



**Identifying practices and opportunities for increasing HEIs impact in
Innovation and Entrepreneurship**

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Abstract

There is a growing need to provide more I&E skills within universities. These skills are fundamental not only for young entrepreneurs looking to start businesses, but they are also qualities that employers increasingly look for in new hires.

This dissertation was produced out of the necessity to promote innovation and entrepreneurship culture and spirit within the academic community.

This involved conducting a literature review to gather the state of the art, conducting interviews for qualitative data gathering within the partners of the INVENTHEI project, to understand the state of the universities' actions being taken, the evaluation of these actions, if there were any metrics involved on said evaluation, if there is a cost analysis being carried out on those activities, if there is student input in starting/developing the activities (user centric), who else is included in the planning/execution of these activities and finally how these activities are being carried out in a post COVID-19 world, meaning if they are remote, face-to-face or hybrid. It also involved creating a taxonomy of activity types and finally producing and launching a tool to centralize all this information, the INVENTHEI Handbook platform MVP.

The outcome of this dissertation is a knowledge catalogue of the current practices of the partnering universities, suggestions on other types of events and improvements, and a summary of the current literature on the topic. This dissertation also suggests future research as well as future improvements to the Knowledge Catalogue MVP. This document also provides a taxonomy on types of activities that are currently being carried out.

Keywords: INVENTHEI; COVID-19; Entrepreneurship; Innovation; Teaching;

Resumo

Há uma necessidade crescente de educar os alunos para que ganhem características de inovação e empreendedorismo. Estas características são fundamentais não só para jovens que queiram começar os seus negócios no mundo empresarial, como também são qualidades que os empregadores cada vez mais procuram nas novas contratações de colaboradores.

Esta dissertação foi produzida de modo a sugerir e centralizar métodos para promover cultura de inovação e empreendedorismo entre a comunidade académica.

Isto envolveu fazer uma revisão de literatura para obter o estado da arte, fazer entrevistas para coletar dados qualitativos com os parceiros do projeto INVENTHEI, de modo a compreender o estado dessas mesmas Instituições de Ensino Superior em relação a empreendedorismo e inovação e as ações e eventos que tomam nesse sentido. Também investiga a avaliação desses eventos, como são classificados internamente em ser bons ou maus, se há métricas para essas avaliações, se há uma análise de custo para essas atividades, se há input dos estudantes no planeamento e desenvolvimento dessas atividades, quem é que está incluído no planeamento/desenvolvimentos das atividades e ainda como é que estão a ser levadas a cabo num mundo pós-COVID-19, ou seja se são sessões remotas, físicas ou híbridas. Também envolveu criar uma taxonomia de tipos de atividade que engloba as atividades mencionadas na literatura e nas entrevistas, e ainda a produção e lançamento da ferramenta para centralizar toda esta informação, o MVP da plataforma INVENTHEI Handbook.

O resultado desta dissertação é um Catálogo de Conhecimento das práticas atuais das universidades parceiras do projeto INVENTHEI, sugestões de outros tipos de eventos e de melhorias ao estado atual, e um resumo da literatura atual sobre o tópico. Esta dissertação também sugere tópicos para pesquisa futura e eventuais melhorias ao website do Catálogo de Conhecimento, que será nesta fase um MVP.

Keywords: INVENTHEI; COVID-19; Empreendedorismo; Inovação; Ensino;

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List of abbreviations

AE – Academic Entrepreneur

BFF - Backend for frontend

EI – Entrepreneurial Intention

EIT – European Institute of Innovation & Technology

HEI – Higher Education Institution

KIC - Knowledge and Innovation Community

MSc – Master’s degree

MVP – Minimum Viable Product

PhD – Doctorate’s Degree

RoI – Return on Investment

RQ – Research Question

SDK – Software Development Kit

SPA – Single Page Application

SRQ – Sub-Research Question

TTO – Technology Transfer Office

VC - Venture Capital

1. Introduction

This dissertation will explore practices and the opportunities for HEIs to increase the impact in their ecosystem and identify concrete actions which are specifically tailored to achieve such enhanced impact.

1.1 Project Background

“By 2021 a critical mass of highly educated young entrepreneurs and innovators will be trained by the participating higher education institutions, contributing to the emergence of highly dynamic research and innovation ecosystems – innovation districts – favouring the setup or inshore of knowledge-intensive companies on cutting edge technologies, value added products and services, and innovative business models in the manufacturing and health domains” (inventhei.eu, 2021).

INVENTHEI is a project that is part of the European Institute of innovation & Technology’s Higher Education Institutions Initiative. This project is funded by the European Union and it “builds on existing practices and infrastructure to enhance regional innovation ecosystems and promote innovation-driven research”(eit-hei.eu, 2021), having as a main goal setting up “a HEI-driven European network of innovation districts.” (eit-hei.eu, 2021).

This project supports, among other goals, the creation of Entrepreneurship and Innovation events and the sharing of knowledge between the partners so that a knowledge base can be created.

1.2 Problem Description

This work is positioned within the higher education institutions business, regarding the teaching of innovation and entrepreneurship.

The current education for innovation and entrepreneurship is very traditional, there are courses and curricular units for it, but for a bigger impact in many students this approach should be revisited, in a way that every course delivered could and should incentivize students to have an entrepreneur mindset and to try to be innovative in their day-to-day activities.

Economic growth is a topic that matters for everyone. Literature tells us that “institutions affect economic growth through endogenous factors, such as entrepreneurship and industrial development” (Urbano et al., 2019, p. 38). This means that through entrepreneurship and innovation we can affect a country’s economic growth in a positive way.

The innovation district is a concept that is being implemented in many places, considered to be the next best framework for innovation, entrepreneurship and economic growth. “Innovation districts are a new land-use type, where public and private actors work towards fostering, attracting, and retaining investment and talent to revitalize urban areas and boost knowledge/innovation economy activities” (Pancholi et al., 2020, p. 1). Universities and HEIs play a crucial role in this concept “as placemaking facilitator in achieving a cohesive community and their societal integration at the local level” (Pancholi et al., 2020, p. 1). They help define the district’s brand and identity, meaning the scope and purpose of that district, and they also are the attraction point for researchers, workers and companies. The idea of co-location is that it allows for close cooperation in projects between private companies and universities/HEIs. The University also possibly attracts students worldwide and exposes them to this close connection to the professional world. It “can assist companies in integrating internal and external communities as a ‘living social laboratory’ for the immediate implementation of research and innovation ideas” (Pancholi et al., 2020, p. 1). The same author also states that Innovation Districts also help develop a sense of pride and belonging for their residents, provided they are transparent on the projects they are tackling and the success they have.

To be able to fit in this central role in an innovation district, the HEIs need to first reorganize themselves internally. This shows us a connection between the Entrepreneurial University and the Innovation Districts. Both are new standards that we want to live up to, and both require a big amount of work and reordering to get there.

1.3 Research Questions

This research intends to understand how the literature described the current entrepreneurship and innovation teaching scenario and compare it with how the partnering universities in the INVENTHEI project are tackling the reformulation of their curriculums to teach Entrepreneurship and Innovation, and how they are getting out of the traditional courses and evolving to an event-based learning system, with challenges and other types of events. The research also approaches the evaluation and analysis of events after the fact, the people who are involved in the planning and execution of those events and the post COVID-19 way of thinking about remote teaching, face-to-face teaching and hybrid teaching models.

RQ – What practices and opportunities should HEIs follow to increase their impact in students’ Innovation and Entrepreneurship capacities?

To answer the main research question, it is important to also understand and answer these two following sub-research questions, that are related to the main one.

SRQ1 – How to validate and utilize existing knowledge and good practices?

SRQ2 – How to transfer knowledge between HEIs?

1.4 Report outline

This Dissertation is divided in 6 chapters, with the following logical distribution: Chapter 1 is this introduction to the problem, and then Chapter 2 contains a review of the relevant literature. In Chapter 3 we can get a deep explanation for better understanding the problem at hand. The methods used in the study are then described in Chapter 4, after which the results are presented and discussed in Chapter 5. Finally, Chapter 6 outlines the main conclusions and identifies both limitations of this study and recommendations for future research.

2. Theoretical Framework

The literature researched for this dissertation was extensive so that a good coverage of the existing knowledge on the topic was attained and presented. The search included the following topics in different ways and combinations: “Entrepreneurship”, “Education”, “Methods”, “Evaluation”, “Innovation”, “Teaching”, “University”/“HEI”, “Startups” and “Technology Transfer”. Other keywords were researched but without any significant output or relevant literature being found.

Table 1 - Research done in SCOPUS

Keywords	Total Papers	Papers Kept	Date
hei AND entrepreneurship	166	2	5/2/2022
hei AND entrepreneurial	160	1	5/2/2022
entrepreneurial AND university AND startups	220	0	5/2/2022
"technology transfer" AND university	5181	7	5/2/2022
"technology transfer" AND university AND startups	92	0	5/2/2022
"entrepreneurial capacity" AND HEI	3	0	5/2/2022
"entrepreneurial capacity" AND innovation	55	0	5/2/2022
hei AND impact AND innovation	102	2	5/2/2022
hei AND university AND ecosystem AND innovation AND impact AND entrepreneurship	1	0	5/2/2022
university AND ecosystem AND innovation AND impact AND entrepreneurship	60	0	5/2/2022
documents that cited "Why is the entrepreneurial university important?"	14	1	5/2/2022
creativity AND HEI AND entrepreneurship	5	0	5/2/2022
creativity AND hei AND entrepreneurial	4	0	5/2/2022
creativity AND hei AND innovation	21	0	5/2/2022
"emotional intelligence" AND hei AND entrepreneur	0	0	5/2/2022
HEI AND entrepreneurship AND fear AND failure	0	0	5/2/2022
HEI AND entrepreneurship AND fear	0	0	5/2/2022
HEI AND entrepreneurship AND failure	3	0	5/2/2022

Keywords	Total Papers	Papers Kept	Date
hei AND innovation AND failure	8	0	5/2/2022
hei AND innovation AND fear	1	0	5/2/2022
”entrepreneur*” AND “innovat*” AND “educat*” AND “practice*” AND “method*” AND “teach*”	213	2	30/4/2022
”entrepreneur*” AND “innovat*” AND “educat*”	5692	3	30/4/2022
”entrepreneur*” AND “educat*”	18660	0	30/4/2022
”innovat*” AND “educat*”	110652	0	30/4/2022
entrepreneurship education	11066	1	30/4/2022
entrepreneurship education methods	2074	3	30/4/2022
entrepreneurship education evaluation	782	0	30/4/2022
academic entrepreneurship evaluation	1602	1	30/4/2022

The Prisma Flow Diagram was then used to select the papers identified through database searching and other sources.

Table 2 - Prisma Flow Diagram (adapted from Page et al., 2021)

Phase	Recommendation	Total
Identification	Records identified through database searching	24
	Additional records identified through other sources	11
Screening	Records after duplicates removed	33
	Records excluded	2
Eligibility	Full-text articles assessed for eligibility	40
	Full-text articles excluded, with reasons	23

Phase	Recommendation	Total
Included	Studies included in qualitative synthesis	17
	Studies included in quantitative synthesis	0

*Reasons for exclusion: Wrong context (n=8); Title was misleading (n=3); More oriented towards psychology (n=4); Related with TTO (n=4); Related with Spin-offs (n=4);

The resulting outcome was composed of 24 sources and from those 17 were chosen as the main ones, the other ones not being relevant to this dissertation. This content was then grouped into a logical categorization of itself, resulting in a list of subtopics, which are discussion points.

The university becomes entrepreneurial only if the people in it become entrepreneurial, meaning the academic community (managers, professors, students, researchers, etc) also become entrepreneurs, developing “the capacity for effective adaptive reform” (Ruiz et al., 2020, p. 715).

The same author proposes a model for HEIs to evolve into Entrepreneurial Universities. This model is divided between six dimensions: Management, Infrastructure, Internationalization, Finance capital, Academic community and Entrepreneurial ecosystem and partnership.

This theoretical framework focuses on three of those dimensions: The management dimension, specifically on the curriculum renewal aspect with the subtopic of “The way of teaching Entrepreneurship”, and also with the subtopic of “Educational changes and Entrepreneurial University”, the academic community dimension, with the subtopic of “Initiatives”, “Personal Characteristics of an AE” and “Effectiveness of different course types in students’ Entrepreneurial Intention” and finally the Entrepreneurial ecosystem and partnership dimension, with the subtopic of “Policies”.

Management Dimension

This dimension has two elements that are relevant for this chapter: The first one is the Curriculum and program renewal, which is targeted in the first subtopic, and the second one is the Transition to strategic management and entrepreneurial culture, mentioned in the Educational changes and Entrepreneurial University subtopic.

The way of teaching Entrepreneurship

One of the cited sources proposed an interesting classification of class/teaching types. These are: “(i) the Supply Model, which is mainly based on frontal lectures; (ii) the Demand Model, which is mainly based on classroom experiences; and (iii) the Competence Model, which is primarily based on tackling real-world problems or opportunities. There are also two hybrid models: (iv) the Supply–Demand Model, based on a mix of traditional lectures and classroom experiences; and (v) the Demand–Competence Model, based on a mix of classroom experiences and real-life problems to be solved” (Cascavilla et al., 2022, p. 2).

The author then concludes that “teaching models that include experiential-based learning (i.e., Supply–Demand, Demand, and Demand- Competence), such as labs and simulations, are generally better than courses that are exclusively based on traditional frontal lectures focused on knowledge transmission (i.e., Supply). On the other extreme, however, pure Competence Models are not significantly more effective than pure Supply Models” (Cascavilla et al., 2022, p. 17), meaning the options on the extremes, purely theoretical or purely practical are the ones that translate into worst Entrepreneurial Learning outcomes when compared with the more balanced hybrid teaching models.

Another very important subject to tackle in the category of how we teach entrepreneurship and on our target audience gaining the most Entrepreneurial competences and EI is overcoming the gender gap in entrepreneurship. This source states that “techniques that can positively promote female entrepreneurs to comprehend the relationship among gender issues, entrepreneurship, and business operations and strategies include experiential learning, the case study through female role models, and debate or ongoing discussion among female entrepreneurs” (Pimpa, 2021, p. 7). Some of these techniques are already being applied in the topic of engaging female students in Engineering courses and subjects, and a similar approach should be used in entrepreneurship.

Educational changes and Entrepreneurial University

There are changes the HEIs can make that are not policy related, but rather related to their core teaching model and habits. “In higher education institutions, the results of many studies show how an intensifying appetite for more knowledge that will sustain business and industries is re-writing the rules of business education, changing the mindset of learners when it comes to how they study and what they study towards“ (Kripa et al., 2021, p. 2).

“Even after the COVID-19 crisis, universities will have to deal with the urgent need to reconfigure traditional programs using digital technologies” (Kripa et al., 2021, p. 3). The

HEIs have traditionally been focused on their motto of research and teaching and are now starting to shift their focus towards a third objective regarding entrepreneurship. “Traditionally, universities were only focused on two missions (research and teaching). However, over time, there was a need for many academics to participate and be involved in entrepreneurial activities, which are considered the “third mission” of universities” (Gomes et al., 2021, p. 3).

A new and necessary trend within the HEI world is to work towards becoming an entrepreneurial university. This involves a redesign of the way the HEI is providing its learning paths and the tools it provides its students with. “In an entrepreneurial university, academic entrepreneurship processes and activities are embedded in the university system, encultured in its academic faculties, embodied in its community of practice and embraided in each individual academic” (Yusof & Jain, 2010, p. 90).

The Entrepreneurial University can be defined as “an institution integrated into an entrepreneurial and innovative ecosystem, capable of changing, innovating, recognising and creating opportunities. Its academic community (managers, professors, students) is proactive, willing to take risks and respond to challenges, aiming at internal and external development and creating different values (economic, social, cultural, and environmental, among others) through knowledge generated by the university” (Ruiz et al., 2020, p. 717).

Academic Community Dimension

This dimension includes the initiatives that can be developed to elevate the students’ and the teachers’ entrepreneurial intentions and knowledge.

Initiatives

A big aspect of this dissertation is the initiatives currently being implemented and the efficiency of those initiatives. It is said that “it remains unclear to what extent commercialization initiatives to support academic entrepreneurship are an effective and efficient way to enhance innovation and growth” (Sandström et al., 2018a, p. 1233). A general guidance on Academic Entrepreneurship tells us that the initiatives should “remove obstacles the market cannot handle on its own, thereby improving the efficiency by which universities transfer knowledge and spin out technologies” (Sandström et al., 2018a, p. 1233).

Most of the Technology Transfer fails because of an inapt or unprepared researcher that would prefer to stick to his research than to venture off into a spin off (Sandström et al., 2018a). An initiative that may very well improve this scenario is “the employment of external

actors such as ‘surrogate entrepreneurs’ from industry to work with researchers”, which has been highlighted as potentially more beneficial (Sandström et al., 2018a, p. 1240).

A lot of the current initiatives are guided towards social innovation, to have entrepreneurs solve social issues with an out-of-the-box idea. This makes it so that even if the students/AEs do not necessarily solve the issue they get educated in a new topic and learn about a social issue, shifting the person’s position towards a more T-shaped person. “Social innovation proposes inclusive learning which, together with social capital, impacts the distributed knowledge that brings growth and is therefore considered a crucial element for local development” (Kripa et al., 2021, p. 2).

Personal Characteristics of an AE

There is a lot to say about the characteristics of an AE, mostly personality-wise but also characteristics related with the environment on which the person lives or was brought up. “Academics involved in entrepreneurial activities tend to be those with high productivity and an ability to identify opportunities to link research and commercialization” (Sandström et al., 2018a, p. 1240). A profiling of sorts can be made about the potential AE’s personality. “From the entrepreneurial intention, we can comprehend that the attractiveness, easiness, or difficulty that an individual feels about becoming an entrepreneur and the influence of specific groups or societies favourably influences the relationship under study” (Gomes et al., 2021, p. 11). Another very relevant aspect of entrepreneurial qualities is the AE’s financial and social environment. A “central aspect of such entrepreneurial qualities seems to be related to academics’ social capital or network” (Sandström et al., 2018a, p. 1240). With COVID-19 we also got to see entrepreneurial characteristics at work. “As entrepreneurs are used to dealing with uncertainty and failure, they can demonstrate flexibility and adapt their business models to the new situations caused by the pandemic crisis COVID-19” (Gomes et al., 2021, p. 5). Lastly there is a very relevant factor within the AE’s environment that the university does not yet have an influence on: their family circle. “The social pressure that can be exerted by the people who are closest to them, such as family, friends, or other important people in their life, in the decision to undertake entrepreneurship” (Gomes et al., 2021, p. 11).

Effectiveness of different course types in students’ Entrepreneurial Intention

The literature mentions something very interesting regarding the choice of different course types taking in account the characteristics of the target audience, meaning the students in this case. One of the sources states that a Business Plan course raises EI in people who have

little EI, while a Lean Start-up Camp is better suited for people who already have a high level of EI (Schultz, 2022).

The same author also states that an individual's EI increases due to taking part in a course of Entrepreneurial Education (Schultz, 2022), however an increase in EI does not mean an increase in entrepreneurial competences (Bolzani & Luppi, 2021), meaning the student may get higher intentions but that does not mean they will translate to having competences in entrepreneurship because of the business challenge alone. The literature states that for that, a “multi-disciplinary education in entrepreneurship, integrating projects and training sessions, is effective and favours the acquisition of entrepreneurial competences and increases the interest in transformative thinking and behaviour” (Fernández de Caleyá et al., 2022, p. 2).

Nevertheless, having high EI and having participated in a competence model course correlated with engaging in more entrepreneurial activity after completing the course (Schultz, 2022).

A different source also indicates, with evidence from an online international entrepreneurship program, that “it appears to be more effective for MSc students than for PhD students or students that never attended any Entrepreneurship program before” (Colombelli et al., 2022, p. 1).

Entrepreneurial Ecosystem and Partnerships

This dimension's element that is targeted within this chapter is the External Partnership element, pertaining to a partnership between the university and the government, namely the policies and help the government can provide to a university to help them become more entrepreneurial.

Policies

Policies that are meant to improve a HEIs impact on entrepreneurship should be robust. “A robust system is capable of coping with uncertainties and significant variation in conditions without having its outcome adversely affected. Conversely, a system that lacks robustness experiences a sharp decline in performance when exposed to varying conditions” (Sandström et al., 2018a, p. 1236). This means that robust policies are policies that work with little impact from changes on the surrounding environment and are not only thought of for the specific moment in time.

Regarding spin-offs and technology transfer, literature shows that most policies work in a way of incentivizing the entrepreneurship within the HEIs students. A very common type of incentive is a financial one and “Financial incentives, often in the form of higher royalty shares, seem to have a positive effect on entrepreneurial activity” (Sandström et al., 2018a, p. 1239).

This tells us that giving the academic that is pursuing an entrepreneurial venture a bigger slice of shares gives them a boost in entrepreneurial activity, mindset and overall happiness.

There is also a strong correlation between the location where the university is and that place’s economic strength. “Universities located in economically stronger regions with access to venture capital have been shown to boost University spin-offs’ productivity and success” (Sandström et al., 2018a, p. 1243).

Conclusion

The current literature gives many insights on what is being presently done world-wide within the entrepreneurship and innovation education topic. This chapter presented us with many best practices and advice on what types of courses work best for what kind of students, a taxonomy on classes/teaching types (Cascavilla et al., 2022), the same author then concluded that Supply–Demand, Demand, and Demand-Competence are the types with the best results in terms of effectively transferring knowledge to the students.

The chapter also mentioned characteristics of an academic entrepreneur, and ways of profiling students with the correct characteristics (Sandström et al., 2018b), insights on policies and recommendations for policies, the pairing of students with entrepreneurial mindset and researchers to get their technology to market in the Initiatives subtopic, and the characteristics of the Entrepreneurial University, that tells us the only way for a university to be entrepreneurial is to have everyone with an entrepreneurial mindset, not only the students, and this aligns with the INVENTHEI program’s topic of not only training students but teachers as well.

Special attention should be given to tackle gender gap issues and activities should consider inviting female guest speakers and role models, during the planning phase (Pimpa, 2021).

3. Problem Characterisation

Creating a culture of innovation and entrepreneurship is the goal, but it is a hard goal to achieve. A good number of European HEIs are engaged in entrepreneurship education, successfully implementing a wide range of innovative and experimental approaches to entrepreneurship education, with “experimental” being the key word: there are no frameworks in place for entrepreneurship and innovation education.

The world is moving towards an approach of creating innovation districts, as the next big thing, and innovation districts require an Entrepreneurial University in order to generate the required results. Every university that wants to take this step and become the centre of an innovation district must transform and evolve into an Entrepreneurial University. Failing to do so means being stuck in the past and overcome by universities that take that opportunity. “For an effective contribution to the success of an innovation district, universities need to identify and practice their multi-layered role for developing a cohesive community within innovation-scape, and its integration with its local community” (Pancholi et al., 2020).

Currently the education for innovation and entrepreneurship is either traditional, being more of a type of traditional company management program adapted to include buzzword courses and activities, like design thinking for example, or it is experimental, with results yet to be known because of the young age of these initiatives. The traditional courses present a small increase in entrepreneurship, hence the need for changes, and the new courses and activities’ impact is yet to be known.

The new Strategic Innovation Agenda (SIA) of the European Institute of Innovation and Technology (EIT) for 2021-2027 (Official Journal of the European Union, 2021) includes as one of the specific objectives the creation of systemic impact in higher education at the institutional level, by supporting HEIs to increase their innovation and entrepreneurial capacity and better integrate into and engage with innovation ecosystems.

Another problem that is connected to this one is the necessity of involving all students in entrepreneurship and innovation education, while traditionally students from engineering areas are the ones who adhere to these programs (Duval-Couetil et al., 2012), there is a necessity to get everyone on board and aware that entrepreneurship is a possibility and encourage those students to pursue it.

I&E Education still has a lot of obstacles that must be overcome by the HEIs, and the INVENTHEI proposal application document mentions three dimensions as barriers: Resources, Institutional Infrastructure and Development.

The number of initiatives and events is closely linked to the number of resources allocated by a specific HEI for I&E education, the infrastructures take time to show results so they face a lot of pressure, which does not mix well with innovation, and the developing of the student's capabilities must be paired with the development of the academic staff's capabilities.

As can be seen in the previous chapter, there is an underlying problem in defining initiatives and creating a plan on what to do so that the students can be educated to have an entrepreneurship mindset.

This problem is being tackled as part of the INVENTHEI program, which has six partnering universities and some more institutions. INVENTHEI is a project that builds on existing practices and infrastructures to enhance the regional innovation ecosystems and promote innovation-driven research. One of its main objectives is to setup an HEI-driven European Network of Innovation ecosystems and use the network's information and data on the experience to further improve the implementations across the network, so that everyone learns from each other, expediting the R&D process associated with these experimental activities.

Other project's objectives include increasing the proactivity of the partnering universities and having everyone develop their entrepreneurial skills, both the student body and the academic staff.

INVENTHEI aims to improve the entrepreneurship and innovation world in three dimensions that are connected to the EIT pillars: Learning and Mentoring programmes for both students and staff, linked with EIT's education pillar, Learning and Teaching structures, linked with EIT's innovation pillar, and Learning and Collaboration which improves collaboration between industry, research and academia, linked with EIT's business pillar.

The problem this document is tackling reports to the first dimension, regarding Learning and Mentoring programmes, and focuses on how to systematize and share information on the practices of teaching entrepreneurship and innovation in HEIs, both in the case of an already established university trying to improve its practices and in the case of a university that is just starting to think about entrepreneurship and innovation education.

This topic is an identified gap in the literature, as practical ways and techniques of teaching entrepreneurship and innovation are not yet identified and catalogued. Nothing further than Business Model Competitions (or Business Plan Challenges) and Lean Start-up Camps can be found, meaning the literature is not yet diverse enough to explain new and creative ways of teaching the topic at hand.

To answer this problem and to try to overcome the current barriers, the idea is to take on the production of a tool where a systematized list of initiatives and techniques which already used in partnering universities and their outcomes can be catalogued, a repository where knowledge can be shared and curated.

4. Methodology

The Methodology chapter is where the research design for the defined problem is explained.

Firstly, a gap was identified together with the INVENTHEI project, while reviewing the current literature, however still managing to find supporting literature for the surrounding topics. Then a plan was made on how to gather the necessary information to produce an outcome that is valuable enough so that it can add value to the literature. Data collection and analysis procedures are also presented in this chapter.

The purpose of this study is to facilitate the choice in the future for HEI to plan their teaching path and course offering considering the expected outcomes of situations based on previous experiences in other HEI, instead of blindly experimenting with random initiatives to confirm if they add value to their teaching of entrepreneurship and innovation or if they don't.

4.1 Comparative analysis of existing approaches and reasons for the choice of adopted approach

There are six methods of data collection: Questionnaires, Interviews, Focus Groups, Tests, Observation and Secondary data (Tashakkori & Teddlie, 2015).

Method of Data Collection	Research Approach Continuum		
	Pure Qualitative	Mixed	Pure Quantitative
1. Questionnaires	1	2	3
2. Interviews	4	5	6
3. Focus groups	7	8	9
4. Tests	10	11	12
5. Observation	13	14	15
6. Secondary data	16	17	17

Figure 1 - Data Collection Matrix, adapted from Tashakkori & Teddlie (2015)

Given the nature and timeframe of this dissertation, which is to collect initiatives that have already been done and the state of the partners in INVENTHEI, Tests and Observation are automatically overruled. Focus groups also does not make sense for this case, since the sample is relatively small. This means there is Questionnaires, Interviews and Secondary data left. The target of this data collection is a group that is very small for quantitative data

collection, meaning questionnaires (6 partners), leaving us with only two possibilities: Interviews and Secondary data.

4.2 Methods used in the project

In this project both above-mentioned final options were used. The Secondary data collection is present in the Theoretical Framework chapter, and the project partner HEIs were interviewed.

For the Secondary data collection extensive research was done within the Scopus online library to gather the state of the art of teaching entrepreneurship and innovation. There were two different moments where there was a collection, the first one looking for University Entrepreneurship, Technology Transfer, HEI Impact in Entrepreneurship, HEI Impact in Creativity and Innovation, and similar words and combinations. In the second moment was more focused on perspectives in entrepreneurship and innovation teaching practices and methodologies. Entrepreneurship, Innovation, Education, Practice, Teaching and Evaluation were the keywords used for research, in multiple combinations.

For the qualitative data gathering six online semi-structured interviews were held with representatives from each of the INVENTHEI partnering Universities, with their consent.

These representatives are the target group of these interviews, which are people connected to the INVENTHEI project, each from the partnering university and connected to the area of expertise analysed in this document, so that they were best suited for providing insight on the current state of their HEI's offering.

There were seven questions to gain knowledge on specific topics, that fall under four categories: Question 1 belongs to the "Specific actions being taken" category, Questions 2-4 fall under the "Activity evaluation", Questions 5 and 6 fall under the "Student Input" category and Question 7 belongs to the "Remote vs Face-to-face vs Hybrid teaching models category"

Table 3 - Interview Questions

Question	Purpose
1. What actions are being taken to increase your HEI's impact on entrepreneurship and innovation?	The answer to this question should explicitly name what activities the HEI is implementing to foster innovation and entrepreneurship within their student body.

Question	Purpose
2. Have you identified good and bad actions?	The answer to this question should be an introductory answer to the next question. Here the HEI representative should name the ways in which they are screening their activities.
3. What are the metrics/calculations for the evaluation?	The purpose of this question is to gather specific ways of calculating and evaluating the outcome of an activity or event.
4. Do you have any cost vs. benefit metric being applied/used to evaluate initiatives?	This question is like the previous one, except it is focused on the events' RoI, and if that is being considered.
5. Do you allow students to suggest/start their own initiatives?	The answer to this question should give information on the permission and openness of the HEI for its students to be proactive and spread entrepreneurship and innovation on their terms.
6. Who do you include in these initiatives' planning/execution?	This is an exploratory question with the intent of figuring out if the students are being included in the planning and execution of the initiatives, or if they are merely attendants of those same initiatives.
7. What teaching models do you use, remote, face-to-face or hybrid? Why?	This question should explain the HEIs plan in terms of how they want to teach, if physically, online or in a hybrid model.

The results of these interviews were then analysed and split into tables, which were divided according to the four categories, and are in this report in the “Interview Results” subcategory of the “Results” chapter (Chapter 5).

5. Results and Proposed solution

The proposed solution was known since the beginning of this dissertation, and it is to develop a Knowledge Catalogue to support HEIs to increase their innovation and entrepreneurial capacity, so they integrate and engage with innovation ecosystems. The value of this dissertation is the knowledge inside the knowledge catalogue, and the outcome of the literature review, which are suggestions on what's not being done within the INVENTHEI partnering universities.

This chapter focuses firstly on a summarized version of the results from the interviews, then the analysis of those results and finally the description and exposition of the MVP of the Knowledge Catalogue Website.

5.1 Interview Results

This section contains the summarized results of the interviews held with the INVENTHEI partnering universities' representatives. They are split by university, meaning each table represents a single interview and its results.

The analysis and discussion of these six interviews' results are in the next subtopic.

Table 4 – Results of interview with Universidad de Santiago de Compostela (USC)

Category	Findings
Specific Actions Being taken	They have done a kind of business model competition for the gerontology and psychogerontology master's and now they want to expand it to other areas of education within their university and involve senior students from their Senior University program.
Activity evaluation	Inquiries to participating Students and Teachers. They have not evaluated cost-benefit analysis, but they would if they were provided with examples.
Student Input	No explicit way for students to participate in planning/executing programs. Activities planned by the university's services and staff.
Remote vs Face-to-face vs Hybrid teaching models	In-person activity but remote mentoring, meaning a hybrid model is used.

Table 5 - Results of interview with University of Sheffield (USFD)

Category	Findings
Specific Actions Being taken	They are making organizational changes, such as creating new Head of Innovation role in the University, overhauling their innovation department, creating an office for entrepreneurship that focuses on developing students' entrepreneurship skills, they also allow their staff to create spin-offs, and the researchers can now be promoted for innovation (like spin-offs or patents) instead of just by teaching/researching. They usually have speakers at the university, and they try to bring people from the Entrepreneurship field, speakers from investment fields, like banks, VCs and alumni. They have 'managing directors clubs' where they bring in regional businesses to have dinner with speakers talking about an aspect of innovation culture. They also try to have a more practical learning by taking field trips to visit industrial museums and advanced manufacturing parks (like boeing, maclaren, rolls royce).
Activity evaluation	Inquiries to participating students. They have a cost-benefit analysis comparing student satisfaction from the inquiries and compare the satisfaction with the budget spent.
Student Input	They have students promoting their own presentations about entrepreneurship. PhD students have co-produced events with university staff.
Remote vs Face-to-face vs Hybrid teaching models	They promote a hybrid approach to lectures, with a broadcast link for each event. This gives them more value from the same resource and equality and diversity inclusion.

Table 6 - Results of interview with TTK University of Applied Sciences (TTK)

Category	Findings
Specific Actions Being taken	They have a centre of innovation & entrepreneurship, which should develop connections with companies and other stakeholders, and improve their students' and academic staff's capability for innovation and entrepreneurship. They had a business model competition. They offer optional courses for entrepreneurship bases, pitching and problem solving, but the students are not enrolling. They held a two-day seminar on start-up basic knowledge, with 24 attendants. They have a student-organized Inspiration Day, where they bring presenters from outside the university, people who have created their own companies

Category	Findings
	or work as managers to show students how to use entrepreneurship skills. They are modernizing their courses to talk less about accounting and more traditional management topics and more about problem solving and presentation/pitching skills.
Activity evaluation	They evaluate by number of participants and student satisfaction through inquiries.
Student Input	Inspiration day, organized by students. The rest of the activities are organized and executed by faculty staff.
Remote vs Face-to-face vs Hybrid teaching models	Fully face-to-face.

Table 7 - Results of interview with Valahia University of Târgoviște (VUT)

Category	Findings
Specific Actions Being taken	Classes on entrepreneurship with 3 partners, who are other local universities, where they teach both students and professors. Every year they organize contest for students to submit business plans, and then they select the best ones and help them develop the ideas. They hold innovation days where they talk about innovation faculty wide.
Activity evaluation	Student satisfaction inquiries and some activities have written evaluation to assess students' learning.
Student Input	Decided to develop a course on entrepreneurship together with the students. They have an association for entrepreneurial students and a future entrepreneur centre, and both these groups organize meetings with students and professors and people from the economic sector (supervised by professors). They plan activities using University staff but sometimes they get input from the president of the student association.
Remote vs Face-to-face vs Hybrid teaching models	Everything is face-to-face.

Table 8 - Results of interview with Univerzita Pardubice (UPce)

Category	Findings
Specific Actions Being taken	They are relying on IVENTHEI to be a tool for them to push or systemize the basis for an official entrepreneurship course. They had a course for students to develop an idea and then go through a market validation phase to assess

Category	Findings
	with potential customers and report back to a mentor.
Activity evaluation	They evaluate by number of participants and student satisfaction. They hold a cost-benefit analysis on the cost of a speaker compared with the number of participants and the inquiries results. They also look out for the number of registered participants and real participants in events.
Student Input	Some lectures and talks are organized by students. Events are organized by university staff. Student satisfaction inquiries.
Remote vs Face-to-face vs Hybrid teaching models	They are planning to move to a hybrid model but for now they remain face-to-face for the person-to-person connections.

Table 9 - Results of interview with Universidade do Porto (UP)

Category	Findings
Specific Actions Being taken	They are launching the LGP-Project Management Lab which is a sort of lean start-up camp but with the duration of a whole semester. The University has master's programs on entrepreneurship and innovation and other master's include the topic in their curriculum. They also have talks and lectures on the matter. They held a BIN event in 2021 (Business & Innovation Network) they named BIN@Porto. The industrial engineering department has a congress on entrepreneurship.
Activity evaluation	Most if not all the activities have a satisfaction survey at the end. Usually, the costs with these activities are low and the university does not care about the money spent in those initiatives, so no cost-benefit analyses are held.
Student Input	They may support student initiatives if they come from the student association. Events are planned using university staff and resources. Sometimes they invite the student association to take part in planning, but not regularly.
Remote vs Face-to-face vs Hybrid teaching models	There is a bit of everything, but the majority is face-to-face.

5.2 Result Analysis

These interviews provided a good level of detail regarding what each HEI is doing at the time of writing regarding entrepreneurship and innovation. This chapter will analyse the Interview Results by category and discuss the outcome of the interviews.

The categories described below are the ones specified in the “Methodology” chapter, in the “Methods used in the project” subchapter, which have already been used in the previous subtopic to summarize the results.

Specific Actions Being Taken

The HEIs actions and initiatives data can be summed up by the following list: creating contests like business model competition, lean start-up camp, talks and lectures, networking events, creating departments focused on Entrepreneurship and Innovation and offering traditional courses or degrees in Entrepreneurship and Innovation.

The contest type initiatives are classified by the literature as a good way to engage and teach students about entrepreneurship and innovation. Literature claims that a Business model competition is a good way to raise EI (Schultz, 2022), to spark the creative entrepreneurship and innovation mindset, but are an unrealistic learning experience for medium to long term business development and management. Literature also claims that a Lean Start-up camp type of competition is better suited for people who already have high levels of EI (Schultz, 2022), meaning both could be used as a kind of two-step entrepreneurship program: The entry level would be the business model competition type challenges, which would screen the students and let them understand their take on entrepreneurship and innovation, and those who would want to pursue it should be encouraged to take a Lean Start-up camp type of competition to further improve their understanding of what the field offers and requires. I also suggest this to be done not only to entrepreneurship field students, or engineering students which are commonly associated with the entrepreneurship field, “Students in certain engineering disciplines such as electrical and mechanical engineering were found to participate in entrepreneurship education at higher rates than others” (Duval-Couetil et al., 2012, p. 425), but with all of the university’s campus, a campus-wide competition as a way of networking and getting to know their peers and also understanding their own EI.

Talks and lectures are a more than well-known way of spreading theoretical knowledge, however they are very dependent on the invited speaker, meaning they can be very engaging with the audience and get them to actively listen to what is being presented, or they can be a waste of time and money. These speakers should be selected carefully and not freely chosen just for the sake of a talk in a topic, especially when considering the financial expenditure.

Networking events are always a great way of promoting connections between students and the private companies’ world but are often just a way for companies to recruit young talent for specialty work in their companies, losing the entrepreneurship and innovation bond.

These should be planned with the correct business-side partners, people with genuine interest in helping the entrepreneurship community evolve, and people from the VC world which are usually close to risky entrepreneurship ventures and have deep knowledge of the entrepreneurial and innovation world. These events could have as an ice breaker a sort of panel where the audience would ask questions and gather knowledge from the panel, and later a food and drinks section where everyone would ideally talk and connect. The major problem to overcome here is how to engage people that are naturally shy and create the environment for everyone to be able and encouraged to talk. “While humans may be social creatures, it is a mistake to think that all people will naturally and automatically network with ease, especially in professional contexts” (Mandeno & Baxter, 2022, p. 1). Nevertheless, these events are very important for entrepreneurship and should be provided, literature even claims people who want to be entrepreneurs should seek out networking events (Bullough & Renko, 2013).

The creation of departments focused on entrepreneurship and innovation can have two problems: the first one being focusing on technology transfer and essentially being a disguised TTO, and the second one being the profile of the people in charge of those offices. An innovation office can never have non-innovative people running it, just like an entrepreneurship office cannot have people running it that have no entrepreneurial background and experience. The creation of a department for dealing with a specific theme is the traditional approach and should be done if no current department already exists. However, the mere creation of a department does not guarantee results and will rely heavily on the ability of its personnel in creating events and engaging the academic community.

Lastly, the offering of Entrepreneurship and Innovation courses and degrees. This is something that has been done since the early 2000s and is effective in some ways. However, most Entrepreneurship and Innovation programs forget to be innovative after first creating their syllabus and end up not offering the very state-of-the art subjects that are taught in high-end and popular schools for innovation and entrepreneurship. The suggestion here is for the courses to be regularly maintained and for student feedback to be gathered on the course, not only upon completion of separate subjects but upon completion of the whole course, and the courses adapted accordingly, taking an agile approach to syllabus changes.

This shows that there are activities being taken on by the participating HEIs that are also mentioned in the current literature.

Activity Evaluation

All the HEIs reported conducting a survey at the end of their events in order to get feedback and student satisfaction. “It is evident that student evaluation, whether of courses, teaching quality or the overall student experience, is extremely important and has a significant role to play in the quality assurance process” (Leckey & Neill, 2001). This feedback should always be taken seriously to avoid students losing interest in giving it when they think it does not matter.

Regarding cost-benefit analyses two of the HEIs (USFD and UPce) reported doing an analysis on the satisfaction vs the event’s cost, other three (USC, TTK, VUT) reported not having them in place and one (UP) reported not caring about the costs since they are usually very low. The standard cost-benefit analysis would be the one already in place USFD and UPce which is to compare student satisfaction with event cost. These analyses are something each university should consider when they are planning on investing in entrepreneurship and innovation education. Taking knowledge of the costs and analysing if said costs are having a good RoI is essential to keep improving the offering and provided knowledge by the University.

One of the HEIs (VUT) reported conducting student assessments in some events to quantify the student’s learning and using that to evaluate the activity, a type of metric about quantifying the retained knowledge. Student assessments, although having a high efficacy in demonstrating if the knowledge was transferred, have a weight on students, and could lead to them not wanting to attend certain events knowing they would be evaluated on their learning. It could also lead to students losing EI. This should be avoided, and assessments should only be done in a way that they assess the event but not the students’ knowledge, meaning they should be done in anonymity and not be associated with the students’ process. However, when talking about courses and degrees this cannot currently be avoided. This topic is mentioned in the future research section of this dissertation.

The systematic evaluation of both cost-benefit metrics and other metrics such as timeframe and impact on students, although not having an immediate effect, will allow for a classification of activities in the handbook and later for a user to research by cost, or by impact, or by any other metric collected in the process.

Student Input

The following paragraphs contain a summary of what is being done regarding student input in activity planning and execution. They are ordered by least involved to most involved.

One of the Interviewees (USC) reported not having any type of inclusion of the students in the planning and execution of events, being fully planned and carried out by university staff.

Another (UP) reported sometimes involving the student association and reported that students can propose ideas through the association, not directly.

Three interviewees (USFD, TTK, UPce) reported having student activity being carried out and the rest being done by university staff.

The last one (VUT) reported having two student entrepreneurship-focused associations that collaborate with the university staff in planning these events.

Student input is fundamental for teaching, both in student feedback, as stated in the previous subtopic, and in student opinions on planning events for students. Failing to include students in these meetings and in organizing/executing events is both a loss in teaching/mentoring students how events are planned and executed and a loss in User Centric focus. Having academic staff planning and executing activities relying solely on their knowledge of the matter can backfire, and student interest in subjects may be lost.

Remote vs Face-to-face vs Hybrid teaching models

Regarding teaching in the post-COVID-19 era the opinions are divided: Many want to return to the previous way of teaching, as reported by three of the interviewees (TTK, VUT, UP), and others adopted the hybrid teaching model, as reported by two of the interviewees (USC and USFD). UPce reported having plans to transition into hybrid but currently only teaching in face-to-face model. Fully remote teaching is not reported by any of the interviewees apart from the early-COVID-19 period, where people were forced to do so. Both face-to-face and hybrid models are very interesting and have their own pros and cons.

The face-to-face teaching model brings social benefits, like having off-topic conversations and meeting new people and is way better for networking than the remote model. However, for a non-interventive lecture this brings no advantages, and this is where the hybrid model's advantages are recognized: The hybrid teaching model gives the university the ability to further extend the range of students able to attend a specific lecture, that otherwise would not be able to, be it because of personal reasons for not being in town, or for the event auditorium being fully booked. In USFD they promote a hybrid approach to lectures, with a broadcast link for each event. This enables them not only to get more value from the same resource but also to promote equality and diversity inclusion.

Conclusions

These interviews provided the current context of the interviewed universities and, although not necessarily bad, there is room for improvement. The activities sector could use more diversity of examples and experiences, the evaluation methods of said activities leaves much to be desired, most if not all rely on traditional student satisfaction inquiries, student input seems to lack in activity planning and execution, this poses an opportunity for student growth and engagement, and the teaching models could be adapted to an optional hybrid teaching model, where students who want to participate but don't have the chance get an easier way to gather some of the taught knowledge, at the same cost for the universities.

The activities were generally categorized as belonging to one of the categories mentioned in the "Specific Actions Being Taken" subtopic, namely creating contests like business model competitions and lean start-up camps, talks and lectures, networking events, creating departments focused on Entrepreneurship and Innovation and offering traditional courses or degrees in Entrepreneurship and Innovation. This gives us a taxonomy that manages to fit the current offering within the partnering universities in the INVENTHEI project and is supported by the literature discussed in the Theoretical Framework chapter.

A diagram representing the taxonomy and some examples can be seen below. The examples were taken from current activities being done by the INVENTHEI partnering universities.



Figure 2 - Proposed Taxonomy diagram with INVENTHEI activities examples

The activities developed by the partners of the INVENTHEI should follow the build-measure-learn cycle (Ries, 2011), because the project follows the Lean Start-up methodology.

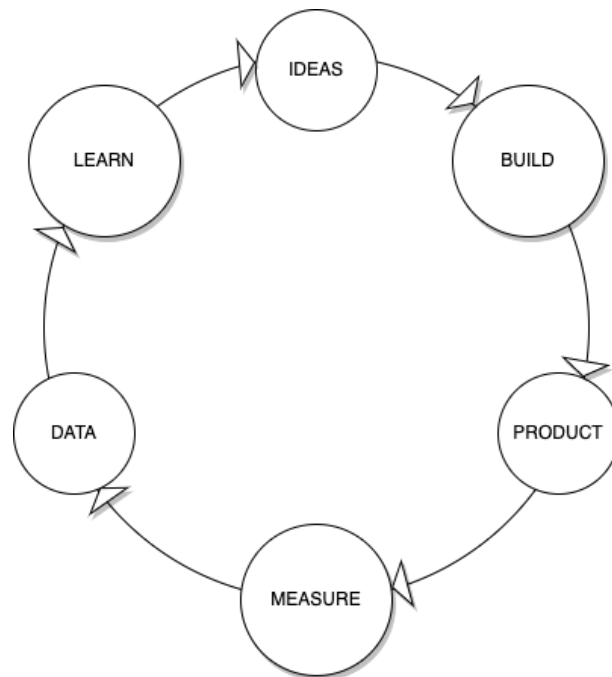


Figure 3 - Build-Measure-Learn feedback loop, adapted from Ries (2011)

This means the activities should be implemented (build), data should be gathered from those activities using metrics (measure) and then the activity should be upgraded with these new inputs (learn). The data should be updated in the Knowledge Catalogue, so that other HEIs can make use of this valuable information and experience.

A user-centric approach should be used where users exist. In this case activities planned for students should include students in the planning and execution phase. Failing to do so makes the students miss out on an opportunity to learn about event management and planning and may also lead to less interest in an activity because of misalignments between the planner's idealization and the students' perception of the event.

Activities and Courses should be planned to consider the promotion of Entrepreneurial Self-efficacy, which is the "belief in one's ability to be an entrepreneur" (Bullough & Renko, 2013, p. 2). This essentially means the activities should guide the students but promote independence in their actions, so that they believe in their capabilities as entrepreneurs.

This dissertation's proposed solution for systematizing these learnings and opportunities is a Knowledge Catalogue. This catalogue will be a website that contains best practices for teaching entrepreneurship and innovation and examples of past activities and experiences. This is explained in detail in the next subtopic.

5.3 Proof of Concept / MVP

As stated previously, the outcome of this dissertation is, besides this document, the Knowledge Catalog, called INVENTHEI Handbook. The MVP for this is a website where the information is displayed, as a centralized knowledge source regarding entrepreneurship and innovation teaching practices.

Product Vision for the INVENTHEI Handbook

The INVENTHEI Handbook Knowledge Catalog should allow its users to get and provide insightful knowledge on entrepreneurship and innovation activities and best-practices quickly. The purpose of this platform is to collect practices and activities and then classify them according to specific categories, so that the platform's users can make an educated choice on what they want to implement next, based on their needs.

It should have all the knowledge related to an activity that it could, and display it in a user-friendly way, with data symbols and round numbers. For example, to classify an activity for its cost, the euro sign symbol “€” could be used, classifying “€” as cheap events, “€€” as medium cost events and “€€€” as high-cost events.

Other metrics should be created for time required to implement activity, using for example an hourglass symbol “🕒”, where “🕒” would be for quick activities lasting for about two weeks, “🕒🕒” would be for intermediate activities lasting for about 3 months and “🕒🕒🕒” would be for activities lasting for 6 months or more. For student-satisfaction regarding that activity a star symbol “★” should be used, representing a scale of 1-5 with a direct connection to student assessment of said activity. Lastly for impact/effective output, meaning a raise in EI or its efficacy in improving students' entrepreneurial skills, a percentage should be shown directly related to the students' perception on how the activity will help them in the future.

Technical Implementation Details

This being done within the INVENTHEI project makes it so that it was decided that the MVP website should be hosted within the project's domain (inventhei.eu), within a sub host, making the final MVP url “inventhei.eu/handbook”

This MVP website was decided to be able to respect the following user stories:

As a user:

- US1 - I would like to check information on a previously held activity.

- US2 - I would like to look at all the activities that we know so I can choose one.
- US3 - I would like to check feedback on an activity I want to implement.

As a website administrator:

- US4 - I would like to add a new initiative to the catalogue.
- US5 - I want the website to be password-protected against creation or deletion of activities.

Taking these use cases into account, the MVP is a website that has a centralized display of information (check visual mock-up in Appendix A). On the left it has a menu-style section with the activities that are in the database. On the right it has a ‘display window’, which when an activity is selected displays the information related to said activity. There is also an administrator section which allows a user with the password to add, edit or delete actions and their information (at the “inventhei.eu/handbook/crud/backoffice” url)

This application was architected in the following way: to develop the frontend project Angular SPA framework version 13 was used and to develop the backend project Firebase’s Firestore technology was used, as a backend for frontend (BFF) architecture.

Angular is an open-source frontend platform for building mobile and desktop web applications. It was created with Typescript, and it was built and is maintained by Google’s Angular team.

For the frontend part of this project two main pages were needed: the user’s view of the read-only data and the administrator’s view of the read-write data.

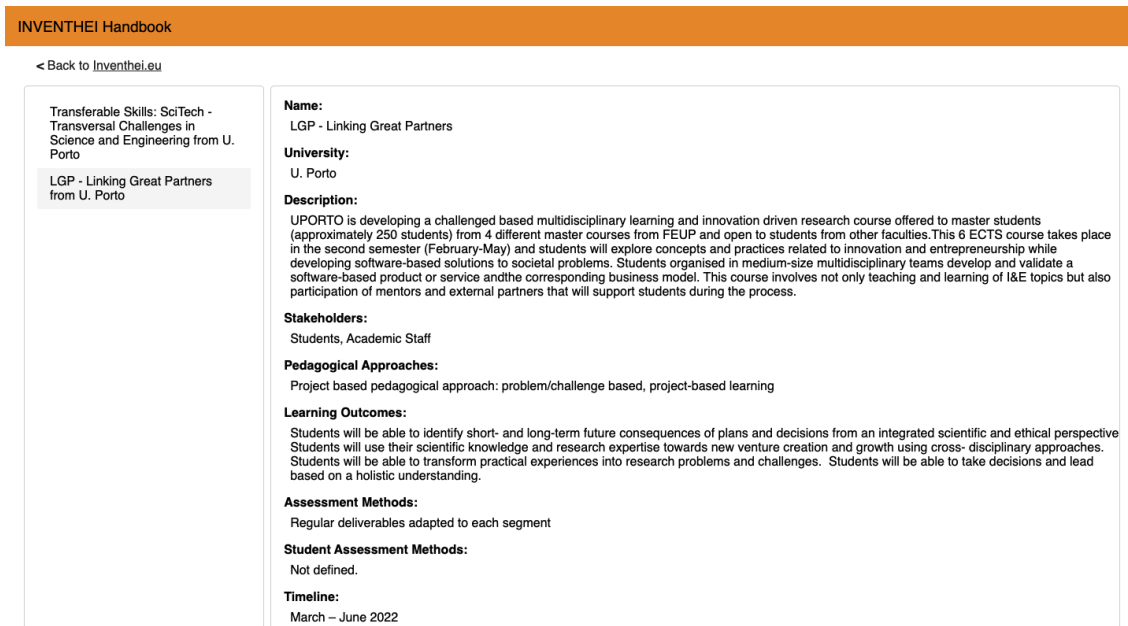


Figure 4 – Application’s User View Screenshot

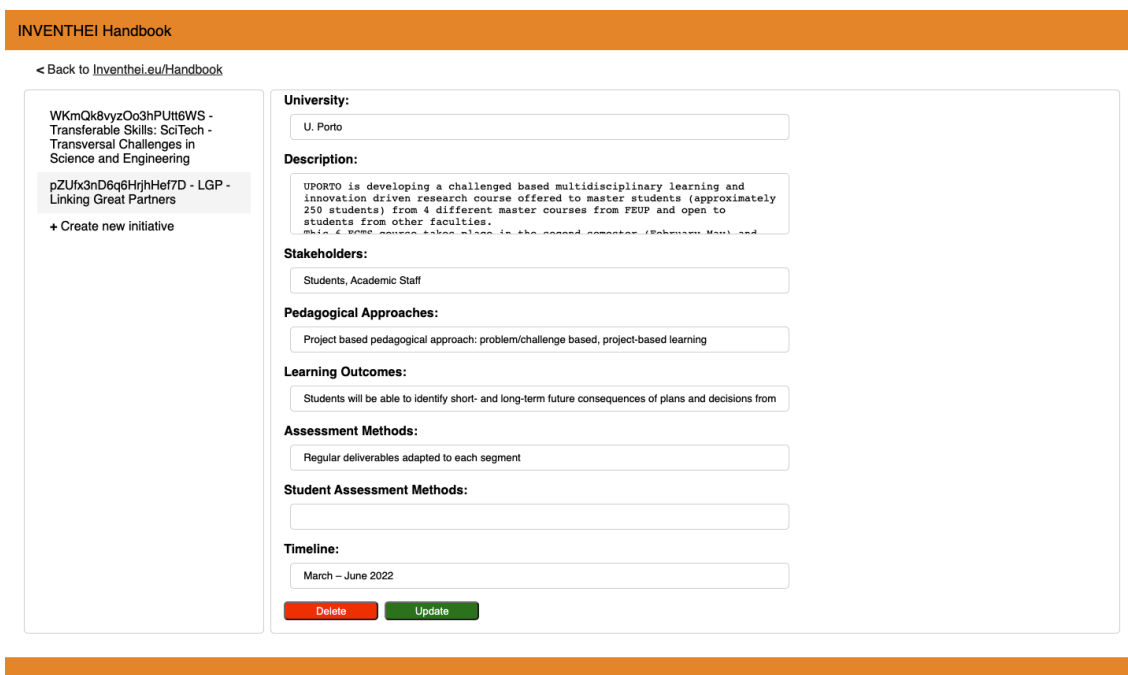


Figure 5 – Application’s Administrator view Screenshot

To accomplish this the base visual template was created and then adapted for both cases, one having only display fields and the other one having a form for editing/adding information. Two components were created for each view, one for the outer-most part that

contains the left menu list, and one for the inner part that displays the information relative to each activity. This was done for encapsulation purposes. This was the presentation layer.

The project also needed a data service layer, and this was created using an angular service and the firebase SDK. A service for crud operations was created in the root folder and that service is then injected in the components that need it.

The data fetching process was done in an eager-loading pattern, because the homepage displays information stored in firebase, meaning when the page loads it is in the user's interest to have information readily available for him to read. To achieve this a function was created that fetches the data from firebase. The application also had to be changed to display something dynamic while the data is fetched, so that the user knows something is happening in the background. This meant creating a page-loading spinner, which makes use of the INVENTHEI logo that spins while the data is loading. A phrase saying "Loading INVENTHEI Handbook" also appears below the spinner.



Figure 6 - Loading spinner

For the backend project, a new project was added to a firebase account, the Firestore functionality was activated, and the access keys were used to connect it to the frontend application. Firebase Firestore is a NoSQL database (non-relational database) with an SDK that allows a developer to integrate it with an application. This technology follows a serverless architecture.

Future Improvements to the MVP

This subtopic introduces future enhancement suggestions for the MVP in order to add features to the webpage that are useful for its users, in the form of user stories.

As a user:

- US1 - I would like to reorder the information display so that it is more readable.
- US2 - I would like to have multiple examples aggregated to the same activity.
 - E.g.: An activity front page and then inside it all its implementations' examples.
- US3 - I would like searching and filtering capabilities, such as difficulty of implementation, time to get results from an activity, etc.
- US4 – I would like to be able to distinguish activities based on metrics with visual indicators. One of these metrics should be a classification using the proposed taxonomy.

As a website administrator:

- US5 - I would like to attach sample material to an activity, such as videos, photos or documents.

The first user story (US1) should translate to a reordering of the visual display of the content.

The second user story (US2) should translate into a reordering of the data structures, so that the main structure is like the current structure, containing more general aspects of the activity, and then the substructures contain information regarding each HEIs attempt at recreating the activity, so that everyone's experience is logged and available.

The third user story (US3) should translate into a feature which would allow searching of the content, and filtering. This is important as the content grows, because it will get harder to track and to find certain activities. It would also allow users to find what they wanted in exploratory visits to the website much faster, being able to filter by activity timespan for example.

The fourth user story (US4) proposes that the data structures should be adapted to have metrics available for storing classifications of activities as mentioned in the product vision section. These should be the cost metric, classifying cost with euro signs, the time required to implement activity metric, a student-satisfaction metric and an impact/effective output metric, that demonstrates the effectiveness of said activity. The activities should also be

categorised following the proposed taxonomy, and the taxonomy adapted if a new activity is not to fall under one of the categories.

The last user story (US4), targeted for administrators and users alike, should translate into adding the correct fields to the data structure so that videos, photos and documents could be uploaded as extra information for an activity.

6. Conclusions

This dissertation expanded on three topics: firstly, the literature review which gathered a state of the art on the current literature's best practices and details in teaching entrepreneurship and innovation.

The literature review contains valuable inputs on multiple topics for this dissertation, with the main ones being the Entrepreneurial University definition, which teaches us the steps necessary to become one, it gave us the suggestion to create a program in which researchers are paired with an entrepreneurial student, which is linked with a better chance of spin-off success, it gave us insights on policies and policy recommendations, the definition and characteristics of an academic entrepreneur, and how to profile students for being academic entrepreneurs or not. We also learned a taxonomy for classes/teaching types, and research on which type gives the best results, and lastly the basis for the activity taxonomy which contains advice on what types of courses work best for students in different phases of EI.

Secondly, the qualitative interviews' results, regarding interviewing representatives of the partnering universities in the INVENTHEI project, gave feedback on the industry's current practices in teaching entrepreneurship and innovation. Some still carry more traditional approaches and are starting to modernize their approaches, and others are already on their way with experimenting new events and new ways of providing their students the best tools for them to increase their Entrepreneurial Intentions and Capabilities.

These interviews provided the current context of the interviewed universities and, although not necessarily bad, there is room for improvement. The activities section could use more diversity of examples and experiences, the evaluation methods of said activities leaves much to be desired, most if not all rely on traditional student satisfaction inquiries, there is a lack of student input in activity planning and execution, this poses an opportunity for student growth and also for better student engagement, and the teaching models could be adapted to an optional hybrid teaching model, where students who want to participate but don't have the chance get an easier way to gather some of the taught knowledge, at the same cost for the universities.

Activities and initiatives like a business model competition, a lean start-up camp, organizing talks and lectures, networking events, creating departments focused on Entrepreneurship and Innovation and offering traditional courses or degrees in Entrepreneurship and Innovation are a taxonomy that manages to fit both the current offering within the partnering

universities in the INVENTHEI project but also the literature discussed in the Theoretical Framework chapter.

This dissertation suggests that activities which fall under this classification should be performed within the scope of improving the HEI's impact in entrepreneurship and innovation teaching, but while paying special attention to specific actions' details, such as having User Input, in the case student input, not only at the end of the activities but also before the activities, during the planning phase.

A user-centric approach should be used where users exist. In this case activities planned for students should include students in the planning and execution phase. Failing to do so makes the students miss out on an opportunity to learn about event management and planning and may also lead to less interest in an activity because of misalignments between the planner's idealization and the students' perception of the event.

The implementation of these activities should follow the build-measure-learn loop (Ries, 2011) iteratively, meaning with each iteration of the activity the HEI should not only repeat but also improve where possible.

Lastly, the MVP of the Knowledge Catalog, the INVENTHEI Handbook, which is a first version of the centralization space for all INVENTHEI knowledge in best practices and activities. This will provide a place for educators to look for activities and gather and provide feedback on them, so that they can hopefully make a right decision and utilize the best tool for their use case. This tool should be kept updated with all the HEIs experiences in all their activities' iterations, as to gather as much data as possible so that the activities can be better classified.

The research questions proposed in this dissertation were answered. The main research question (RQ), defined in subchapter 1.3, was answered with a taxonomy and the explanation about how each category helps on increasing impact in student's innovation and entrepreneurship capacities. The categorization implied by the taxonomy also included best practices to further improve impact on learning. The first sub-research question (SRQ1) was also answered, and the proposed solution was also the taxonomy. With the taxonomy being created through the current literature we were able to categorize best practices and best types of activities. With this we can validate new and existing knowledge and good practices by comparing them to the taxonomy and proposed best practices, as was done with the current activities taken form the INVENTHEI partners. The second sub-research question (SRQ2) was also answered, and the proposed solution was created, it being the INVENTHEI

Handbook MVP. The platform's purpose is to share knowledge between the HEIs, firstly the activities and then the activities' results.

This dissertation comes, however, with its own limitations and suggestions, which are explained below, in the "Limitations and Future Research" subtopic.

Limitations and Future Research

For limitations, the qualitative data collection pool for this dissertation was very small, consisting of only 6 HEIs, and the target group consisted of INVENTHEI partners, which limits the pool to HEIs who are interested in increasing their entrepreneurship and innovation contributions. These interviews could be repeated with a larger group of HEIs and could also try the perspective of interviewing HEIs within countries with higher perceived entrepreneurship skills (such as the U.S) and countries with lower perceived entrepreneurship skills and study the contrast and the reasons behind it.

Another limitation is that there was only a first round of initiatives, meaning the activities the HEIs mentioned were only tested out by themselves, no other university tried to replicate it.

For future research, this dissertation suggests the study of the impact of a certificate of participation in student's perception of an activity, the study and classification of ways to evaluate initiatives, which could be beneficial for HEIs to analyse their own activities, and the study and classification of cost-benefit analyses on activities, which could be related to the previous suggestion.

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Appendix

Appendix A – Visual mock-up for the MVP

INVENTHEI Activities manual

- Actividade 1 - U. Santiago
- Actividade 2 - U. 2
- Actividade 3 - U. 3
- Actividade 4 - U. 4
- Actividade 5 - U. 5
- Actividade 6 - U. 6
- Actividade 7 - U. 7
- Actividade 8 - U. 8

Centro Senior de ... - U. Santiago



Esta atividade consistiu em ...(Description) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nunc in ante scelerisque, porta nibh in, ornare eros. Cras maximus, elit in fringilla auctor, enim nisi tincidunt dui, in tincidunt mi ipsum sed diam. Quisque eu finibus felis. Integer porttitor lectus nec leo euismod semper. Nulla sagittis orci vitae mattis facilisis Maecenas vehicula dolor in sagittis dapibus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos.

Stakeholders:

Pedagogical approaches:

Learning outcomes:

Assessment methods:

Student assessment methods:

Timeline:

Contactos

Appendix B – Taxonomy activities' description and justification

This annex lists the activities and categories mentioned in the proposed taxonomy model and justifies the inclusion of each example within the category it was assigned.

Talks and Lectures

Alumni I&E success stories (UPce)

-Presentation and discussion of Alumni regarding their Innovation and Entrepreneurship success stories.

Building an innovation culture (VUT)

-Seminar on the topic.

Innovative Entrepreneurship (VUT)

-Seminar on the topic.

Innovation and Eco-Innovation (VUT)

-Seminar on the topic.

3D print and scan day (UPce)

-Discussion of 3D print and scan with industry partners.

Innovation Day (VUT)

-Talks about innovation faculty-wide.

Entrepreneurship Inspiration Day (TTK)

-Theoretical introduction to entrepreneurship competences, expectations from labour market linked to presentations held by companies, group discussions, participants' self-reflections and conclusions by the end of the day.

Lean Start-up Camps

LGP - Linking Great Partners (U. Porto)

-Challenge based multidisciplinary learning and innovation driven research course.

E&I Departments

USFD

-They created an office for entrepreneurship that focuses on developing students' entrepreneurship skills.

Centre of I&E (TTK)

-They have a centre for innovation & entrepreneurship which should develop connections with companies and other stakeholders, as well as improve their students' and academic staff's capability for innovation and entrepreneurship.

Courses and degrees In E&I

Gerontological I&E for teaching and research (USC)

-Course for teaching and research staff to familiarize with the concepts of innovation and entrepreneurship in the context of higher education, reflect on the needs of innovation and social entrepreneurship in an aging society and acquire basic teaching skills to promote innovation and entrepreneurship skills in students of different degrees.

Computer Vision for Innovation in Business (UPce)

-A course to introduce computer vision hardware (industrial cameras, RGB-D cameras, laser scanners, various lenses and lights, processing units, etc.) and software tools for practical implementation of computer vision tasks.

Machine Learning for Innovation in Business (UPce)

-A course to introduce machine learning tools and models for practical purposes. Specifically, the students find out, what machine learning is, how to transform business and industrial problems into machine learning use cases, how to verify those use cases considering feasibility and impact, how to carry a machine learning project through its various phases from the primal idea into a practical implementation, and how to implement machine learning and artificial intelligence responsibly.

Service Learning (USC)

-A course that combines processes of community service and learning in a single well-articulated project, in which participants learn while working on real needs of the surroundings in order to improve them.

Masters program in I&E (U. Porto)

-A masters program that promotes an integrated training of managers and entrepreneurs through practical training (hands-on-approach). It is based on solid theoretical concepts and on permanent and professional supervision, which enable the development of skills and knowledge in order to produce an efficient knowledge and innovation management in new businesses.

Business Model Competitions

Start-up Entrepreneurship ABC (TTK)

-A training that provides participants with basic knowledge (start-up) about starting a business as well as initial experience of developing an idea through various exercises.

Senior Innovation Lab (USC)

-A challenge-based learning approach where different real-life obstacles were analysed in order to develop solutions.

Networking Events

Managing Directors Clubs (USFD)

-An event where they bring in regional businesses to have dinner and speakers talking about innovation culture.

Appendix C – Platform Screenshots

Case 1 – No activity chosen

INVENTHEI Handbook

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Transferable Skills: SciTech - Transversal Challenges in Science and Engineering from U. Porto

LGP - Linking Great Partners from U. Porto

Pick an initiative from the left panel to read more about it

Case 2 – First activity chosen

INVENTHEI Handbook

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Transferable Skills: SciTech - Transversal Challenges in Science and Engineering from U. Porto

LGP - Linking Great Partners from U. Porto

Name:
Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

University:
U. Porto

Description:
The program, structured in three sequential phases, provides for the approach of the following topics: Designing a prototype · Seminar 'Rules, requirements and materials' · Prototype pre-planning · Use of materials and tools · Final product assembly · Evaluation Case Study · Presentation of the case study · Case analysis through the available material · Competition · development of theoretical solutions · Evaluation Debate competition · Presentation of topics for debates · Seminar 'Public presentations and argumentation' · Competition · application of learning from the seminar and assessment

Stakeholders:
Students

Pedagogical Approaches:
Transferable Skills Course Unit (time management, team management, project management); Project Based Learning

Learning Outcomes:
Planning and project development skills · Teamwork · Materials management and budgeting · Ability to argue · Public presentations · Analytical thinking · Creativity

Assessment Methods:
Not defined.

Student Assessment Methods:
The teaching-learning methodology is based on expository and active methods, in which explanatory lectures are immediately followed by practical application of learning through exercises that take the form of building prototypes, oral presentations, reports, etc. In the theme 'Concept of the Prototype', the scripts with all the necessary information for the planning of the prototype will be made available, followed by the autonomous study to carry out the respective planning. Afterwards, participants will have to attend a lecture in which they will receive indications on the use of the tools to be made available. After the lecture, they will have to build a physical prototype, using sustainable materials. In the theme 'Case study', after the introductory lecture to this method, there will be a presentation of the cases that will be carried out by each group. Afterwards, the autonomous study (in group) and analysis of the case follow, using available materials. Student groups will have the opportunity to analyze and solve problems based

Case 3 – Second activity chosen

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Transferable Skills: SciTech -
Transversal Challenges in
Science and Engineering from U.
Porto

LGP - Linking Great Partners
from U. Porto

Name:

LGP - Linking Great Partners

University:

U. Porto

Description:

UPORTO is developing a challenged based multidisciplinary learning and innovation driven research course offered to master students (approximately 250 students) from 4 different master courses from FEUP and open to students from other faculties. This 6 ECTS course takes place in the second semester (February-May) and students will explore concepts and practices related to innovation and entrepreneurship while developing software-based solutions to societal problems. Students organised in medium-size multidisciplinary teams develop and validate a software-based product or service and the corresponding business model. This course involves not only teaching and learning of I&E topics but also participation of mentors and external partners that will support students during the process.

Stakeholders:

Students, Academic Staff

Pedagogical Approaches:

Project based pedagogical approach: problem/challenge based, project-based learning

Learning Outcomes:

Students will be able to identify short- and long-term future consequences of plans and decisions from an integrated scientific and ethical perspective. Students will use their scientific knowledge and research expertise towards new venture creation and growth using cross- disciplinary approaches. Students will be able to transform practical experiences into research problems and challenges. Students will be able to take decisions and lead based on a holistic understanding.

Assessment Methods:

Regular deliverables adapted to each segment

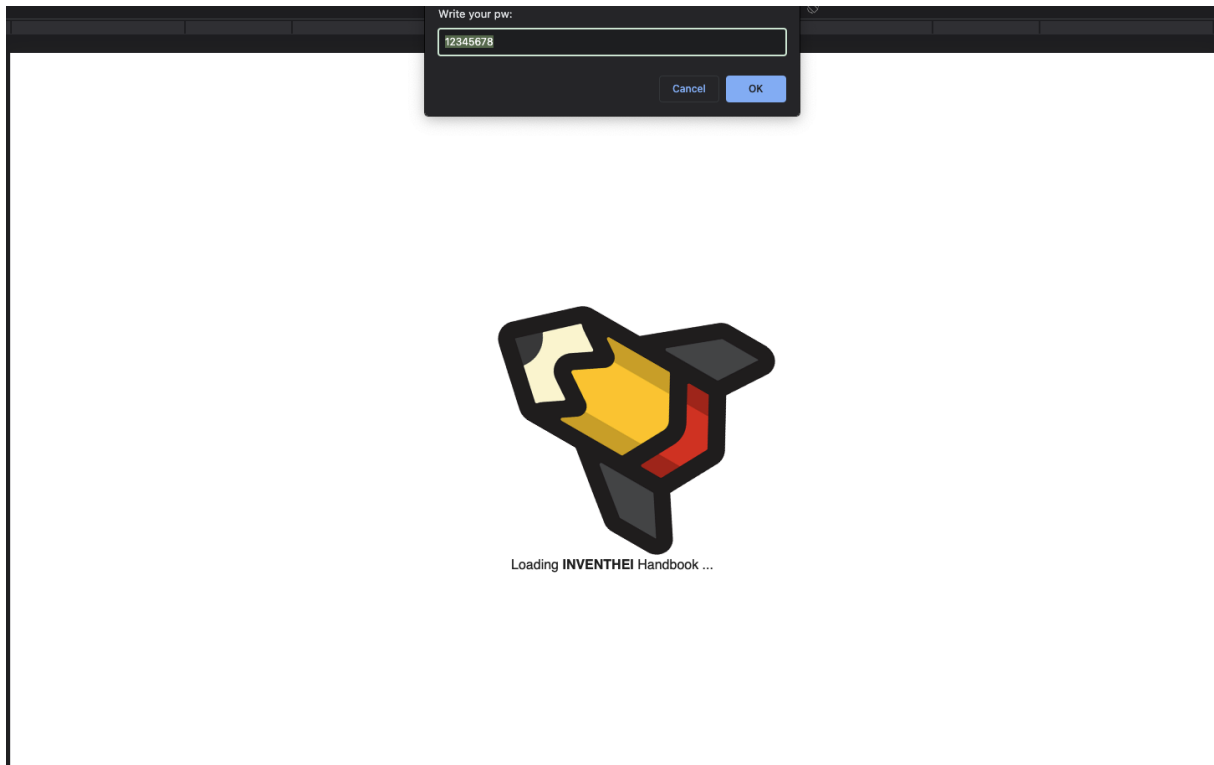
Student Assessment Methods:

Not defined.

Timeline:

March – June 2022

Case 4 – Administrator login



Case 5 – Administrator View: First activity chosen

INVENTHEI Handbook

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WKmQk8vyzOo3hPUt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

+ Create new initiative

Id:
WKmQk8vyzOo3hPUt6WS

Name:

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Case 6 – Administrator: Second activity chosen

INVENTHEI Handbook

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WKmQk8vyzOo3hPUt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

+ Create new initiative

Id:
pZUfx3nD6q6HrjhHef7D

Name:

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Case 7 – Administrator: Second activity chosen, scrolled to bottom

INVENTHEI Handbook

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WKmQk8vyzOo3hPUt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

+ Create new initiative

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Timeline:

Case 8 – Administrator: Update button clicked, confirmation modal

Are you sure you want to update this record ?

INVENTHEI Handbook

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WKmQk8vyzOo3hPUt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

+ Create new initiative

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Timeline:

Case 9 – Administrator: Delete button clicked, confirmation modal

Are you sure to delete this record ?

Cancel

INVENTHEI Handbook

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WKmQk8vyzOo3hPUtt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

[+ Create new initiative](#)

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Timeline:

Case 10 – Administrator: New activity creation view

INVENTHEI Handbook

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WKmQk8vyzOo3hPUtt6WS - Transferable Skills: SciTech - Transversal Challenges in Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP - Linking Great Partners

[+ Create new initiative](#)

Name:

University:

Description:

Stakeholders:

Pedagogical Approaches:

Learning Outcomes:

Assessment Methods:

Student Assessment Methods:

Timeline:

Case 11 – Administrator: New activity creation view, scrolled to bottom

< Back to [Inventhei.eu/Handbook](#)

WKmQk8vyzOo3hPUtt6WS -
Transferable Skills: SciTech -
Transversal Challenges in
Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP -
Linking Great Partners

+ Create new initiative

University:

Write university here

Description:

Write description here

Stakeholders:

Write stakeholders here

Pedagogical Approaches:

Write pedagogical approaches here

Learning Outcomes:

Write learning outcomes here

Assessment Methods:

Write assessment methods here

Student Assessment Methods:

Write student assessment methods here

Timeline:

Write timeline here

Create

Case 12 – Administrator: Create button clicked, confirmation modal

Are you sure to create this record ?

Cancel

OK

< Back to [Inventhei.eu/Handbook](#)

WKmQk8vyzOo3hPUtt6WS -
Transferable Skills: SciTech -
Transversal Challenges in
Science and Engineering

pZUfx3nD6q6HrjhHef7D - LGP -
Linking Great Partners

+ Create new initiative

University:

Write university here

Description:

Write description here

Stakeholders:

Write stakeholders here

Pedagogical Approaches:

Write pedagogical approaches here

Learning Outcomes:

Write learning outcomes here

Assessment Methods:

Write assessment methods here

Student Assessment Methods:

Write student assessment methods here

Timeline:

Write timeline here

Create