroom to shift from physical to online, the use of the LMS's integrated tools have become a daily practice for both teachers and students.

Databases and Wikis – for registering and systematizing student researched-and-produced content, making it accessible to all the students who share a specific course. Terminology and theoretical concepts definitions are the main content systematised, enabling editing, improvement, and further completion of the contents by the involved students and teachers.

Workshops – provide a dynamic environment for including students' presentations and videos, linking these to the databases and wikis.

BigBlueButton is integrated in ISEP's moodle, allowing video conferencing with a full class, or working in breakout rooms, which makes it possible for structuring team tasks in classes where the number of students is often above 35.

Online apps (not integrated in Moodle) such as Mentimeter, Kahoot.it, b.socrative are used to devise steering activities, specific content recallers, and informal assessment tasks.

[5] KU Leuven

Private and Public channels on TEAMS; Collaborative Learning Library Folders

Virtual and Remote Engineering Labs[6] are also used, proving the students the possibility of performing electronics experiments and procedures in their browser (example: http://physicslabfarm.isep.ipp.pt/).

3.2. Challenges and Opportunities of Co-creation Across the Partners' Institutions

Drawn from the literature review and the partners' experience and insights, considerable challenges and opportunities were identified for the integration of co-created knowledge in higher education.

University of Wolverhampton (United Kingdom)

Affordances arising from technology's increased user application and the social and participatory nature of such software have long been understood but nevertheless still need to keep pace with students' evolving social, recreational and informal experiences digital and expectations of digital technology. These affordances don't need repeating here, but it is worth noting that collaboration has consistently been central to technology's affordances for students, whatever the theoretical model or framework referenced. Co-creation is (and was) a far greater stretch in transforming education than enhancing student-centred participation as it went from the reproduction of information to user ('student')-generated content creation. Yet co-creation represents an aspiration for institutions who rightfully regard students as partners in the learning process, as people not having education done 'to' them, but with them. This goes beyond what we have previously referred to as 'passive learning' to 'active learning'. It also goes beyond personalisation – as in the personalised learning plans of students mapping what they want to learn, what they want to develop and how they want to learn and be assessed. Co-creation is a far more ambitious step change that involves an epistemic shift in how students view knowledge and how they view their participation with knowledge and the world. Therefore, any discussion of its challenges, must recognise that at its core, the opportunities involve addressing why it is right for students to be co-creators and that this is a question of power through participation. As Paavola and Hakkareinen have it, a dialogical ecology forms part of the participation metaphor of learning, where co-creation sits: "...a view where the interaction with the culture and other people, but also with the surrounding (material) environment is emphasized" (2005: 539).

The challenges in any theoretical approach come down to praxis: how is the conceptual understood and how is it applied? With relatively emergent theory, practitioners may initially struggle to assimilate it and reify it in context. We are sure this is not exclusive to Wolverhampton, but we are relatively blessed to work in a faculty that prides itself on teaching innovation, rather than fixations on 'what works well' or supposed evidence-bases. An institutional and open mindset to innovative

[6] "Remote labs stand for physical apparatus connected to computer-controlled instruments able to be remotely accessed for carrying out real-world experiments" while "Virtual labs" refer to simulation and modelling using a computer (Source: http://ave.dee.isep.ipp.pt/~rjc/Docs/2016/CISPEE2016/paper_CISPEE2016.pdf)

teaching and learning is an opportunity that can emancipate teachers from the challenge of thinking 'how do I do this in practice?' It is difficult in education to innovate, to take risks, make mistakes in situ and try again, but if not exercised in authentic contexts, then when and where should pedagogy become innovative? Our opportunity is that we are in Teacher Education and our students, prospective and becoming teachers, allow us the liberty to attempt to model theory-in-practice, or praxis. With such teaching, we are essentially undertaking a design-based research approach (Brown, 1992), which involves flexible procedures and iterative reflections and analysis of implementation, that especially lends itself to introducing new technologies and associated theory.

A challenge, of course, is that all pedagogical implementation and praxis is contextualised. What we accomplish in UK-based university Teacher Education is unlikely to be transferable holistically across contexts, subjects, age groups, etc. In effect, all we can do is describe and report what happened when we did what we did.

We will hope to involve partners in this work, because we have large networks of practitioners and organisations, often showing willing. A challenge will be to introduce any new element into over-burdened workloads, even when we predict that the use of a tool will save time or improve processes. There is always a degree of acclimatisation and perseverance in introducing any new technology into practice, both for the teacher and the student group and attrition can be problematic if there are no immediate obvious gains or appeal. We know from Garrison, Anderson and Archer's Community of Inquiry model (2000) that any harmonious teaching and learning environment and community (and its tools), must integrate necessary social elements, alongside cognitive ones. This remains to be seen with co-creation, though it would appear to be inherently social in its nature. However, the circumstances of COVID have brought numerous challenges to education, but principally it may be considered that the fun and caring elements of education were overlooked by teachers rushing to deliver lessons and talk of students 'falling behind' in their learning and of a need to catch up. When learning loses its sense of the social, of the soulful, of the event and the occasion, it ceases to have relevance in the real world. So, the gains from co-creation and associated technologies must be shown not in terms of improved grades or faster learning, but of more meaningful participation.

The challenges then are present in how we persuade adoption, for after all we must believe in the technology and theory and not try to sell it. In Teacher Education we have an apprehension to explain affordances and would rather 'becoming teachers' realise these advantages for themselves. There is a need to present tools somewhere on the Gartner Hype Cycle's 'Plateau of Productivity' (www.gartner.com). This is done not to lessen the imagination or diminish the teacher's creativity, but to avoid entering into the hype of inflated expectations. As we well know, the technology is not the feature, it is the human use that holds any potential and promise. Here, we are really not concerned with this tool or that tool, but the pedagogical application. Co-creation is a human endeavour. Knowledge, whether it is situated in the pages of a text or applied in skilled practices, is not static and fixed, it is malleable and can be modified according to who the student is, what they already know, and how the knowledge is being manipulated, used and treated.

In our Access to HE course, for example, co-creation is practiced in a fashion that directly legitimises who our students are and builds a curriculum flexibly around their contributions, which comprise free writing exercises as biography. These biographies exemplify and embody theory that we go on to teach in subsequent sessions - and students' stories are referenced directly in the ensuing resources. The teachers provide stimulus prompts, the students respond, the teachers respond to

those as the responses coalesce into teaching and learning material (Scott and Bennett, 2021). In short, the students literally write the course, and the teachers remain flexible to whatever arises. Until now we have used personal writing spaces for these activities ('Canva' - an online writing space), but the aspiration is to make writing collaborative and social and literacy to be the visible, public instrument it is in the real world (Scott, 2018). As already stated, a co-created curriculum helps empower students and hone the agency with which they act on the world - a development from 'learning about' to 'learning as becoming' (Brown and Duguid, 2000).

To return to an earlier remark, it is worth considering how students' use of digital technology, especially of social media mediated by mobile phones and perhaps, in the case of part-time students in various professional contexts, of working collaboratively, might be reconsidered as informal or unrecognised co-creation. In different ways, knowledge may be co-created content, for example co-authored professional reports, or may be co-created understanding, for example shared responses and comments in social media posts. These all represent patchy 'prior experiential learning' that students bring to co-creation in academic settings, with the possibility of engaging with higher level skills such as meta-cognition and critical appraisal.

Advantages/opportunities of co-creation

In general, social constructivism states that students learn through sharing experiences and that they build knowledge and understanding through discussion. Co-creation can facilitate the sharing of experiences through jointly creating course material or discussing course material. Research has furthermore shown that students understand the material better after discussing it with others, creating an advantage for co-creation involving discussion around the material, and improved academic performance or higher quality of work from students (Bovill 2014, Deelye & Bovill 2017). As KU Leuven as any higher education institute wants to **improve the learning outcomes and experience** of students, could take advantage of co-creation. For the particular example of a social annotation platform, Miller et al. (2019) showed that students complete their reading assignments in a flipped teaching setup significantly more when using a social annotation platform, and that students using the social annotation platform perform significantly better on in-class exams than students using a simpler annotation tool.

Co-creation has a high overlap with the concept of **active learning** (Bovill, 2019) and therefore has potential to activate the student in the learning process hereby aligning with KU Leuven's vision towards student activation. Co-creation creates a shared responsibility, implying a **greater level of student agency and empowerment** (Bovill, 2019), and therefore had the potential to trigger **high quality and high intensity of student engagement.** Students can perceive themselves as active agents in the process, rather than passive clients, where they feel greater autonomy, can practice self-regulation and responsibility. Students feel more in control if they can steer the learning process, for instance when based on the questions they asked when preparing for class in a flipped teaching session, the interaction during class is adapted.

As students interact with other students and with teaching staff during the co-creation process, co-creation has the potential of strengthening the **relationships between students and between students and teaching staff (Bovill, 2019)** by creating interactions connected to the course material. Students can feel as an integral part of the learning process and can feel valued by other students and teachers as they can positively contribute to the development of the course. Students get the opportunity to feel part of the disciplinary learning community, which can strengthen the disciplinary

future self of the students, which is key in KU Leuven's vision. When in a flipped teaching setting the teacher can connect to the questions and discussion of students around the preparatory material, students feel valued and recognized.

Both teachers and students can profit from **high-quality material** that is developed during co-creation. The material can not only serve the current student cohort but also future cohorts. Moreover, the co-creation can profit from available **Open Educational Resources (OER),** or can result in new OER material that can be further shared and potentially create impact far beyond the own institute.

The creation of course material can be one of the **learning goals** itself. For instance, in the educational master, students co-create material that will be used as learning material in class later on.

Co-creation in higher education can also be looked at from a managerial or even economic perspective. It can **create value** for students and the institute itself as it has the potential to attract students, retain students, and increase student satisfaction (Dollinger, 2018). In the context of Flemish higher education, this managerial and economic perspective is not as prominent as in UK, US, or Australian contexts due to the differences in the financing of higher education.

Often **technological platforms** are used to facilitate co-creation. The fast technological development of such platforms and the increased user-friendliness and ease-of-use contribute to the potential of co-creation, especially regarding asynchronous interaction between students that might even be at very different locations. For KU Leuven these technological platforms for co-creation offer possibilities for high-quality and interactive online or blended teaching and multi-campus education (supporting the multi-campus model of KU Leuven). The latter has become even more important due to COVID-19, where teachers and students have been looking for approaches supporting interactivity when face-to-face education is impossible.

Co-creation offers the opportunity to have **interaction and discussion directly connected to course material**. Too often discussion and interaction opportunities *about* the course material are *separated* from the course material itself as they take place on dedicated online discussion boards. As a result, students do not see the interaction or discussion when studying the course material, hereby missing a potential important learning opportunity. For large classes, these separate discussion boards and their separation from the course material have also led to a lack of overview of the interaction and discussion. This subsequently makes it more difficult for the teaching staff to spot repeating difficulties and thus opportunities for improvement. It also causes students to repeat questions and discussion points, creating additional work for teachers and support staff, and moreover contributing to the lack of overview.

Challenges of co-creation

Co-creation also comes with a set of challenges for the KU Leuven context. Teaching staff will be **less in control** of the teaching process as students can steer the learning process and/or material. This can create stress and anxiety. There will be a **decreased level of control of the pace** of the learning process and **time** dedicated to particular activities. Especially when the teaching is already "packed", teachers will feel extra pressure and feel less inclined to give away part of the control. Moreover, teachers use part of the control over the material or learning process that is being created and might be concerned in particular over the **quality of the learning material and/or learning process** created. Teaching staff will also be concerned with the experience of students and will, due to the teacher/course evaluation that can influence the career of teaching staff inside KU Leuven, be less inclined towards innovative approaches.

Teaching staff can be **reluctant to change towards co-creation,** as this will involve time and effort that might be hard to offer considering the already over-full agendas and time schedules of most of the teaching staff. **Additionally,** their **course material can already be fixed and well-established** after many years of experience. Additionally, the nature of the course material can make it harder to use for co-creation. One particular constraint is the use of existing textbook of (international) publishers, which often do not allow for adaptation.

Co-creation requires that students actively engage in the course already during the running semester, and not only towards the final exams. The structure of the **academic calendar** does not always allow for. The KU Leuven calendar for instance still relies on dedicated weeks for studying ("blokperiode"), preceding the also long exam periods. As a result, curricula have to be built such that students can still spend time for processing of the courses in these dedicated studying and exam periods, leaving less time during the teaching weeks. During the teaching weeks the courses are, as a result, perceived to compete for time and attention, making a course using co-creation potentially harder to accept by teachers of courses in the same program.

The higher expected active engagement of students during the semester can also **create resistance to change with students.** First, as elaborated before co-created course are expected to increase the required attention and time-spent during the semester, which students are not always prepared to offer due to different reasons (they expect more flexibility to distribute their time, they have a student job during the semester, they already have other courses demanding a higher engagement during the teaching weeks, …). Second, students often prepare an "easy" pathway that does not necessarily lead to optimal learning. Thirds, depending on the level of co-creation students can feel **uncomfortable and anxious** due to the potential **decreased predictability** of the learning process, the structure of the course, or the fact that part of the learning material still has to be co-created. Finally, if only a single of a minority of courses is using co-creation students could have already settled in the passive mode of "receiving education", making it harder to activate them in co-creation.

As Bovill (2019) indicates co-creation only works if it can build on a **good relationship between student and teacher and between students and other students.** Co-creation requires a safe atmosphere of mutual appreciation and understanding where trust is key. Obtaining such a relationship can be challenging especially in settings with **large groups** and with teachers that are perceived to be "unreachable" experts.

Co-creation has been shown to be hard to obtain in whole class teaching setups with **larger groups** (Bovill 2019), a setting in which KU Leuven often operates. Moreover, the increasing **diversity** of the student population at KU Leuven creates an extra challenge to make sure that all students inclusively collaborate to co-creation.

Connected to the former is the challenge of potential **unequal participation of students.** As often, we can expect that the already more engaged and motivated students will engage most in co-creation. How to engage *all* students? Moreover, unequal participation can be especially worrying is the process of co-creation is part of the assessment.

Regulatory constraints might also hinder co-creation. KU Leuven teachers have to get their syllabus, teaching approach, and assessment strategy approved the academic year before the course takes place. This limits the freedom that teaching staff can still offer in the co-creation. As mentioned earlier, the course/teacher evaluation can also hinder change towards co-creation as teachers are less inclined to experiment in a setting where their course/teacher evaluation might directly influence their career.

A multitude of technology-related constraints can also hinder co-creation. Platforms for co-creation should be integrated with the LMS to get optimal acceptance. Moreover, they should come at no additional or a very low cost. Many teachers and student unions at KU Leuven are particularly sensitive to additional costs that have to be made for studying. Finally, the current technological limitations can also hinder adoption. One particular concern is that a lot of the course material in scientific courses heavily rely on formulas and scientific publishing languages such as LateX. Scientific formulas, and pdfs resulting from the scientific publishing languages, are often not well supported in technological platforms. Finally, the technology should allow for easy integration of existing course material, integrate seemingly with the learning platform, be easy to use, still allow for export of the created material (no lock-in), allows to easily follow-up student interaction with the course material, etc.

Finally, sustainability is always a concern. Pedagogy and approaches for co-creation should not only work with the highly engaged and motivated staff for the first year but should also be able to continue after the initial years of deployment and should be able to convince teaching staff beyond the early-adopters.

Opportunities for KU Leuven

Connection of co-creation to the educational vision and policy of disciplinary future self, student activation, and Going Digital @KU Leuven.
Flipped teaching has been getting a more popular pedagogy. Co-creation can be connected to the preparatory assignments/exercises/reflection modules or to the in-class activities.
Discussion and questions connected to the course material itself.

3.3. Conclusions

Increasing student participation, co-creation has recently become a trending topic in higher education. Co-created courses leverage input from students to create better higher-quality courseware that is continuously kept up to date. By enabling students to actively partake in the creation of their learning resources, we unlock the potential to create a positive feedback loop with micro-rewards for every successful interaction. What is more, COVID pandemic and the pivot to online teaching have reinforced our belief in the need for developing further innovative alternative to the already in use solutions, strengthening the possibility of acting as catalysts for innovation.

Co-created courseware comes with many benefits out-of-the-box. On the one hand, students are not only encouraged to delve deeper into their subject of study, but also to excel in 21st century skills such as digital literacy, citizenship, and eloquence; to be entrepreneurial, if only by taking the initiative to propose a meaningful change, and to interact with their classmates in a constructive way. These qualities are elementary in a global, digital society where the only constant is a continuously increasing rate of change. Co-creation also allows teachers to put their finger on the pulse of their student population, without the overhead typically associated with conducting tests.

In higher education, there are more and more attempts to actively involve students in the pedagogical process in terms of their partnership and co-creation. Often these activities depend on the available tools and approaches chosen by the individual teachers, group of teachers or the part of the institution or nevertheless the whole institution. We can often also observe that such collaborations are very differently named (not necessarily co-creation), tied to selected tools, e.g. gamification (Mentimeter,

Kahoot, Socrative), points, challenges, time-limited activities (tests, quizzes), narratives, all available inside Moodle, or just short assignments, conversation, references and similar especially in cases where the tools are not used. These will depend on the activities, tools, organisation of teaching and even course teachers.

The major challenges facing co-creation is engaging teachers in the process of reorganising and restructuring course materials as well as overcoming institutional procedures (regulatory environment), especially when already validated learning platforms are at use. Moreover, the culture of each organization, implied in the institution's management policy, the need for training and the resistance to change cannot be disregarded. Other constraints for adopting co-created courseware approaches pointed out by the partners refer to the number of students in each course, the often text-based, using in-house materials in Word doc format, for example, and the adjustments implied to ensure a stable curriculum and pro-active lecturers.

4. Nextbook in review

The Nextbook platform was built from the ground up with collaboration in mind. The platform is designed with the aim to actively involve students in the creative process, in the pursuit of multiple goals:

1. **Capture the students' knowledge and insight.** Students have a unique perspective, based on their experience as "information gatherers", in the process of creating a mental model from scratch. As such, they are exquisitely positioned to identify gaps, inconsistencies, or otherwise opportunities for improvement in the learning material at hand.
2. **Improve student appreciation** of and engagement with the course material. The IKEA effect is a well-documented cognitive bias in which consumers place a disproportionately high value on products they partially created. Without overstretching the analogy, this can be applied to courseware as well.
3. By bringing students together in a social environment that is designed to be encouraging and conductive to participation, the creators of Nextbook hope to provide a building block to **grow the social tissue** amongst students in absence of a physical classroom setting.
4. By (partially) outsourcing the responsibility of keeping the courseware up to date to the readership of a book, we **decrease the burden for authors** in their (periodical or continuous) review to bring or keep their courseware up to date. Even if large, substantive improvements are unlikely (e.g., due to the highly technical nature of certain works), co-creation offers the potential for academic literature to be improved in smaller ways such as through adding references, correcting typos, flagging outdated segments, formatting, interlinking content, fixing small mistakes or by means of typographic improvements. Given this large variety in potential contributions, co-creation the potential for incentive structures (such as rewards for helpful suggestions) to be implemented later on.
5. Students are not the only ones who stand to gain from co-creation. **Authors** can more easily keep a proverbial finger on the pulse of their readership, especially when their book is distributed beyond the audience of their own lectures.

While some of the co-creation features of Nextbook are still under active development, in its current form, the platform enables students to provide feedback on the courseware and help each other study through an integrated chat functionality.

The co-creation tooling in its current form consists of a system that enables students and teachers to provide feedback on any content on the platform in an integrated way. Specifically, any piece of text can be annotated with a private highlight or private note, or with a public comment. These comments provide the starting point for discussions to take place on the platform.

Furthermore, the platform enables authors to embed several interactive modules into their course texts, such as text entry fields which allow for students to provide their feedback in private to the teacher or author.

Since the start of this project, we have been able to get several learning about what does and doesn't work when it comes to encouraging students to actively participate in a digital forum such as Nextbook. Although these findings are still preliminary and have yet to be confirmed at scale, they already provide a very useful starting point for future exploration.

What Works Well

The main driving force in having students participate in a co-creation process is active encouragement and instruction by their professor, lecturer, teacher or TA.

We have seen in limited trials at the K.U. Leuven that students who were prompted to process the following works:

- Computer-supported collaborative learning
- One framework to rule them all?
- Supporting classroom orchestration with real-time feedback

The students were divided into two groups per document, making for six groups in total. (The Nextbook platform offers the ability to group students in virtual classrooms that are closed off from one another, to split up groups across years or, as in this instance, to subdivide a large audience into smaller, more workable groups.)

One of the advantages of working with smaller groups of students in parallel is that teachers can reuse questions several times, significantly reducing the workload of having to create an abundance of quiz material. Furthermore, answers can be compared later (e.g., in a physical classroom setting, as here was the case).

We have learned that students are more forthcoming with providing feedback in a private setting. Whether this is an inherent characteristic of online classroom interaction remains to be evaluated across different audience sizes. However, qualitatively, we have already identified several avenues via which student confidence (and perhaps, consequentially, participation) can be improved.

Opportunities for Improvement

In our quest to provide an online environment for students to interact that inspires familiarity, comfort, and safety to experiment; several improvements can be made to the platform.

- **Onboarding guidance.** Students should get a better feel of who gets to see their public comments, whether they can be deleted later, whether their teacher gets to see the same, if comments are permanently displayed in the courseware of their peers, etc.
- **Non-intrusiveness.** In their current incarnation, comments can be seen as relatively intrusive, as they're always visible in the courseware of all classmates (i.e. students taking part in the same digital classroom environment), above certain screen sizes. (At smaller screen sizes, comments have to be toggled open by clicking the corresponding text that has a light blue underline, which is also permanently visible.) Ideally, the system would hide older comments, questions that have been answered, or remarks of lesser importance — either in an automated way or through moderator interaction.

- **Usability.** Currently, comments have to be "attached" to textual content, which can be a single character, a word, phrase, or multiple blocks of text. However, it can readily be seen how certain questions pertain to entire sections as a whole, or do not naturally correspond to any specific content. Likewise, graphical content such as images would benefit from a more intuitive method of annotation (such as point-and-click, linking the comment to a (x,y) coordinate on the graphic).
- **Visibility settings.** Questions of less than universal importance would benefit from a menu enabling their reach to be set, e.g., one classmate only, a group of close friends, or everyone except for the teacher. Such functionality is currently absent, but in the pipeline. The same applies to comments that are a continuation of previous offline conversation.
- **Notifications.** The utility of a commenting system is based in part, and to a significant degree, to the expected response time after the question has been posted. Although the Nextbook platform sends email notifications to its administrators upon submission of a comment, such functionality should be extended to its users as an optional setting. In addition, different methods for delivering notifications (desktop, app) are desirable and a repeatedly mentioned suggestion.

The design of Nextbook is centred around its content model, which at the same time enables its unique features, and comes with some challenges that are specific to the platform. In this section, we will provide a non-technical but detailed overview of the platform architecture, and contrast this with several competing platforms and the different trade-offs that they make (i.e., different advantages and disadvantages).

From the onset, the development of Nextbook has been guided by a focus on (1) Compatibility, (2) Automation, and (3) Usability as follows.

(1) Compatibility

In contrast to alternatives, books on Nextbook are not saved as documents. Instead, all learning content on Nextbook is a) organised in a relational hierarchy and b) stored as structural information with strictly defined semantics.

a) Hierarchical organisation of content

Books on Nextbook are organised as a content tree, with the topmost title being the book title, below which are the chapters, sections, subsections, etc. It is from this title hierarchy that a table of contents is generated. Each title comes with a set of corresponding learning content, and any number of subtitles, recursively.

The design of this system is such that titles can be reused across multiple books. Although the authoring tools have yet to be implemented, in the future it will be possible to compile a book by picking and choosing content from different authors, and combine this with self-written material.

b) Structural information with strictly defined semantics

Being a browser-based web application, Nextbook is faced with the challenge of displaying learning content in a visually appealing way across many different screen sizes — from tiny smartphone screens with a portrait layout to large browser windows on desktop screens with a landscape layout. Because of this, the Nextbook platform chooses the ideal layout based on the viewport size, document semantics, and user settings. In other words, the platform doesn't require and doesn't store any information related to formatting — with the sole exception for inline text markup such as bold & italics. All other layout and formatting choices are made "on the fly".

There are no limitations on possible types of content. Currently, the platform has implemented the following content types:

- Blockquote
- Box, i.e. a segment with a callout (such as "Exercise", "Warning" or "Tip")
- Codeblock
- File
- Formula
- Image
- List
- Multiple choice question
- Paragraph
- Table
- Textual input area
- Video
- 3D model

This can be extended. Some types of content can be containers for an array of content, recursively. These are: Blockquote, List, MultipleChoice and Table. For example, tables can contain images, text (i.e., paragraphs), and lists, which in turn can contain the same.

(2) Automation

The generic and extensible nature of this design enables mapping to and from existing file formats. Currently, an advanced content conversion algorithm has been implemented that extracts the content with (semantic information and a subset of formatting) from Word (.docx) files. This conversion takes care of extracting, rescaling, and cropping images; extracting cross references, hyperlinks, footnotes, and endnotes; applying several typographic improvements; and enriching the content wherever possible. Two examples of such content enrichments:

- Lists with open circles as bullet points are often intended as multiple-choice questions. When the content conversion algorithm recognises such content, it is automatically implemented as

a multiple-choice question that can capture and retain student input — all without any intervention from the author.

- Dotted lines of sufficient length are generally intended as text input fields. The content conversion algorithm detects these and converts them to (inline or block) text input fields, which are enabled without requiring any further configuration.

While this content model enables the platform to enrich content in an effortless way, it comes with two main trade-offs, as follows.

One, the conversion algorithm is not yet built into the platform. This means that, for the time being, there is still a human "in the loop", necessitating an email workflow. Although temporary, this prevents interested authors and teachers from freely experimenting and familiarising themselves with the platform.

Two, some information loss from the original manuscript is inevitable. While all textual content can be retained, sometimes it is desirable to retain certain formatting that is not yet recognised and capture by the content upload algorithm. In these instances, either a one-off manual intervention is required, or the conversion algorithm can be adapted to enable the platform to henceforth capture such content. A recent example encountered during this project, is the capturing of endnotes in Word files, which are similar to footnotes and occur rarely.

In the future, it will be possible to upload content from other file formats. Early prototypes exist for LaTeX (.tex) and Markdown (.md) files.

Like the content upload, the platform enables exporting to any type of output format. Although this export process is technically much simpler because we can start from a well-defined input, it has yet to be implemented.

(4) Usability

Being a tool to be used in an educational setting and with the aim of being a credible substitute for paper, it is of paramount importance that the Nextbook platform provides its users with a frictionless user experience that is pleasant, accessible, and effortless.

As a rule of thumb, designs and features that improve accessibility for students with an impairment, also improve the usability of the platform for all other users.

Nextbook has currently implemented the following accessibility and usability features.

- **Text to speech.** All content on the platform can be read out loud by a synthetic voice adapted to the language of the text. This feature is enabled out-of-the-box for all content and free of charge. The user has the option to tune the reading speed, volume and — for some languages — the accent. A visual indication (underline) is provided for the sentence that is being read.
- **Visual themes.** To accommodate reading at any time of the day, readers have the choice of applying a light, dark ("night mode"), or high-contrast visual theme. Because the platform applies certain restrictions on the visual formatting of its texts, it can enable students to apply formatting to their own preference.

- **Keyboard navigation.** The platform is navigable by keyboard for the most part, including navigation via dynamic elements such as the dropdown menu at the top. The sole exception to this is the text highlighting feature, which by its very nature requires a point-and-click device.
- **OpenDyslexic.** Users can choose between several typefaces — one of which is specifically designed for people with dyslexia. The font consists of asymmetric and dissimilar shapes, so that those who are suffering from dyslexia can read with ease and are less likely to interchange the position of the characters. (See the website of OpenDyslexic for supporting research.)
- **Browser-based.** Being a web app, Nextbook offers the accessibility and ease-of-use that comes with using a web browser, including the ability to copy and paste text, adjust the font size, open multiple copies side-by-side for comparison, share "deep" hyperlinks to specific parts of the text, etc.

Prior Art

There is a large variety of alternative learning platforms that come with different trade-offs.

5. Proposed framework

Driven from Dollinger's proposal (2018) (Table 3), combined with Bovill's Co-creation of Learning and Teaching Typology (Bovill, 2019a, 2019b) and the pedagogical methodologies systematised in the Innovating Pedagogy Reports (Sharples et al, 2015; Ferguson et. al., 2019), Table 4 introduces our proposed framework for co-creation, which may be applied in diverse settings (lifelong learning, autonomous learning, online learning, blended learning) and educational levels (Pre-school, Grammar school, High school, Higher education, Vocational education and training) for a wide range of purposes (language learning, mathematics learning, engineering-related content improvement, health matters learning, history, geography, sciences, etc.).

Table 3. DIMENSIONS (From Dollinger's, 2018)

First-order Construct	Modification to Higher education
Knowledge	How does the student integrate their knowledge, experiences and/or other resources into the value proposition of higher education?
Equity	Does the student have equal access to the development and design of the higher education value proposition?
Interaction	What is the quality of the interactions between the student and the higher education institution to integrate resources and co-create the value proposition?
Experience	How does value co-creation impact student experiences within higher education?
Personalization	To what extent can students personalize their higher education value propositions?
Relationship	How does value co-creation impact student relationships to their higher education institution?

Table 3. CiC Pedagogical Framework

DIMENSIONS	QUESTIONS	POSSIBLE RESPONSES
Relationship	Who starts the co-creation?	Staff-led | Student-lead | Staff and students
Knowledge	What is the focus of the co-creation?	Entire curriculum (co-creation of the curriculum) | Learning & teaching (co-creation in the curriculum | Educational research & Evaluation | Disciplinary Research | Wider student experience | other (business-driven, company-related, world of work)
Relationship	What is the context for the co-creation?	Curricular | Extra-curricular | University- wide | ….
	How many students/participants are involved?	1-5 | 6-10 | 11-20 | 21-30 | 31-100 | 101-500 | over 500
Equity	Are students/participants selected from a larger class or is the whole class involved? (institution's sector | whole institution	Selected | Whole- Class |
Equity	Which students are involved?	Retrospective | Current | Future/Aspiring
Equity	What year of study are the students/learners/participants in?	First- year Bachelor | Later than the 1st year | Master | PhD | Postgraduate | Life-long learning | VET | Pre-school | Grammar School
Knowledge	What is the scale of the co-creation?	1 class interaction moment | several classes / interaction moments | 1 project | several projects | entire course | faculty/school wide | institution wide
Experience	How long does the co-creation last?	Days | Months | Years
Interaction	What is the role of the student?	Representative | Consultant | Co-researcher | Pedagogical designer | Participant
Experience	What is the nature of student involvement?	Informed | Consulted | Co-researcher | Pedagogical designer | Contributor
Personalization	What is the nature of reward or recompense given to students?	Payment in money/ vouchers | Refreshments | No payment/reward
Experience / Interaction	What is the goal of co-creation?	To improve the course | To enhance student engagement | Aiming for a socially just higher education | Impressed by benefits | Incorporating the student perspectives | to enhance student's skills

In a nutshell, the proposed framework for co-creation of knowledge, embraces diverse facets (institutional, curricula, social, cultural), and intends to be applicable to a variety of educational settings (lifelong learning, autonomous learning, online learning, mobile learning, blended learning), as well as educational levels with especial focus on higher education, and vocational education and training. Students are perceived as partners, co-creators, co-producers, i.e., directly intervening in the educational process.

6. Next Steps

A Delphi study will be conducted for discussing the proposed framework to apply co-creation within education contexts, collecting perspectives from experts in pedagogy, key actors in training and education institutions.

Furthermore, piloting Nextbook will take place across the partners' institutions, comprising different course units, levels and purposes. Reporting on the process and results will follow.

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