Creativity Techniques for Higher Education Teachers (CHET)
IO1- CHET Curriculum Design and Development

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1. INTRODUCTION

CHET (Creativity for Higher Education Teachers) focuses on engineering education, contributing to the demands for modernization of Higher Education (HE) systems in Europe. HE institutions have to provide their students education that will enable them to adapt to an increasingly globalized, competitive, diversified and complex working environment, in which creativity, the ability to innovate, entrepreneurship and a commitment to continuous learning are just as important as the specific knowledge of a given subject. Current educational systems lack of answering the demands of the labour market for professionals with innovative, problem-solving and entrepreneurial capacities. It is thus necessary to make HE engineering teachers aware about the need for renewal of teaching methods to promote the competences in creative and innovative skills of their students. A paradigm change was observed in the last decade in the characteristics of HE students, due to economic pressures and demands of the labour market as well as a swift in the career development of engineering students. All the above poses a challenge on HE teachers, which have to deal with students from a variety of backgrounds and skill levels. This has generated a challenge for HE teachers to be more effective and make teaching and learning relevant, for society, for the labour market and for their students. By providing HE teachers with competencies to integrate creativity and innovation in their teaching activities, they will contribute to a better preparation of their students and are better placed to provide an answer to the needs of the varied classrooms. CHET focuses on engineering HE teachers, because in parallel with the global megatrends (Accenture, 2016) that accelerate the industrial and societal growth such as, new and sustainable resources for production, changing -environmentally responsible and digitally driven- societies, leading to emerging markets of open innovation, engineering education system was drifted towards evolving new opportunities and its own learning trends (Patil, 2012). Today, engineers and technologists have to confront socio-scientific issues as described above and have to increase their soft (people) skills (Lavernia et al 2013), thus, HE engineering teachers are in a pathway to integrate and offer a holistic approach integrating the important issues into their curriculum such as communication techniques, ethics, environmental conscience, social media etc. Moreover, entrepreneurship necessitates not only technically decent, but also creative engineers that can work well in multidisciplinary teams. Bringing about a change in the way education approached, addressing better the needs of the labour market and in the light of the global megatrends, CHET also aims to increase the attractiveness of engineering studies and reduce dropout rates. Experiences have

shown that using creativity techniques increases the problem-solving and innovative capacity of students, while at the same time increasing their motivation (independent of background or skill level) leading to reducing university failure/leave. The participating HE institutions recognize that preparing and motivating students is key to the solution, as their teachers are pivotal in fostering and developing students' creative and innovative capacities. **CHET addresses those challenges mentioned above by providing HE engineering teachers with the skills and pedagogical competences to embed and apply creativity techniques in their teaching activities.** To make this happen, the project will develop e-learning materials and content, based upon the needs of engineering HE teachers, delivered through the CHET learning environment, which will allow them to implement learner-centred teaching approaches that promote creativity and innovation among their students and provide them knowledge and insights on how to increase their interactivity with teachers and peers. Transnationality is vital to learn from each other's experiences in how different national educational systems address the issues and to detect good practices across different countries. Knowledge from different EU regions are combined and integrated into the CHET Curriculum.

The optimal approach to teach engineers creativity is analysed in two ways; first, by looking at how creativity is taught in HE and second, by looking at how teaching of engineering students is the most effective. An extensive literature search carried out to analyze the state-of-the-art findings in this research area.

Evidence for a lack of innovative teaching in engineering classes can be found in Baumann and Seidl`s (2018) paper on engineering students in Germany. By analysing the curricula of 52 engineering programs in Baden-Württemberg they found that only 6,5% of them contained creativity promoting content. In another sample, they found that 90.6% of engineering students consider the promotion of creativity during their studies to be important and that 79.5% of those surveyed would like to see more events on this subject during their studies. At the same time, only 12.1% stated that teachers promote creativity in their courses.

There is a large number of research that promotes the idea that engineers learn best when teachers facilitate project-based learning (PBL). This means that a real-life issue introduced as a long-term part of the class and scientific knowledge should be applied to this. Mills (2003) finds that a mixture of project and problem-based learning appears to be the best solution although any sort of change in the actual teaching methods towards project or problem-based is desirable. Zhou`s (2012) qualitative study of 20 students led to the following conclusion:

"The findings show that, on one side, creativity training was thought necessary and useful by most students and the students got benefits such as learning methods of initiating projects, stimulating motivation of study and understanding creativity theory. These benefits help students shape their social identity of being creative collaborators and creative engineers in their future careers. On the other side, limitations of the strategy indicate that creativity training should be a long-term element integrated into the PBL curriculum and supervisors are needed to introduce creativity techniques in daily instruction work and help new students better understand the PBL educational model."

A few practical solutions to implement creativity given by Cropley (2015). Students need to be able to ask questions and engage in discussions regarding the taught content. Team-based activities engage students to discuss and promote their own ideas. They need practice in coming up with new ideas. A broad knowledge is important to be creative. Knowledge in courses related to their creativity has to be promoted. The uniqueness of real-life problems and ever-changing environments can be simulated if students need to overcome obstacles and build resilience in the course through a great sum of project work. Students must be allowed to make mistakes and learn from them. So that they develop a risk assessment for themselves. Encouraging tolerance of ambiguity for example by not giving explicit instructions but by stating briefly what is expected from them and let them try out. In order to avoid the "I'm not creative" fallacy they need to build creative self-efficacy and find out what excites them. Therefore, they need assistance in exploring different fields as well as organizations. The importance of delaying gratification must be taught so to show them that success sometimes involves hard work and more than the norm-based procedures. Finally, teachers should provide a favourable environment. The engineering teachers need to embrace creativity and innovation in order to be recognized as a role model.

The introduction of innovation in engineering courses is important and should follow a holistic approach. Starting by the curricula and ending at the individual teacher level. Their personal willingness to change should be guided and assisted by useful and feasible techniques.

Instructional Design is a systematic process that links teaching with theories and hypothesizes in order to improve the quality and standard of teaching activities and to improve the teaching process in accordance with learning needs in a valid and reliable manner (Cowell et al, 2006). ADDIE is the most widely used teaching design model when using many teaching design models today. ADDIE model is a cyclical process consisting of "Analysis, Design,

Development, Implementation and Evaluation" stages, aiming at creating effective teaching resources (Branch, 2009). ADDIE was chosen as an instructional design model for CHET project because it is (i) a very well-known instructional design model, (ii) practiced in many different fields and (ii) used in different cultures.

In the analysis phase, which is the first phase of the ADDIE model, needs of the learners are determined and analyses for these needs are carried out. In this context, while conducting needs analysis, data collection is carried out from the target audience in order to determine the target audience characteristics, source - environment needs and assessment tools required for learning. The needs analysis is carried out and the learning objectives are carried out at this stage (Branch, 2009; Mayfield, 2011). At this stage, many data collection and analysis techniques are used when determining the needs. One of these techniques is "Delphi Technique". Delphi technique, used to transform these views into a common text; is the process by which this text is presented to the experts again and their opinions are received and this process continues until all experts give their opinion on a common idea by taking the opinions of the selected subject area expert. This process takes place anonymously (Thangaratinam and Redman, 2005; Brill et al, 2006). The important point is that the expert group has taken a common view from a rational and written approach and has a common inference from these views.

Accordingly, it is expected that the selected group of experts will act independently without knowing each other and answer the questions sent to them separately. The Delphi technique has the ability to be used in a wide range of ways, from the creation of training programs to the direction of educational policies, the creation of new programs, and the determination of steps to be taken to improve the current situation. Delphi is a preferred technique in the process of determining training needs, when qualified information is needed at the level that requires expertise.

Delphi technique appears as a technique that is used for determining possible situations that may arise in the future rather than describing the current situation. At this point, analytical needs determination approach is taken. The use of the technique is defined as the creation of a consensus by getting the view of these experts. The stages of this process are briefly described below.

Stage 1: Determining the main purpose of the study
Stage 2: Determination of the expert group

Stage 3: Identifying the variables to be worked on and sending these questions to experts through questionnaires

Stage 4: Analysing the views of experts, creating new questions and sending them back to experts

Stage 5: Starting from this stage, depending on the views of experts, (if it is needed) the number of data collection rounds more than one (sometimes up to 4 or more)

The important point in the way of determining the need with Delphi technique is that the analyses obtained at the end of the study are based on forming a common opinion of experts. At this point, it should not be forgotten that the results are acted to reveal the estimates or assumptions rather than the exact results (Demirel, 2019).

2. CHET TRAINING PROGRAMME- FRAME and CURRICULUM DESIGN

2.1 General Information about the Program

CHET aims at providing engineering higher education (HE) teachers with the skills and competences to embed innovation and creativity in their teaching activities. The CHET Curriculum is designed based upon the needs of HE teachers. It will be delivered through the CHET e- learning environment that contains the CHET curriculum and the digital learning content.

The CHET Training Programme addresses:

1. The learning objectives,

2. Overview of the learning contents and curriculum,

3. The methodology to be used to assess if the HE teachers have acquired the skills.

Within the scope of the project, a modular program approach has been adopted to acquire creative teaching techniques for HE teaching. In this context, the knowledge and skills that engineering higher education teachers will need in each unit and the qualifications gained by the course are presented. The content of the program, and particularly the skills and related knowledge to be gained, were enlightened by the information obtained from the need analysis as summarized below. The field experts have agreed on the modular program and topics. Each lecture is designed to consider how these skills will be taught in engineering teaching and creative teaching strategies will be developed. Program development process is created in the following steps in accordance with the objectives above:

1. Need analysis,
2. Determination of aims,
3. Selecting and scaffolding of content,
4. Designing the learning-teaching process,
5. Assessment and evaluation.

Thus, the CHET learning content covers two aspects:

- Understanding and knowledge on the specific creativity techniques and the underlying processes of educational innovation in teaching activities,

- Understanding and knowledge on when and how to apply a particular creativity technique, depending on the learning context and circumstances.

2.2 Need Analysis

It is decided to use the Delphi technique to collect data for the analysis phase. Please see the below algorithm scheme that visualizes the process.
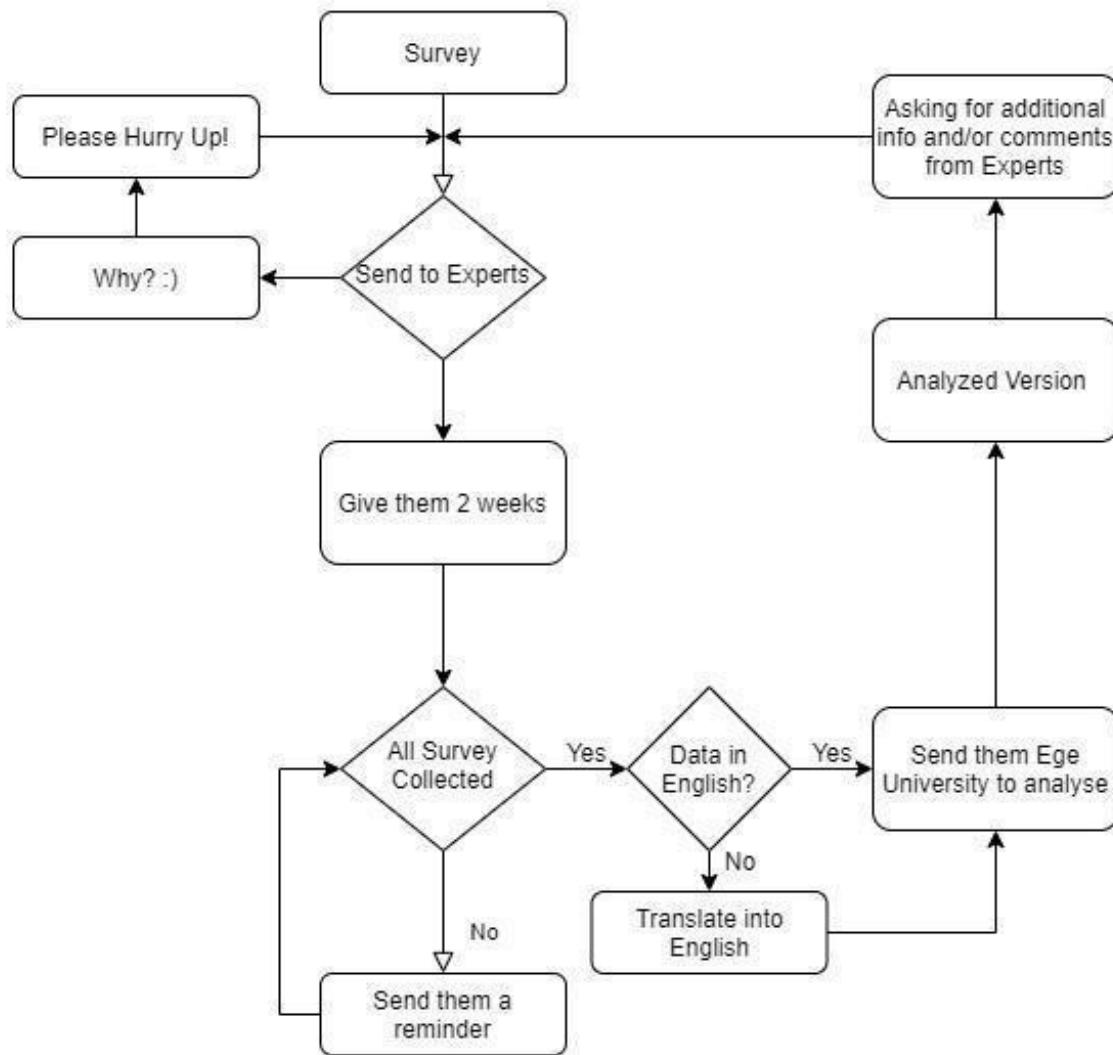
Figure 1 CHET project Delphi Methodology Algorithm

Delphi technique was employed for the need analysis. In order to prepare the survey used in the analysis process, views of engineering higher education teachers were taken, and then the survey was conducted in the form of an online questionnaire in two rounds.

This process went through 2 rounds of analysis in the Delphi method. A total of 101 participants attended the first round and 66 participants attended the second round from engineering higher

education entities from Spain, Turkey, Denmark and Lithuania. The remaining number of participants (n=35) who joined the first round but did not act in the second, stated that they accepted the first-round answers as it is. All participants were from the engineering faculties and had teaching experience. According to the second-round results, the data was accepted as it is in consensus of all participants, therefore, it was decided not to go for more rounds by researchers.

2.3 Results and Findings: Round 1

The result of the first round of the CHET survey did not bring the level of details in the results we were looking for in order to successfully start IO2. The main issue is that the questionnaire was rather general, so that it was difficult for the answers to be translated into concrete results for us. We therefore added more questions to the second round. There was also a lack of clear distinctions between certain words, phrases which were corrected in the second round.

Steps for Rounds

1. The Round 1 questions are asked to participants (See Appendix 1)
2. The results of Round 1 were re-sent to the participants to ask their second views (See. See Appendix 2)
3. The additional questions were added to get data in depth for the second round (See. Appendix 2)
4. The results for second round were shared with participants as you can see below.

Analysis of the first round survey;

The most important qualifications that the students gain by engineering education was supposed to be analytical skills and problem solving due to the HE teachers. Technical and subject area skills were followed by this, only app. 14% of the HE teachers think that creative thinking is an important qualification for an engineering student to gain (See Table 1).

Table 1 Question 1. What qualifications should students gain by engineering education?

Q1. What qualifications should students gain by engineering education?	n	%
Analytical skills and problem solving (analyse information, problem-solve, and make decisions)	52	51,49
Technical problem solving (e.g maths, physics, electronics)	24	23,76
Subject area skills (engineering subjects)	24	23,76
Academic knowledge (knowing theories and research methods)	19	18,81
Collaborative working (working together in a team)	16	15,84
Creative thinking (finding creative solutions, thinking out of the box)	14	13,86
Project design (ability to design projects for engineering works)	12	11,88
Innovative thinking (stretching out the comfort zone, doing something that differentiate from a regular project	8	7,92
Management skills (managing projects, teams)	8	7,92
Technological tools usage (engineering software, laboratory devices)	6	5,94

Among the important skills that today's engineers should have analytical skills and problem solving are still among the most important skills to be developed, cooperative working and creative thinking follows these skills accordingly (See Table 2).

Table 2 Question 2. Write the 5 most important skills that today's engineers should have and explain with a sentence why these skills are important.

Q2. Write the 5 most important skills that today's engineers should have and explain with a sentence why these skills are important.	n	%
Analytical skills and problem solving (analyse information, problem-solve, and make decisions)	61	60,40
Cooperative working (working together in a team)	42	41,58
Creative thinking (finding creative solutions, thinking out of the box)	33	32,67
IT/ technology knowledge	24	23,76
Communication skills	23	22,77
Academic knowledge (knowing theories and research methods)	20	19,80
Personal skills (soft skills like dependability, adaptability, motivation etc)	15	14,85
Management skills (managing projects, teams)	14	13,86
Innovative thinking (stretching out the comfort zone, doing something that differentiate from a regular project	14	13,86
Interdisciplinary working (working in the teams of different disciplines)	9	8,91

When it was questioned about the skills the "instructors" need to have to earn these qualifications to their students, it was not a surprise that the most teachers found pedagogic and academic knowledge among the most important skills (See Table 3).

Table 3 Question 3. What skills do engineering instructors need to have to earn these qualifications to their students?

Q3. What skills do engineering instructors need to have to earn these qualifications to their students?	n	%
Pedagogical knowledge (knowledge on effective teaching)	28	27,72
Academic knowledge (knowing theories and research methods)	25	24,75
Communication skills	21	20,79
Creative thinking (finding creative solutions, thinking out of the box)	13	12,87
Motivation (ability to motivate students)	12	11,88
Research skills (ability to search for knowledge)	10	9,90
Team working (ability to work in teams)	10	9,90
Analytical skills and problem solving (analyse information, problem-solve, and make decisions)	8	7,92
Interdisciplinary working (ability to work in teams of different disciplines)	6	5,94
Leadership skills (patience, empathy, effective feedback)	6	5,94
Innovative thinking (stretching out the comfort zone, doing something that differentiate from a regular project	6	5,94

The HE teachers mostly used lecturing and problem-based learning in their courses, sometimes using team-working. It was a misconception that the HE teachers mixed up instructional methods and techniques, as "assessment and evaluation" not being instructional techniques (See Table 4).

Table 4 Question 4. Write down the instructional methods / techniques that you currently use in your courses.

Q4. Write down the instructional methods / techniques that you currently use in your courses.	n	%
Lecturing	51	50,50
Problem based learning	25	24,75
Collaboration and team-working	23	22,77
Assessment and evaluation	22	21,78
Case study	16	15,84
Project based learning	16	15,84
Presentation	12	11,88
Experimentation	12	11,88
Gamification	10	9,90
Discussion	8	7,92
Q&A	8	7,92
Design thinking	7	6,93

The knowledge of HE teachers in creativity was questioned by asking them to write down 5 creative and instructional methods that they can use in their courses. The results showed that HE teachers should enrich their knowledge on defining creative and innovative instructional methods/ techniques. Because some answer doesn't reflect certainly understanding of creative and innovative instructional methods / techniques the such as presentation (See Table 5),

Table 5 Question 5. Write 5 creative and innovative instructional methods / techniques that instructors can use in engineering education.

Q5. Write 5 creative and innovative instructional methods / techniques that instructors can use in engineering education.	n	%
Blended learning	25	24,75
Project-based learning	18	17,82
Gamification	16	15,84
Problem-based learning	11	10,89
Presentation	11	10,89
Quizzes	10	9,90
Collaborative learning	9	8,91
Using web 2.0 tools for teaching (YouTube videos, communication channels)	8	7,92
Design thinking	8	7,92
Case study	8	7,92
Discussion	6	5,94
Brainstorming	6	5,94

It was questioned that if those teachers think that the engineering instructors other than themselves used creative teaching methods or not, for most of the instructors, the response was no (See Table 6).

Table 6 Question 6. Do you think that other engineering instructors use creative teaching methods / techniques during their courses?

Q6. Do you think that other engineering instructors use creative teaching methods / techniques during their courses?	n	%
No	56	55,45
Yes	45	44,55

Interestingly, nearly all (96%) of the engineering HE teachers think that they need training to learn how to use creative teaching methods/techniques (See Table 7).

Table 7 Question 7. Do you think that engineering instructors need training to learn how to use creative teaching methods / techniques?

Q7. Do you think that engineering instructors need training to learn how to use creative teaching methods / techniques?	n	%
Yes	97	96,04
No	4	3,96

The engineering HE teachers think that the training would last for approximately one month (See Table 8).

Table 8 Question 8. How long this training should be?

Q8. How long this training should be?	n	%
1 Month (30 days)	35	34,65
Life Long	12	11,88

Most of the HE teachers think that blended learning technique can be used for the delivery of the course (See Table 9).

Table 9 Question 9. How should the training course be delivered? (Online/Blended/Face to Face)

Q9. How should the training course be delivered? (Online/Blended/Face to Face)	n	%
Blended	61	60,40
Face to face	42	41,58
Online	20	19,80

The topics to be included in these training courses are given below. Most of these results are considered in the design of the curriculum (See Table 10).

Table 10 Question 10. What topics should be in these training courses?

Q10. What topics should be in these training courses?	n	%
Creativity techniques	30	29,70
Effective learning techniques (imagery use for text learning, rereading, practice testing etc.)	15	14,85
Innovative techniques (argumentation, workplace learning etc.)	14	13,86
Communication techniques	12	11,88
21st century skills (information literacy, media literacy, technology literacy)	6	5,94
Collaborative learning	6	5,94

Even though most of the HE teachers still preferred printed materials to take the course (the survey was conducted before the Covid-19 pandemic) the importance of digital learning tools have become inevitable (See Table 11).

Table 11 Question 11. What kind of materials should be used?

Q11. What kind of materials should be used?	n	%
Printed materials	17	16,83
Video materials	14	13,86
Computer	13	12,87
Online tools	10	9,90
Presentation tools	8	7,92

Considering the assessment of the training, most of them preferred to have an evaluation at the end of the course (See Table 12).

Table 12 Question 12. Should there be an assessment/evaluation process?

Q12. Should there be an assessment/evaluation process?	n	%
Yes	66	65,35
No	32	31,68

The teachers preferred a practice-based exam or a quiz as the assessment of the course (See Table 13).

Table 13 Question 13. How should the exams be designed? (Quizzes/Open Ended Exams/Oral Exams/Practice Based Exams)

Q13. How should the exams be designed? (Quizzes/Open Ended Exams/Oral Exams/Practice Based Exams)	n	%
Practice based exam	44	43,56
Quiz	36	35,64
Oral exam	10	9,90

Most of the teachers (86%) would like a certification to be gained after the successful completion of the course (See Table 14).

Table 14 Question 14. Should a certificate of attendance be given at the end of such training?

Q14. Should a certificate of attendance be given at the end of such training?	n	%
Yes	87	86,14
No	11	10,90

2.3 Results and Findings: Round 2

After the first round, the results of data was re-sent to participants. "Accept as it is" or "If you would like to add something, please write below" options were added. Also, in the second round, there were some additional open-ended questions added to gain more data in depth. The general results of round 2 questions were analysed in Table 15 and replies to additional questions are presented below.

Table 15 General Results of Round 2

What we can so far see from the answers is the following:

● 97% of the respondents think that **there is a need** for a training on how to use creative teaching techniques/methods – and only 56% believe that their colleagues use such teaching methods/ techniques.

● The majority wants a course with **formal exams and certificates**.

● There are some **insights about the contexts and purposes** for which the to be developed training program shall offer creative and/or creativity teaching methods:

  ● **Classical teaching setting:** most of the respondents provide their students with analytical skills (52%), technical problem-solving skills (24%), engineering skills (24%) and academic knowledge (19%), what means that the methods of the training will be mostly used in a classical conventional teaching setting

  ● **Team collaboration:** 16% want to provide students with insights on how to work together in a team, what usually happens by the use of group, project or teamwork. The training shall contain methods that fit these contexts.

  ● **Mind-set shifts:** 14% feel that engineering education shall provide students with skill in creative thinking and 8% with skills in innovative thinking – this indicates that the how-to of teaching engineering students approaches to creative thinking should be part of the framework of the training program

● From question 4 we see that most of the respondents use lecturing most of the time (51%) but are also using to ¼ -1/5 of their teaching problem and case based learning as well as team based collaborative learning. We can thus assume that they are familiar with the most standard teaching techniques. The training shall thus **build on these experiences and extend them**, and in these extensions **focus on less frequently** (and maybe also less well-known) **used methods/ techniques** related to experimentation, gamification, creativity and discussion. In question 10, 30% of the respondents ask for training in creativity techniques.

● We will understand better what for and in which situations they wish to use creativity methods from the second round.

Q1 What qualifications should students gain by engineering education?

Additional Data:

- I think in the world we live in and more with the current situation. The importance that our students know how to adapt and look for new solutions is very important.
- Not only collaborative working, working in teams, but working in interdisciplinary teams should be a skill to be gained.
- Basic engineering ethics and codes of conduct can be added
- Intercultural competencies can be added

Results:

Participants highly mentioned that students should have collaborative skills and have the ability to work in interdisciplinary and intercultural teams, obey engineering ethics and codes.

Q3 What skills do engineering instructors need to have to earn these qualifications for their students?

Additional Data:
- There is a confusion between the creativity and innovation among the participants of the survey, the definition of these two concepts should be taught in the course
- Industrial experience may be added

Results:

Participants recommended that creativity and innovation concepts and industrial experience to add into the course curricula.

Q4 Write down the instructional methods / techniques that you currently use in your courses.

Additional Data:
- Experimentation and problem-based learning may be merged
- Seminars can be added

- ICT tools knowledge should be added
- Online teaching definitely has been added due to Covid-19 lockdown
- Assessment and evaluation should not be in this list

Results:

Participants highlighted that they would like to add seminars and ICT tools which they currently use in their courses and online teaching has gained importance after Covid-19 pandemic.

Additional question after question 4:

- What are the situations in which you feel you would like to use creativity techniques in teaching?

Results:

The most frequently mentioned circumstance is problem-based learning. It seems that HE teachers believe that creativity techniques will offer students more solutions to tackle specific problems. Also, methodologies design thinking and project-based learning.

We also have more exotic answers, like: culture-based learning (art, music and dance), personalized learning, environment management and circular economy (probably examples of STEM from a problem-based approach) and laboratory work.

The purpose of focusing on creative teaching methods/techniques would be to make lectures more interesting, enable deeper learning and increase the involvement of students.

Teachers' perspective:
- Think of new ways of teaching topics (to diverse audiences), e.g. during the lockdown
- Create diverse explanations of a topic to illustrate it as seen from different perspectives.

Students:
- Get (groups of) students to come up with ideas for solving problems
- Make the students put theory into practice (connecting theoretical knowledge to solving practical problems)
- Make room for personalized learning (students learn differently).

- What would you like to achieve by using creativity techniques in your teaching?

Results:

The motive here seems clearly to be higher student engagement. By that they learn more from the subject, find it more interesting and develop critical thinking skills.

The aspirations of focusing on creative teaching methods/techniques are to:

● Motivate and engage students create a (more) dynamic learning environment
● Encourage students to experiment (not being afraid to make mistakes) and see things from different perspectives/consider multiple pathways encourage critical thinking
● Make students come up with novel, innovative ideas that represent holistic/sustainable solutions, improve their creativity and encourage innovative thinking among them
● Make knowledge stick better, because students work more in-depth with topics
● Make them think out of the box and not just focus on existing knowledge
● Make them understand how they can adapt to changing situations and approach these in flexible ways
● Make students perform better/achieve more
● Make students communicate and work (well) together.

Q5 Write 5 creative and innovative instructional methods / techniques that instructors can use in engineering education.

Additional data:

● Presentation is not a creative method, it can be deleted
● Role playing may be added
● Blended learning is not a technique or instructional method

Results:

The participants would like to add role playing technique and take out presentations and blended learning which are not creative techniques.

According to the information obtained from the surveys, knowledge, skills and competences are prepared in the form of objectives and outcomes. The required skills, the teaching methods

and techniques that can be used in the program are specified for the program. Finally, a draft program has been created including assessment as a part of the program.

After question 8:

- How should one month be distributed? One month full time or spread in a year?

Results:

● Creativity tools and resources training can last even a month, but creativity training may be continuous learning

● Most of the participants suggest the course to be spread in a year then full time a month.

● It could be taken in two weeks or in a few weekends as well. It could be refreshed once every few years, according to the needs of the teacher.

Q10 What topics should be in these training course?

Additional question after Question 10:

- Can you explain more about the course topics below?

Results:

There is high uncertainty about the topic of creativity techniques. Some would like to try them first with colleagues, some would like to be introduced to them first. Also, they would prefer some exchange with colleagues about certain techniques.

They want techniques that are applicable to problem-based learning to induce creativity.

Often mentioned is the term collaborative learning.

Some explanations of the course topics are:

● Creativity techniques are manifold and can also be good for collaborative learning

● The context should be considered teaching in a creative/creativity-inducing environment (flexible, practical)

● (New) technologies should be considered (for enhancing creativity)

● Fundamentals could be taught through reading a document or watching a video

● Teachers should be taught how to facilitate creative processes, e.g. with clear descriptions of creativity techniques (such as aim, method, steps, tools, results and group size)

● Teachers could practice together

To sum up; with regards to the data obtained from Delphi analysis, below additional important notes were considered and discussed by the experts before finalizing the curriculum.

- It is observed that the instructors have limited knowledge and experience in creative teaching, most of them believe that the engineering teachers do not use these techniques (55%) and majority of them would like to attend a training course on creative teaching (97%).
- Most of the instructors prefer a blended course around 30 days long period. However, second round data which was collected during the COVID-19 pandemic showed a higher preference for delivering a training course online.
- Regarding the assessment process, instructors prefer to have practical exams, however, second round data which was collected during the COVID-19 pandemic, it was highly preferred to have online quizzes.
- Most of the instructors would like to have a certificate after they complete the training course.

3. CHET TRAINING CURRICULUM

3.1 General Objectives of the Program

Gains expected for engineering HE teachers:

- will be able to use creative techniques in their teaching processes,
- will be able to know how to use collaborative techniques in connection with creative teaching techniques,
- will be able to use and find new, creative ways to motivate their students in their learning process,
- will be able to design teaching processes based on creative thinking skills,
- will be able to have the skills to use creativity related technological tools during the teaching process,
- will be able to know how to evaluate the students' creative learning process.

3.2 Impacts expected for engineering students:

- will be able to solve problems using both divergent and convergent thinking,
- will be able to create original solutions for the technical problems they face,
- will be able to integrate theoretical and practical information regarding creativity,
- will be able to develop collaborative working skills on creative problem solving,
- will be able to offer solutions to real life problems using creative thinking skills,
- will be able to use creativity methods/tools in physical and digital environments,

3.3 Qualifications expected to be gained by teachers:

- Creative Learning Techniques,
- Motivation Skills related to creativity,
- Creative Thinking related to creativity,
- Problem Solving Skills,
- Digital skills related to creativity,
- Evaluation Skills related to creativity.

3.4 Duration of the Program:

The program is set as 3 units and can be completed between 18 to 25 hours.

3.5 Program Content

The process of taking the modules and their lectures is independent of each other, but they complement each other. The gains, duration, content, teaching methods and techniques of each unit are designed independently.

Unit 1: Introduction to Creativity (6-8 hours)

Unit 1 introduces HE engineering teachers into creativity and creativity teaching. It provides them with a definition of creativity, phases of the creative process and examples for creative thinking. It then elaborates on when and what for creativity techniques and methods can be used in HE teaching. Here, it specifies the contribution of creativity techniques for different types of learning like project based, problem based and collaborative learning. Finally, it presents strategies for motivating engineering students to participate in teaching using creative techniques.

- o Topic 1: Creative Thinking – What is it?
- o Topic 2: When is it useful to use creativity tools in HE teaching? Its relation with project based learning, problem based learning, collaborative learning
- o Topic 3. How to motivate engineering students to participate

Unit 2. Creativity Techniques Toolkit (The Toolkit; 6-8 hours) – Factsheets of techniques classified according the categories below and according to a set of criteria. A technique can belong to more than one of the categories.

- Creativity techniques for communication & motivation
- Creativity techniques for critical and lateral thinking
- Creativity techniques for problem solving
- Selecting the right technique/tool for the right moment (tips and tricks to bear in mind when choosing)
- Creative assessment and evaluation techniques

Unit 3. Creativity and Technology in Teaching (6-8 hours)

Unit 3 introduces HE engineering teachers how to use technology with creativity techniques, the methods and tools for teaching using creative techniques. It will help teachers to get acquainted and learn how to use the most effective technological tools for creative teaching and using creativity methods and tools in a technology supported online teaching environment.

- Topic 1: Technology and creativity
- Topic 2: Using creativity methods/tools in an online teaching environment

- Topic 3: Using technological tools for creative teaching
- Topic4: Example tools for online and creative teaching
  - Video editing tools
  - Image editing tools
  - Audio editing tools
  - Graphical visualization tools
  - Gamification
  - MOOCS

Criteria for classification of techniques (search categories for teachers)

- Category /Categories
- Phase of creativity processes (when to use it)/ or at least convergent vs. divergent phase
- Group or individual / size of group
- Duration of the technique application 0-30 min; 30-60 min; 1-2 hours; > 2 hours
- Digital / face to face
- Type of class: Theory-based / practice-based / undetermined
- Materials/tools needed (PC, whiteboard, paper, etc.)
- Classroom activity / self-work by students
- Number of ideas that will likely be created

3.6 Assessment and Evaluation

The assessment methodology to be used to evaluate whether the HE teachers have acquired the skills is based on quizzes which are included in each module and the quizzes are expected to be solved when the module training is completed. The quizzes have closed end questions, each module containing 15-20 questions having a total grade of 100 and the total length for the quiz will be 30 minutes. The aim of the assessment is self-evaluation, so it is not expected to have a pass-fail criteria, they will have the possibility to redo the test to see if their knowledge is improved or not, indeed a criterion to understand the generic knowledge level will be served for guidance. An online certificate will be prepared for successful (>70%) participants.

Below 50: poor Between 50-60: moderate   Between 60-70: improvable

Between 70- 90: good   Above 90: very good

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ANNEX 1 CHET CURRICULUM

Course Title	CHET Training Programme
General Information about the Program	CHET aims at providing engineering higher education (HE) teachers with the skills and competences to embed innovation and creativity in their teaching activities. The CHET Curriculum is designed based upon the needs of HE teachers. It will be delivered through the CHET e- learning environment that contains the CHET curriculum and the digital learning content.
General Objectives of the Program	Gains expected for engineering HE teachers: • will be able to use creative techniques in their teaching processes, • will be able to know how to use collaborative techniques in connection with creative teaching techniques, • will be able to use and find new, creative ways to motivate their students in their learning process, • will be able to design teaching processes based on creative thinking skills, • will be able to have the skills to use creativity related technological tools during the teaching process, • will be able to know how to evaluate the students' creative learning process.
Impacts Expected For Engineering Students:	• will be able to solve problems using both divergent and convergent thinking, • will be able to create original solutions for the technical problems they face, • will be able to integrate theoretical and practical information regarding creativity, • will be able to develop collaborative working skills on creative problem solving, • will be able to offer solutions to real life problems using creative thinking skills,

	• will be able to use creativity methods/tools in physical and digital environments,	
Qualifications expected to be gained by teachers:	• Creative Learning Techniques, • Motivation Skills related to creativity, • Creative Thinking related to creativity, • Problem Solving Skills, • Digital skills related to creativity, • Evaluation Skills related to creativity.	
Program Content	Unit	Topic
	1	Topic 1: Creative Thinking – What is it?
		Topic 2: When is it useful to use creativity tools in HE teaching? Its relation with project based learning, problem based learning, collaborative learning
		Topic 3. How to motivate engineering students to participate
	2	Topic 1: Creativity techniques for communication & motivation
		Topic 2: Creativity techniques for critical and lateral thinking
		Topic 3: Creativity techniques for problem solving
		Topic 4: Selecting the right technique/tool for the right moment (tips and tricks to bear in mind when choosing)
		Topic 5: Creative assessment and evaluation techniques
	3	Topic 1: Technology and creativity
		Topic 2: Using creativity methods/tools in an online teaching environment

		Topic 3: Using technological tools for creative teaching
		Topic4: Example tools for online and creative teaching • Video editing tools • Image editing tools • Audio editing tools • Graphical visualization tools • Gamification • MOOCS
Criteria for classification of techniques (search categories for teachers)		• Category /Categories • Phase of creativity processes (when to use it)/ or at least convergent vs. divergent phase • Group or individual / size of group • Duration of the technique application 0-30 min; 30-60 min; 1-2 hours; > 2 hours • Digital / face to face • Type of class: Theory-based / practice-based / undetermined • Materials/tools needed (PC, whiteboard, paper, etc.) • Classroom activity / self-work by students • Number of ideas that will likely be created

Assessment and Evaluation

The assessment methodology to be used to evaluate whether the HE teachers have acquired the skills is based on quizzes which are included in each module and the quizzes are expected to be solved when the module training is completed. The quizzes have closed end questions, each module containing 15-20 questions having a total grade of 100 and the total length for

the quiz will be 30 minutes. The aim of the assessment is self-evaluation, so it is not expected to have a pass-fail criteria, they will have the possibility to redo the test to see if their knowledge is improved or not, indeed a criterium to understand the generic knowledge level will be served for guidance. An online certificate will be prepared for successful (>70%) participants.

Below 50:	Poor
Between 50-60:	Moderate
Between 60-70:	İmprovable
Between 70- 90:	Good
Above 90:	Very good

ANNEX 2 DELPHI TEST ROUND 1 QUESTIONS

#1: CHET Delphi Round 1

We would like to introduce our Erasmus+ project which focuses on creative learning in engineering education, Creativity for Higher Education Engineering Teachers (CHET).The research team is asking you to take part in this research study because of your strong expertise in the field. It is very important for us to have your views on that specific topic. The curricula of an e-learning platform will be designed by your expertise and feedbacks.

Thank you for your effort!

CHET Research Team

1. Name Surname

2. Entity

3. Country

4. What qualifications should students gain by engineering education?

5. Write the 5 most important skills that today's engineers should have and explain with a sentence why these skills are important.

6. What skills do engineering instructors need to have in order to bring in students these qualifications?

7. Write down the instructional methods / techniques that you use currently use in your courses.

8. Write 5 creative and innovative instructional methods / techniques that instructors can use in engineering education.

9. Do you think that engineering instructors use creative teaching methods / techniques during their courses?

    ◯ Yes

    ◯ No

10. Do you think that engineering instructors need training to learn how to use creative teaching methods / techniques?

    ◯ Yes

    ◯ No

    If your answer is Yes;

11. How long this training should be?

12. How should the training course be delivered? (Online/Hybrid/Face to Face)

13. What topics should be in these training course?

14. What kind of materials should be used?

15. Should there be an assessment/evaluation process?

    ◯ Yes

    ◯ No

16. How should the exams be designed?(Quizzes/Open Ended Exams/Oral Exams/Practice Based Exams)

17.   Should a certificate of attendance be given at the end of such training?

⬭ Yes

⬭ No

ANNEX 3 DELPHI TEST ROUND 2 QUESTIONS

Dear Participants,

As you remember, we collected the data to design the curriculum for engineering higher education teachers to teach creative teaching techniques. The data was analysed and their frequencies was reflected in this form. (relatively if the frequency of data less than 5%, the data wasn't shown, the sum of the frequencies are higher than 100%, because some options had multiple responses)

This form is to show you the most common thoughts in data and give you a second round to add your additional inputs if it is needed.

After the second round, in the light of your comments, the draft curricula will be developed and will be shared with you. The results of each question will be shown in a table and ask you if it is acceptable as is. If there is something that you would like to add to these responses, you will see a text box to add your thoughts and comments.

This survey might take less than 10 minutes to fill out.

CHET-Team

* Essential

1. **Name Surname (Optional)**

2. **Country** *

Please mark only one option.

Denmark

Spain

Turkey

Lithuania

Other

3. **Institution** *

Question 1

4.

What qualifications should students gain by engineering education?	n	%
Analytical skills and problem solving (analyze information, problem-solve, and make decisions)	52	51,49
Technical problem solving (e.g maths, physics, electronics)	24	23,76
Subject area skills (engineering subjects)	24	23,76
Academic knowledge (knowing theories and research methods)	19	18,81
Collaborative working (working together in a team)	16	15,84
Creative thinking (finding creative solutions, thinking out of the box)	14	13,86
Project design (ability to design projects for engineering works)	12	11,88
Innovative thinking (stretching out the comfort zone, doing smthing that differentiate from a regular project	8	7,92
Management skills (managing projects, teams)	8	7,92
Technological tools usage (engineering software, laboratory devices)	6	5,94

Please mark only one option.

◯ **Accepted as it is**

5.   If you would like to add something, please write below

Question 2

6.

Write the 5 most important skills that today's engineers should have and explain with a sentence why these skills are important.	n	%
Analytical skills and problem solving (analyze information, problem-solve, and make decisions)	61	60,40
Cooperative working (working together in a team)	42	41,58
Creative thinking (finding creative solutions, thinking out of the box)	33	32,67
IT/ technology knowledge	24	23,76
Communication skills	23	22,77
Academic knowledge (knowing theories and research methods)	20	19,80
Personal skills (soft skills like dependability, adaptability,	15	14,85
Management skills (managing projects, teams)	14	13,86
Innovative thinking (stretching out the comfort zone, doing smthing that differentiate from a regular project	14	13,86
Interdisciplinary working (working in the teams of different disciplines)	9	8,91

Please mark only one option.

◯ **Accepted as it is**

7.   If you would like to add something, please write below

Question 3

8.

What skills do engineering instructors need to have to earn these qualifications to their students?	n	%
Pedagogical knowledge (knowledge on effective teaching)	28	27,72
Academic knowledge (knowing theories and research	25	24,75
Communication skills	21	20,79
Creative thinking (finding creative solutions, thinking out of the box)	13	12,87
Motivation (ability to motivate students)	12	11,88
Research skills (ability to search for knowledge)	10	9,90
Team working (ability to work in teams)	10	9,90
Analytical skills and problem solving (analyze information, problem-solve, and make decisions)	8	7,92
Interdisciplinary working (ability to work in teams of different disciplines)	6	5,94
Leadership skills (patience, empathy, effective feedback)	6	5,94
Innovative thinking (stretching out the comfort zone, doing smthing that differentiate from a regular project	6	5,94

Please mark only one option.

◯ **Accepted as it is**

9. **If you would like to add something, please write below**

Question 4

10.

Write down the instructional methods / techniques that you currently use in your courses.	n	%
Lecturing	51	50,50
Problem based learning	25	24,75
Collaboration and teamworking	23	22,77
Assessment and evaluation	22	21,78
Case study	16	15,84
Project based learning	16	15,84
Presentation	12	11,88
Experimentation	12	11,88
Gamification	10	9,90
Discussion	8	7,92
Q&A	8	7,92
Design thinking	7	6,93

Please mark only one option.

◯ **Accepted as it is**

11.   **If you would like to add something, please write below**

12.   **What are the situations in which you feel you would like to use creativity techniques in teaching?**

13.   **What would you like to achieve by using creativity techniques in your teaching?**

Question 5

14.

Write 5 creative and innovative instructional methods / techniques that instructors can use in engineering education.	n	%
Blended learning	25	24,75
Project-based learning	18	17,82
Gamification	16	15,84
Problem-based learning	11	10,89
Presentation	11	10,89
Quizzes	10	9,90
Collaborative learning	9	8,91
Using web 2.0 tools for teaching (youtube videos, communication channels)	8	7,92
Design thinking	8	7,92
Case study	8	7,92
Discussion	6	5,94
Brainstroming	6	5,94

Please mark only one option.

◯ **Accepted as it is**

15.   If you would like to add something, please write below

Question 6

16.

Do you think that other engineering instructors use creative teaching methods / techniques during their courses?	n	%
No	56	55,4455
Yes	45	44,5545

Please mark only one option.

◯ **Accepted as it is**

17. **If you would like to add something, please write below**

Question 7

18.

Do you think that engineering instructors need training to learn how to use creative teaching methods / techniques?	n	%
Yes	97	96,03960396
No	4	3,96039604

Please mark only one option.

◯ **Accepted as it is**

19. **If you would like to add something, please write below**

Question 8

20.

How long this training should be?	n	%
1 Month (30 days)	35	34,65
Life Long	12	11,88

Please mark only one option.

◯ **Accepted as it is**

21. **If you would like to add something, please write below**

22. **How should one month be distributed? One month full time or spread in a year?**

Question 9

23.

How should the training course be delivered? (Online/Blended/Face to Face)	n	%
Blended	61	60,396
Face to face	42	41,5842
Online	20	19,802

Please mark only one option.

⬭ **Accepted as it is**

24.   If you would like to add something, please write below

Question 10

25.

What topics should be in these training course?	n	%
Creativity techniques	30	29,70
Effective learning techniques (imagery use for text learning, rereading, practice testing etc)	15	14,85
Innovative techniques (argumentation, workplace learning etc)	14	13,86
Communication techniques	12	11,88
21st century skills (information literacy, media literacy, technology literacy)	6	5,94
Collaborative learning	6	5,94

Please mark only one option.

⬭ **Accepted as it is**

26.   If you would like to add something, please write below

27. **Can you explain more about the course topics below?**

Question 11

28.

What kind of materials should be used?	n	%
Printed materials	17	16,83
Video materials	14	13,86
Computer	13	12,87
Online tools	10	9,90
Presentation tools	8	7,92

Please mark only one option.

◯ Accepted as it is

29. **If you would like to add something, please write below**

Question 12

30.

Should there be an assessment/evaluation process?	n	%
Yes	66	65,3465
No	32	31,6832

Please mark only one option.

◯ Accepted as it is

31. **If you would like to add something, please write below**

Question 13

32.

How should the exams be designed?(Quizzes/Open Ended Exams/Oral Exams/Practice Based Exams)	n	%
Practice based exam	44	43,564356
Quiz	36	35,643564
Oral exam	10	9,9009901

Please mark only one option.

◯ Accepted as it is

33.   If you would like to add something, please write below

Question 14

34.

Should a certificate of attendance be given at the end of such training?	n	%
Yes	87	86,1386
No	11	10,8911

Please mark only one option.

◯ Accepted as it is

35.   If you would like to add something, please write below

36.   Any other idea?