User Centered Design of a Curriculum for Teaching Creativity Online

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Abstract

Creativity was identified as one of the four cornerstone skills of future engineers and is said to rely on direct connection to others, and on teaching settings allowing for face-to-face phronetic experience. Against the background of the pandemic-caused online teaching, the main objective of the European project TICON – Teaching creativity online - is to identify barriers in engineering Higher Education for teaching creativity online, and to upskill the teachers in terms of digital teaching with appropriate pedagogical approaches.

The underlying curriculum, was developed following a User-Centred Design approach. In the first step, Experience Interviews with 32 Higher Education engineering teachers in Turkey, Irleand, Denmark and Germany have been conducted. As a result, barriers and best-practises as well as further needs and interests have been identified.

On this basis, a first draft of the curriculum – the curriculum prototype - was designed and presented to the target group in Focus Groups in each of the four countries. Within each Focus Group, participants were introduced to the project and findings of the interviews. A group discussion was then held by going through the draft curriculum for three aims: To understand, if the curriculum prototype fits into the problem space derived by the Experience Interviews; to derive further needs and ideas for the curriculum and to validate the prototype. The final curriculum consists of three lessons: 1) Why - Introduction to creativity teaching and its relevance for engineering; 2) What - Method and tool skills for online teaching and 3) How - Skill development for how to teach.

Keywords: Online Teaching, Creativity, User-Centred Design, Experience Interviews, Focus Groups

Introduction

Now the second most common sector in higher education in the EU-27, which is engineering, manufacturing and construction, attracted 15.8% of the 17.5 million students in tertiary education in 2018 (Eurostat, 2020). Engineering curricula in tertiary education have shifted in recent years from teaching purely technical skills to complementing management competences and innovation capabilities (Kolmos, Hadgraft, & Holgaard, 2016). These changes are a response to trends that require visionary problem-solving skills to improve outcomes such as human health, responsible production and greater sustainability (Haase, 2014) (Sheppard, Pellegrino, & Olds, 2008) and to promote entrepreneurial activities (Kolmos, Hadgraft, & Holgaard, 2016). In addition, emerging technologies such as artificial intelligence, machine learning and robotics may pose a threat to job loss through automation. However, "occupations that involve the development of novel ideas and artefacts are the least vulnerable to computerisation" (Frey & Osborne, 2017). As a result, creativity has recently been identified as a critical competence for future engineers, as it cannot be replaced by technology (Brown, 2018) (Kim, Kim, & Lee, 2017). Therefore, HE engineering teachers are increasingly challenged to activate and enhance engineering students' creative abilities.

The global crisis caused by the COVID -19 pandemic has recently triggered another shift in engineering education in higher education institutions (HE): Universities have been "forced to move learning online due to nationwide shutdowns" (Giridharan, 2020), leading to a move towards hybrid and online learning environments, which is expected to continue (Li & Lalani, 2020) (Zancajo, Verger, & Bolea, 2022). As digitalisation becomes a key activity across all sectors (Gandhi, Khanna, & Ramaswamy, 2016), the future of engineering education is being steered towards distance learning. For example, the European Commission prioritises "enhancing digital skills and digital transformation competences" (p. 12) in its "Digital Education Action Plan" for 2021-2027 (European Commission, 2020). However, experts believe that such a transformation requires further training of teachers in the use of digital teaching tools as well as the development and implementation of appropriate curricula (ibid.). Although creativity is hailed as an essential skill in engineering (Cropley, 2015) and HE engineering teachers know that creativity techniques can help improve their students' innovative thinking skills, they believe that it is difficult to apply creativity techniques in the classroom (Anderson, et al., 2022). According to our observations since March 2020, this challenge is exacerbated in an online environment.

Objective

Despite the fact that the awareness, knowledge, willingness and ability of HE teachers to use digital learning materials has increased dramatically since the onset of the COVID -19 pandemic (Giridharan, 2020), we find that current online engineering curricula at European universities are not sufficient to teach and adequately reward creativity. One reason for this could be that creativity requires a direct connection with others, which requires a teaching environment that allows for a face-to-face phronetic experience (e.g. Nonaka & Toyama, 2007) (Kaiser & Fordinal, 2010). This poses a major challenge for teaching creativity online. To make matters worse, there is a lack of systematic approaches to help engineering teachers incorporate the subject into online teaching environments. In addition, student anxiety and discomfort have been found to increase in online environments, preventing participation in creative tasks that require the presentation of ideas outside of normal thinking paths (Giridharan, 2020). Altogether, this represents a significant barrier for engineering students.

Moreover, there are few pedagogical studies that address the teaching of creativity online in HE institutions, which is both surprising and worrying given the urgent need for educational institutions to move to hybrid and online teaching. In order to teach creativity online, systematic approaches need to be explored to enable HE engineering educators to integrate creativity methods and techniques into online teaching environments (Mbati & Minnaar, 2015) (Bashir, Bashir, Rana, Lambert, & Vernallis, 2021).

To address these shortcomings, the research questions are: 1) How could a curriculum for upskilling HE engineering teachers to teach creativity in online classes be designed and 2) what elements should this curriculum have to take existing challenges and needs into account and can be implemented in an online toolbox?

The answer on the first research question is presented in the chapter on Design and research methodology. The second question is answered in the chapter “Final Curriculum”

How: Design And Research Methodology

Within the European project TICON (Teaching creativity online) with project partners from Turkey, Irleand, Denmark and Germany, we had the opportunity to design a curriculum for teaching creativity online using a qualitative (Flick, 2014), iterative and user-centred approach (ISO 9421-210, 2019). The User-Centred Design process foresees four activities with active engagement of future users: (1) Understand the needs of the user, (2) specify the requirements, (3) produce design solutions and (4) evaluate the solutions. These steps are repeated to iteratively refine the design solutions until a satisfactory result is obtained.

For the first step, we conducted Experience Interviews (Zeiner, Laib, Schippert, & Burmester, 2016) with 32 HE engineering educators (eight from each country) from various engineering disciplines to gain insights into challenges, best practices as well as upskilling needs of teaching online. Experience Interviews are a variant of narrative interviews (Flick, 2014) in which interviewees are asked to relate both their most positive and most negative experiences. The interviews were recorded, transcribed, thematically coded (Guest, MacQueen, & Namey, 2012) and analysed over all four countries with Affinity Diagrams (Courage & Baxter, 2005).

Based on the specified findings, we prototyped a draft curriculum as the first design solution. For evaluation and to derive further needs and ideas, this curriculum prototype as well as the findings of step one was presented to 60 HE engineering educators (15 of each four countries) in Focus Groups (Fern, 2001). Focus groups are group discussions that not only make it possible to evaluate the previously collected findings, but also to gain deeper insights into their meaning from the perspective of the respondents (Grudens-Schuck, Allen, & Larson, 2004). The focus group sessions were recorded and analysed with a content analysis similar to the interviews. On this basis, the curriculum prototype was enhanced and refined during a cross-case comparison of all findings in a group interpretation session of the project partners.

Since the specific engineering (Sarsar, et al., 2021) and cultural perspectives (Semmler, Uchinokura, & Pietzner, 2018) influence the practices of teaching as well as its conceptualisation, we used a purposive, variant sampling strategy (Flick, 2014) to recruit HE engineering teachers for the whole process.

Detailed Design Process

Experience Interviews

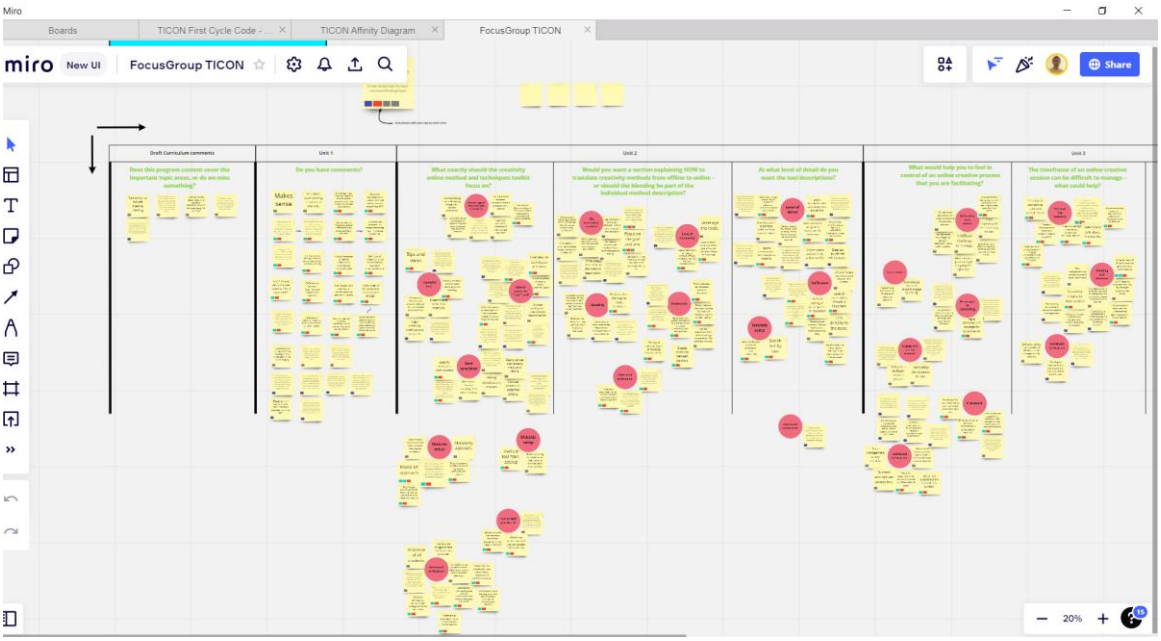
As stated above, the main goal of conducting Experience Interviews in the first needs analysis step of the target group was to identify the specific barriers, challenges and best practices related to using creativity methods and techniques in online teaching as well as to gain insights into upskilling needs. Therefore, interviewees were asked for the elaboration of positive and negative experiences when using creativity methods and techniques in both classroom and online teaching. In addition to socio-demographic data and previous experience, they were additionally asked what knowledge and skills make them successful at teaching creativity, what technical material they use and what and why they would like to learn about online teaching.

The interviews took place in four different countries with attendance of 32 HE engineering teachers (eight from each country) from different engineering disciplines. 14 of

them were female and 18 male. Each interview had an average length of 40 minutes. The experience with using creativity methods or tools in physical teaching has been between one and 30 years with an average of 7.7 years and in online settings between one and 10 years with an average of 2.4 years. Figure 1 shows the according Affinity Diagram above.

Figure 1

Miro board screenshot affinity diagram of first cycle code



While 26 of 32 interviewees had a positive experience with creativity methods and techniques when teaching in classroom less than 50% had a positive experience in online settings. As online positives were mentioned that it is easier to reach and involve more students online, that anonymity can enable student participation, and that there are potentially fewer negative group effects. The main negative mentions were technical difficulties, challenging time management and process moderation or control and that the lack of eye contact and interaction is affecting the motivation and outcome of the teaching for both students and teachers. Also, no one-to-one translation of creativity techniques from classroom to online is possible.

The interviewees expressed interest to learn more about the following topics:

- Creativity methods and techniques that work well online (best practices), and how to blend online and offline environments
- Facilitation skills that relate to the planning and application of the creativity methods and techniques in online classes (session design and time planning, process control)

- Personal soft skills that allow for building trust, enabling engagement and interaction, avoiding negative group effects
- Technologies – programs and applications that can be used when teaching creatively online

Curriculum Prototype

Taking all the findings of the Experience Interviews together, we designed a first prototypical curriculum and according contents with respect to the principles of Universal Design for Learning (Burgstahler, 2021). This early version was shaped by several factors, such as learner's characteristics and needs, learning goals, activities that could support learning, effective assessment strategies, and the larger goal of creating an active learning environment that has the potential to respond to the complex needs of current higher education engineering programs, teachers and students. The initial structure followed the topics, which the educators expressed in the Experience Interviews.

- Unit 1 "Introduction to creativity teaching" covered the topics "creative thinking and teaching with creativity techniques", "importance of creativity in engineering education" and "specific challenges of using creativity in online HE Engineering teaching settings".
- Unit 2 "Improving skills for online education in creativity" was on "creativity methods and tools for teaching in online and hybrid settings", "use of different tools blending online and offline teaching environments".
- Unit 3 "Facilitation skills for online education in creativity" includes "teaching session design", "time planning", "facilitating individual and group", "assessment and evaluation" and "best practices and examples".
- Unit 4 "Soft skills for engineering teachers" covered "engaging students in online and facilitating interaction", "avoiding negative group effects and building trust among groups", "developing empathy in online teaching" and "dealing with the challenge of extra preparation time".
- Assessment of participants: The assessment methodology was based on short quizzes at the end of each unit for registered users to earn an overall certificate.

Focus Groups

The aim of the Focus Groups was to understand to what extent the above curriculum prototype fits into the problem space derived from the experiential interviews and how the curriculum could be further developed based on the data gathered from the focus group interviews and the subsequent analysis and reporting processes.

In the focus group sessions, the curriculum prototype was used as stimulus material and 60 engineering teachers (15 from each of the four countries) were asked to review the curriculum in terms of scope, content, methodology and pedagogy. 28 of them were female and 32 male. Each focus group session lasted between 1-1.5 hours. Overall teaching experience ranged from one to 25 years with an average of 9.3 years. 27 of them stated low, 15 medium and 18 high knowledge of using creativity techniques in the classroom.

The engineering teachers provided constructive ideas about the curriculum, such as what an ideal toolkit for teaching creativity should contain, whether and how current creativity methods could be translated from offline to online, and how detailed the toolkit should be. They also described the specifics of ideal conditions that help one feel in control when conducting creative processes in class, how the time management aspect of a creativity session should be designed, what soft skills engineering teachers need in an online teaching environment, how to effectively motivate engineering students, and how to build trust in an online creativity session.

The engineering teachers also helped to gather further design refinements. According to them, the curriculum should be designed to integrate creativity teaching into online engineering education by putting more emphasis on the engineering design and implementation cycle aspects. For the respondents, the key to innovation is creativity itself, and creative learning exercises would help students improve this skill. As an essential component of a student-centred online creative session, the curriculum should provide efficient feedback in real time. In addition, the curriculum should provide enough room for pedagogical flexibility. More specifically, the curriculum and the final version of the online learning environment should be dynamic enough to allow users to make necessary changes depending on student needs and learning outcomes. The emerging learning environment should also benefit from the active knowledge sharing of all users, which would make it active and vibrant and enable its users to build a supportive community. Participants emphasised that the effective use of creativity skills online requires a significant amount of pedagogical knowledge. In this context, engineering teachers believe that they should be supported with relevant pedagogical information so that they can make productive decisions about their online creativity sessions. Encouraging interactive and group learning, peer learning and ensuring anonymity for students are among the specific skills that engineering teachers feel have room for improvement.

What: Final Curriculum

The insights and collected ideas from the focus group helped us to tailor the curriculum and its content more precisely to the needs of the HE engineering teachers. The final version of the curriculum was reduced to three lessons: 1) Why - Introduction to creativity teaching and its relevance for engineering; 2) What – Method and tool skills for online teaching and 3) How - Skill development for how to teach. Table 1 shows the details for the covered topics.

Table 1

Final curriculum

Unit	Topics covered
Unit 1 – Why	Understanding creativity
Introduction to creativity	concept of creativity and creative thinking
teaching	relevant forms of creativity
	importance of creativity for engineering
	stages and phases of the creative process, and their relation to the engineering process
	Understanding teaching creativity online
	the benefits of teaching creativity online (for both students and teachers)
	challenges in teaching creativity online
	Understanding creativity own level of expertise (assessment)
	knowledge
	own skills and experience
	Understanding this course/ program
	the curriculum (progression, structure, frame and focus)
	key terms used in the curriculum (e.g., tool/ method)
	preparation (what to do before staring the course)
Unit 2 – What	Overarching topics
Method and tool skills for	Effective technology integration and usage of different tools for given and tasks
online education in	Managing the online classroom
creativity	Presentation of creativity methods for teaching online for engineering / HE teachers in this learning environment
	Blending online and offline environments for using creativity methods
Unit 3 – How	Preparation of teaching creativity online
Skills development	Lesson design and framing
	Preparing technology usage
	Preparing students
	Preparing content
	Group- and teamwork when teaching creativity online
	Setting up teams
	Supporting, facilitating, and monitoring effective group- and teamwork
	Engagement of students
	Avoiding negative group effects

Facilitation of online creativity teaching
Facilitating in different lifecycle phases
Keeping time
Providing and receiving feedback
Engaging and motivating students
Ensuring and assessing skill attainment
Tips and tricks for effective teaching
Best practice and trick stories
Case examples
Trust building

Unit 1 has become more focused on basics such as creativity concepts, definitions and showcases of its benefits in the real world. Also, an assessment of the teachers own level of expertise has been included. Unit 2 emphasizes now on technology integration and managing the online classroom as well as blending online and offline. The initial ideas of a method collection now became an extra section of an interactive toolbox which helps to address design problems with specific methods. Unit 3 encompasses now all topics regarding skill development of engineering teachers with a focus on engaging group- and teamwork and a specific tips-and-tricks section from and for teaching experts. Also, the refined assessment methodology now has two levels: Level 1 is a self-directed assessment of own expertise level, which can be taken after each unit for individual development. Level 2 are digital badges which will be given by the system automatically once the teachers finish a task from the self-learning template.

Conclusion And Outlook

In light of the relevance of creativity in engineering curricula and post-pandemic online and hybrid teaching in HE institutions, we have presented a novel curriculum including its elements and associated design process for teaching creativity online to HE engineering teachers to help overcome existing barriers and challenges and to upskill the teachers on digital teaching. The resulting three units educate HE engineering teacher in why creativity is relevant, what to teach in terms of methods and tools and how to design and implement engaging creativity lessons. Moreover, the curriculum contains an assessment methodology for individual development and for gaining a badge, which can be used for having a further career. Following a User-Centred Design process by first investigating existing barriers and actual best-practises with Experience Interviews, prototyping a curriculum and evaluating that prototype in focus groups, we were able to gain deep insights on the challenges and needs of engineering teachers and to shape and refine the curriculum accordingly. The Focus Groups in particular

brought a wealth of relevant ideas for the enhancement, orientation and positioning of the curriculum.

Although the focus of the curriculum design was specifically on the HE engineering education on creativity, some parts of the curriculum such as topics on trust building, group work, motivation and engaging student may be generalised to other subjects of HE education or even to general online teaching. Which parts and how they can be translated to other teaching areas and audiences is the subject of future research.

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