Design Thinking in Higher Education for Promoting Human-centred Innovation in Business and Society

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O1. Learning needs analysis and development of methodological learning frameworks for design thinking in higher education

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EXECUTIVE SUMMARY

Design thinking is a human-centered, solution-oriented approach to entrepreneurial innovation that aims at better understanding of how a user will experience a proposed solution. Design thinking can help find solutions through empathy for understanding actual issues, creativity for innovation, prototyping, and testing with users to ensure that proposed services work (Stanford). The approach is successful both in making businesses successful through offerings that best meet client needs and in solving social issues in social entrepreneurship contexts by introducing solutions through creativity where none may appear to exist. These entrepreneurial skills are particularly relevant for today’s young generation in the face of emerging societal challenges related to population growth, poverty, unemployment, and more.

The higher education sector today faces challenges that call for the adaptation of educational practices to emerging industrial and societal needs. Rapid evolution of technology results into solutions and services becoming quickly obsolete, being replace by emerging technological and research innovations. As a result, the main challenge of higher education is to create adaptive adults that are critical thinkers. Higher education more than ever must prepare students to become knowledge builders by learning how to learn in a way that facilitates their smooth transition into the entrepreneurial and social-entrepreneurial realms. In the content of higher education activities students should be exposed to entrepreneurial practices, in order to build experience and skills that will allow them to effectively enter the professional sector of entrepreneurship. There is a great necessity of incorporating entrepreneurial processes into the already existent curricula in a manner that allows students to build new skills and competenc-
es in a safe and user-friendly learning environment, eliminating any fear of failure.

DesignIT focuses on building design thinking skills and experience which are essential for the students’ future successful career. Design thinking skills will foster learners to apply a user-centric approach during problem-solving procedures. DesignIT teaches students how to empathise with users, to understand how they can better define an existent problem; to ideate in order to come up with as many solutions as they can (without being judged), to prototype their best solution, and finally to test it with the user so as to understand if it meets all the user’s requirements or it needs optimization. If there are changes that should be made, the process will repeat some of its stages. Students play an active role in carrying out the aforementioned design procedure.

The DesignIT project aims at introducing innovative design thinking interventions into entrepreneurial higher education towards preparing students to enter evolving economies by being adaptive, resilient, innovative, and creative and by possessing the practical entrepreneurial skills that will allow them to put ideas into action in business as well as social well-being contexts. DesignIT addresses these objectives through the development of a gamified learning platform that immerses higher education students into design thinking approaches based on ideation, brainstorming, prioritization of ideas, evaluation of ideas, leading to the design of economically viable services that best address the needs of end users.

This report focuses on the analysis of the current situation in higher education on building entrepreneurial skills and on introducing a game-based, active learning framework towards building design thinking skills among higher education students. The report analysis current practices and policies on entrepreneurship education in general and design thinking in par-
icular at the national level in Greece, Estonia, Finland, and Portugal. It analyses how ICT is currently deployed to enhance related educational initiatives. It provides a map of stakeholders that stand to gain from emerging design thinking approaches in higher education and provides an in-depth focus of learning needs for higher education students in relation to becoming entrepreneurial and creative thinkers. It analyses how game-based approaches can contribute to fostering design thinking mind sets. Finally, the report concludes with the introduce of the DesignIT project methodological framework that is based on game and active learning approaches for building design thinking skills and introduces the design of a game-based learning platform that will be implemented and validated in the context of the project.
1. INTRODUCTION AND DESIGNIT PROJECT RATIONALE

Entrepreneurial skills are widely considered as a unique competency which is implemented in every subject and educational level (ET2020). It fosters individuals to explore their talents, to introduce creative ideas, and to take action towards turning ideas into sustainable solutions which contribute to both business development and social prosperity.

Design thinking is a human-centric, solution-oriented approach to entrepreneurial innovation that aims at better understanding of how a user will experience a proposed solution. Design thinking can help find solutions through empathy for understanding actual issues, creativity for innovation, prototyping, and testing with users to ensure that proposed services work. This approach is successful both in making businesses successful through offerings that best meet client needs and in solving social issues in social entrepreneurship contexts by introducing solutions through creativity where none may appear to exist. The entrepreneurial skills built through the design thinking process are particularly relevant for today’s young generation in the face of emerging societal challenges related to population growth, poverty, unemployment, and more.

Project DesignIT aims at introducing innovative design thinking interjection into entrepreneurial higher education towards preparing students to enter evolving economies by being adaptive, resilient, innovative, and creative and by possessing the practical entrepreneurial skills that will allow them to make ideas come true in business as well as social well-being contexts.

The project targets the educational needs of students by introducing design thinking skill building activities that can be incorporated into a variety of subjects and help learners understand the core design thinking concepts as well as explore its practical applications in diverse contexts.
DesignIT further targets the needs of educators by introducing instructor support content for integrating design thinking into learning by challenging students to generate new ideas and bring them into life.

Speaking of the methodologies that DesignIT will apply, they are well accepted active learning methodologies that help students learn-by-doing and build experience. Some argue that great designs are the results of great teams. In this spirit, the project will further promote collaborative and explorative learning frameworks. The project will exploit the advantages of gamification, namely the deployment of game elements in learning contexts, towards promoting student engagement, motivation, evaluation, and step-by-step scaffolding of knowledge.

The above are achieved through a gamified learning environment that encourages learners to apply design thinking methods towards solving non-trivial business and social challenges. Students are exposed to the entrepreneurial concepts of a solution desirability (i.e. how well it addresses user needs), technical feasibility, and business viability (IDEO). Specific learning scenarios inspired by real-world case-studies are designed around clear educational objectives, namely the promotion of soft skills such as creativity, group-work, and customer understanding along with practical skills such as designing a working and viable basic business offering. The scenarios are integrated into the proposed gamified learning environment, will challenge students to generate ideas and solutions through team work, will cultivate a design thinking culture, encourage outside the box thinking, and will promote social responsibility in entrepreneurship.

The DesignIT gamified learning environment is designed for deployment as a complementary educational tool in wider blended learning activities classroom through which learners have the opportunity to learn from each
other and from the teacher through peer idea evaluation as well as the evaluation of the viability of the proposed business solution.

The expected outcomes from this project are the following:

- An active learning framework for promoting design thinking entrepreneurial education through exploration, teamwork, and innovation
- A proof-of-concept gamified learning environment that familiarizes students with design thinking concepts and helps build practical skills
- Educator support for fostering the integration of proposed methodologies and tools into classroom practices towards promoting entrepreneurial student skills

The expected impact of the DesignIT project is to help modernize education by integrating emerging design thinking approaches towards building entrepreneurial skills that are desirable in a student’s future workplace and contributing to employability and sustainable growth through innovation. The project contributes to active citizenship by empowering tomorrow’s professionals to apply their talents towards addressing social issues through entrepreneurial solutions, contributing to social prosperity and cohesion. The project helps build the capacity of educational institutions and educators to adopt emerging design thinking methodologies for linking learning to educational goals.

This report is organized as follows:

- Chapters 2, 3, 4 and 5 displays the objectives and expected outcomes of the DesignIT project respectively, its innovative outlook and the targeted groups of users and stakeholders
- Chapter 6 displays and examines the basic concepts, strategies, and practices regarding the design thinking approach applied in en-
entrepreneurial education. It analyses the characteristics of a problem-solving approach, the various description of the design thinking process, and each one of the prevalent design thinking stages. The chapter further it introduces both entrepreneurship and social-entrepreneurship

- Chapter 7 presents the evolving landscape of higher education and the challenges that drive innovation while Chapter 8 focuses on the national strategies and policies regarding the link between learning practices and industrial policies

- Chapters 9 and 10 present the current situation in countries represented in the consortium through partner organizations in terms of applying design thinking approach towards entrepreneurship, either with or without ICT deployment

- Chapter 11 presents an analysis and definitions of learning requirements for learners and educators

- Chapter 12 focuses specifically on the current situation in relation to serious games deployment in educational contexts for the development of specific professional skills. In addition, it analyses the requirements for tertiary educators on deploying ICT

- Chapter 13 presents the DesignIT pedagogical and methodological active learning framework
2. DESIGNIT HIGH LEVEL OBJECTIVES

DesignIT aims at promoting competence at the entrepreneurial education of the tertiary level by presenting the techniques of the design thinking approach, which teach the students the principles of design thinking; namely, how to empathize with the target users, define problems efficiently, ideate the way that users will experience the suggested solution, recognize opportunities that enables innovation, and synthesize innovative solutions that meet the users’ requirements successfully. The suggested design thinking context offers multiple benefits for students:

- In relation to entrepreneurial education, the approach empowers students to design products that effectively address a customer’s business requirements thus boosting the success potential of a new offer

- In the context of social entrepreneurship, the approach motivates students to design solutions to societal challenges encouraging them to become involved in their community’s wellbeing. Students learn to be active and civic minded

DesignIT satisfies the aforementioned objectives preparing the students to be socially active and highly professional at the same time. It helps integrate social contribution objectives into higher education learning goals. This project presents an active, serious-game based learning intervention that exhibits real-world matters to the students and motivates them to apply the design thinking methodology of empathy, definition, ideation, prototyping, and evaluation towards synthesizing viable solutions that are oriented towards real market and social necessities.

DesignIT introduces innovation through design thinking processes and prepares higher education students to enter evolving economies fully-prepared. DesignIT mentors students on how to be flexible, resilient, and
innovative by obtaining the appropriate entrepreneurial skills that will enable them to make ideas into business and benefit the whole society.

This project focuses directly on students’ learning requirements in terms of entrepreneurial skill development by introducing the design thinking methodology. It builds targeted activities which can be incorporated into a variety of thematic areas. It offers an opportunity to students to build design thinking skills by understanding the methodology’s basic principles and experiencing design thinking by applying it in practical situations in diverse contexts.

DesignIT recognizes the necessity of equipping educators with instructor support material in order to provide them with guidelines that facilitate teaching design thinking and challenging students to participate in brainstorming processes. In addition, the educational support content introduces practical approaches for integrating ICT into design thinking educational offerings towards enriching student communication, collaboration, and collective idea development towards introducing solutions to real world projects related to entrepreneurship and social entrepreneurship.

Last but not least, the project provides opportunities to instructors to advance their careers and to achieve career satisfaction through the development of their own skills and the introduction of innovative educational practices in their classrooms.
3. EXPECTED OUTCOMES
The following results are anticipated from the implementation of DesignIT objectives and activities:

- **An active, experiential, game-based learning framework** for promoting design thinking entrepreneurial education through exploration, collaboration, and creativity. The methodology will be tailored towards building students’ entrepreneurial skills. Active learning allows students to experience entrepreneurial methods, processes, and practices, thus becoming prepared for applying these effectively as professionals upon entering the world of work. Problem-based approaches encourage students to explore in a user centred manner a wide variety of real world problems, collaborate in order to compare the suggested solutions, and use their creativity towards introducing viable solutions, linking higher education outcomes to real-world needs. The methodology will further aim to encourage students to become civic-minded, take an interest in social problems, and focus on introducing solutions to pressing social challenges. The methodology will exploit the advantages of gamification, namely the deployment of game elements in learning contexts, towards promoting student engagement, motivation, evaluation, and step-by-step scaffolding of knowledge. It will help students to become effective future professionals by building work-related experience through active approaches in a safe, simulated environment that draws examples from the world of work.

- **A gamified learning environment** that will be based on the proposed DesignIT active and experiential learning framework. The environment will familiarize students with design thinking concepts and helps build practical skills. It will allow students to practically
apply design thinking approaches through brainstorming, ideation, breaking down of a project into tasks, providing feedback to each other, and synthesizing a solution to a given challenge. Gamification elements that link rewards to engagement and collaboration will encourage participation in collaborative design thinking exercises. The environment will allow students to learn without stress, practicing the application of business processes in a safe, inclusive virtual learning environment that simulates real world practices before being called to apply their skills in real-life contexts. The environment will allow students to learn from their mistakes and from each other building their capacity to bring ideas to life in business or social contexts

- **Educator support** for fostering the integration of proposed methodologies and tools into classroom practices towards promoting entrepreneurial student skills. The supporting content will target explicitly the needs of instructors. It will aim to expose them to design thinking concepts providing them with practical ideas on how to integrate design thinking in entrepreneurial educational practices, and outlining good practices on how to deploy the DesignIT tools in wider entrepreneurial education offerings at the tertiary level. The educator support content will have the following forms:
  
  o **A user guide** that will provide step by step information on the deployment of the DesignIT game-based learning platform for design thinking skill development
  
  o **Guiding support content in the form of videos of good practice** that will demonstrate how the DesignIT active learning design and digital, gamified design thinking environment
can contribute to the development of desired entrepreneurial skills among higher education students.

- **Comprehensive learning activities** that introduce good practices on how to integrate the DesignIT approach into entrepreneurial activities in the classroom and beyond. The content will be in the form of work sheets that walk the reader through well designed learning activities. The work sheets will describe learning objectives, concepts covered, activities deployed, assessment methods, collaboration methods, and more.

- **An evaluation strategy** that will provide an inclusive guidebook assessing the connection, acceptance, and efficacy of project DesignIT outcomes in relation to user aspirations and expectations. This specific strategy will provide both formative and qualitative evaluation methodologies for collecting the participants’ feedback. The aforementioned strategy will provide understanding to external interested parties, including both teachers and policy makers, showing the way to evaluate the proposed learning frameworks and software tools in relation to desired learning outcomes on the design thinking and entrepreneurial education.

- **Assessment outcomes** from the development of the DesignIT methodologies and tools in real-world instructional contexts in Greece, Portugal, Estonia, and Finland towards generating objective feedback with a European footprint, from DesignIT activities in multiple cultural, learning, and economic frameworks.

- **Conference publications** presenting in a scientific way of informing the academic community about the DesignIT objectives and the specialized implementation activities. At least one scientific publica-
tion will be pursued at a scientific conference with the objective of reaching the academic community and industry. The publication will present the scientific background of the project as well as the proof-of-concept implementation of the proposed digital learning tool. Examples of conferences that may be considered include ECEL, IADIS, EDUCA On-line, Future of Education, EduLearn, etc.

- **Contacts with policy makers, instructors, instructor trainers, professionals, and a variety of stakeholders** having as an objective to broadcast the outcomes of the project and promote the using of outcomes in addition to a project portal. It will target general audiences, presenting information through an easy way. The project portal will provide free accessibility to all interested parties project results, including reports, scientific articles, leaflets, software, information on dissemination events, media publications and more.

- **Bi-annual DesignIT newsletter.** A project newsletter is going to be developed every 6 months. The newsletter will target general audiences and will include information on the current status of the project implementation. Depending on the implementation phase of the project, it will present methodologies, software design approaches, evaluation information, broadcast information, information related to DesignIT events, and more.

- **Informational material.** A leaflet will be developed, based on project objectives, activities, and results. The leaflet will target general audiences. It will be made openly available through the project portal. It will be further distributed at dissemination and multiplier events. An early version will be made available promoting project goals. It will be updated close to the completion of the project to present information on project outcomes.
• Articles and presentations to "traditional" means of media, namely TV, radio, newspapers, on-line versions of newspapers, and more. Articles and presentations will be pursued to all of the above. This activity will help reach effectively the general public promoting awareness on the DesignIT project

• Presentations in social media and other Internet resources. The project will have its own social media presence, with pages on popular media such as Facebook(R) and Twitter(R). In addition, publications related to the project will be pursued to other social media where the audiences may have an interest in project activities and results.

• Presentations to thematic portals. The project will be promoted to thematic on-line portals with audiences that have an interest in lifelong learning, technology enhanced learning, serious games, and other related subjects. This activity will help reach effectively the lifelong learning community. Examples of portals to be deployed include SCIENTIX, the Panhellenic School Network of school educators that has 17.000 school members and 100.000 individual members, the European Schoolnet, and more

• Presentations to EPALE and other portals. DesignIT will be promoted to EU portals related to lifelong learning. This includes the EPALE portal for adult education as well as other portals as the opportunity arises

• Presentations to stakeholders. Face-to-face presentations will be also taken place targeting interested parties, including policy makers, educators, SMEs, educational administrations at the regional level, professional associations, and more. The presentations will
highlight project objectives, activities, and outcomes in a focused manner that best addresses the interests of each group
4. DESIGNIT INNOVATION

Design thinking is a human-centred approach to problem-solving that helps not only people but also organizations to act in an innovative and creative way [1]. As mentioned before, it is also solution-oriented and one of its most important features is the entrepreneurial innovation.

Design thinking is a concept that focuses on understanding the actual needs of a user, by predicting how the suggested solution will provide added value. Design thinking focuses on how the user will actually deploy a proposed solution. According to Stanford University’s D-School, design thinking helps come up with solutions by empathizing with the user and understanding the real issues, by applying creative ideas and innovation, prototyping and of course by testing the proposed solution to the users so as to verify that the suggested services function properly [57].

DesignIT is creative in a variety of ways. First of all, in terms of its educational objectives, its applied learning methodologies and of course its educational scenarios that the consortium proposes in the broader framework of suggested best practices and the technology deployed for educational purposes.

Speaking of the educational objectives, the project addresses existing requirements in tertiary education at a European level.

In terms of bringing innovation into learning experiences and better addressing emerging learning needs, DesignIT addresses the following:

- It promotes active learning by doing, which is proven to contribute importantly to knowledge retention (FAS)
- It promotes case-based learning, since it links gaming to the specific scenarios that come up from the workplace practices
- It links the learning outcomes provided by this serious game to the learning activities; the feedback obtained by this process is crucial and necessary
- It cultivates perception by using problem-based learning and experiential learning
- It enables the knowledge obtained to be applied in other subjects through role playing
- It encourages business mind sets which are user-centred
- It promotes long-term occupation with learning through applications that attract students’ attention
- It improves the quality of knowledge built in higher education and its relevance in the work place through scenarios inspired by real life
- It exploits technology in learning contexts in terms of gaming elements integrating to the learning methodologies
- It teaches students how to think out of the box when it comes to solving a problem

**In terms of enhancing entrepreneurial and social entrepreneurial capacity**, DesignIT is innovative by:

- Facilitating the success of businesses by empowering them to design offerings which satisfy completely the requirements of the clients
- Building entrepreneurial capability, which is a unique skill that contributes for the individuals to excel in their workplace, regardless of their work field. Entrepreneurial capacity is necessary in all study disciplines in higher education. DesignIT aims to build entrepreneurial mind sets, helping individuals understand existing problems,
implement ideas, and make these ideas come true by bringing them to the market

- Building social entrepreneurial capacity towards empowering young adults to face societal challenges, including poverty, population growth, unemployment, and others by successfully by designing solutions that are characterized by innovation. This is achieved by empathizing with individuals and striving to understand how individuals will benefit from proposed solutions, thus trimming solutions down to basic, necessary functionality that is feasible and implementable

In terms of linking higher education practices to societal needs, DesignIT is innovative as follows:

- It modernizes higher education by including the emerging concept of design thinking into curricula
- It builds entrepreneurial skills in demand in the industry
- It contributes to employability and sustainable growth through the development of human capital, i.e. by building skills of young, future professionals that will allow the pursuit of business opportunities for growth, benefiting individuals, the industry, and society as a whole
- It facilitates the introduction of solutions to real-existing problems and encouraging students to make up solutions

In terms of bringing higher education into the digital era, DesignIT introduces innovation by addressing:

- The requirement of transforming higher education practices in order to integrate emerging technology. This is pursued through the deployment of a serious games that are specifically designed for educational use
• The need to develop open digital instructional resources for deployment in higher education, which are freely available for deployment in formal as well as informal contexts

**In terms of learning design**, DesignIT is innovative by:

• DesignIT deploys **gamification in learning** contexts by introducing gaming elements to learning design with the objective of promoting long term learner engagement with educational processes. Gamification, when designed properly within learning contexts, can further contribute to the more effective achievement of learning goals. DesignIT gamification is presented later in this report; it aims at promoting creativity, collaboration, knowhow exchange, peer learning, and assessment that leads to knowledge scaffolding

• The DesignIT approach is heavily based on **feedback, generated by the instructor, by peers, and by the DesignIT gamified learning environment**. Feedback allows students to understand the link between their choices and effects those may have to an effective design of a product that successfully addresses user needs

• DesignIT further promotes openness in learning, by introducing a framework that allows students to freely express ideas without fear of judgement, to build on each other’s ideas through brainstorming, to evaluate ideas, both their own and those of others, all with the objective of introducing viable solutions to real world issues
5. DesignIT Stakeholders

In this chapter there will be a brief display of the interested parties that stand to gain directly or indirectly from emerging design thinking methodologies in general and the activities and outcomes of project DesignIT in particular.

Direct stakeholders include:

- **Higher education students**, who are interested in enriching their experiences in the context of entrepreneurial and social entrepreneurial education. They will be exposed to emerging trends of design thinking education; in this way they are expected to think outside the box about facing problems and coming up with solutions. DesignIT will inspire them to use both creativity and innovation in every single situation they may be through; it will also narrow the gap between students who have access in the digital contents at home and those who don’t, because every student will have equal opportunities of accessing this content in the classroom environment of the higher education. Furthermore, by understanding the principles of the design thinking approach, students will be able to face real-world problems, because they will see opportunities through the design thinking mind sets and they will bring ideas into life. Moreover, they will build the appropriate skill sets in order to think and act not only entrepreneurially but also effectively and they will influence the learning design simply by taking part in the proposed scenarios of the DesignIT they are interested in. Through DesignIT, they will participate in learning activities and through particular learning approaches (such as case-based learning, problem-based learning, experiential and active learning), they will be fully-trained to face both entrepreneurship and social entrepreneurship
sufficiently. What is more, they will actually build practical skills to implement ideas and bring them to the market for the benefit of everyone. Scholars are expected to cooperate, negotiate, ideate solutions in entrepreneurial education contexts and develop a healthy competition in this context; firstly, they will learn to empathise with users and experience the provided solutions; then, they will identify opportunities, as mentioned before, experiment by prototyping ideas and finally evaluate the success of the solution they choose. The aforementioned learning activities which have many gamification elements will lead to the desired educational outcomes through the students’ feedback and the latter will be benefited from the long-standing engagement with applications that capture students’ interest.

- **Tertiary educators**, who are attracted to providing up-to-date knowledge to their students in order to enhance their benefits. By using the proposed teaching practices of the design thinking framework, they will raise awareness on emerging trends in entrepreneurial and social entrepreneurial education. They will teach students how to build solutions that meet users’ needs precisely. Furthermore, they will be able to influence the learning design, since they will take part in selecting and designing learning cases to be delivered through the proposed DesignIT gamified learning environment. Additionally, educators will encourage students to build innovation-related skills, by promoting social entrepreneurship and design thinking methodology. What is more, the educators will foster the key entrepreneurial skills, such as the cooperation, the negotiation, the ideation of solutions and so on; DesignIT is a proof-of-concept software tool that will help them prepare students to their transition in the entrepreneurship through a virtual and protected
Another significant positive impact is the educators’ encouragement to integrate innovative ICT and emerging educational frameworks into existing lifelong learning offerings targeting young learners. Last but not least, educators will be able to have access to state-of-the-art digital content and provide this access to the students; as a result, the chasm between students who can access digital content at home and those who don’t will decrease.

Implicit stakeholders involves the following groups of the entrepreneurial education interested parties:

- **Educational policy makers**, who are interested building policies for promoting entrepreneurial capacity towards promoting growth and fighting unemployment. They further are interested in raising awareness about the necessity of students’ engagement with social entrepreneurship towards promoting social well being of communities. DesignIT will encourage a social dialogue between higher education institutes, society, and students, who will exploit the knowledge obtained towards designing innovative solutions for addressing today’s and tomorrow’s business and social issues. Furthermore, policy makers will be in a better position to suggest updates to educational curricula so that the latter include entrepreneurship concepts in a variety of themes related to innovation, thus contributing to the enhancement of entrepreneurship education. Policy makers will further be better informed on how strategic deployment of ICT, and more specifically gamification practices combined with emerging active learning methodologies, can contribute to enriched higher education practices in entrepreneurship and other subjects. The project will, through design thinking methodologies, contribute to empowering higher education students to become
“knowledge builders” and affect their attitudes positively in terms of linking knowledge built in higher education to society

- **Designers of educational software**, who are interested in combining emerging technologies, methodologies, and tools into integrated learning solutions that enrich learning practices and experiences, both formal and informal, in and out of the classroom.

- **The general public**, which has an interest in promoting a boost of entrepreneurial activity among young individuals for enhancing quality of life and promoting growth and social cohesion. Another important benefit for society is that DesignIT promotes employability by teaching students’ principles of entrepreneurship and innovation. DesignIT has the potential, through a more effective link between education and the world of business, to contribute to the reduction of unemployment by preparing students to interact with users, to communicate with them, to better understand their needs and to apply entrepreneurial principles in order to provide solutions for society

- **Academia with a focus on learning design**, a sector that is interested in all the outcomes of the DesignIT project, including methodological educational design, educational services and tools, instructor support material, and validation results. DesignIT will further promote a dialogue between the academic and business communities towards developing young adults that have the skills and knowledge to introduce solutions to emerging, pressing issues

- **SMEs** as future employers, who will benefit from well trained professionals that will allow them to undertake emerging business opportunities that require high level skills for their implementation. Entrepreneurial capacity, as well as transversal related skills promoted
by DesignIT, such as critical and creative thinking, and in high demand in the industry

6. DESIGN THINKING RETROSPECTIVE, STRATEGIES AND PRACTICES

This chapter provides an introduction to entrepreneurship, social entrepreneurship, and design thinking approaches.

6.1 Entrepreneurship and social entrepreneurship

Entrepreneurship is a complex term which has been defined in multiple ways. Entrepreneurship can be considered as a procedure that includes designing, introducing, and supervising a new business; this business is about to provide a product, a procedure or even service. Characteristics of entrepreneurial skill include the ability and eagerness to develop, organize, and run a business enterprise. On the other hand, entrepreneurship includes risks, such as deficiency of financing, wrong business decisions, the economic crisis, deficiency of market demand, or even a combination of the above.

On the other hand, entrepreneurs are individuals who have the ability to spot opportunities, evaluate them, understand fully if specific ideas are viable solutions to a given problem, and use these ideas towards developing new products or services. Entrepreneurs set up new firms or industries and they create wealth. Of course, there is uncertainty whether a business enterprise will be profitable or not, which is the result of insufficient business expertise or lack of financial or social capital.

According to Joseph Schumpeter (1883–1950) [127], an entrepreneur’s role can be considered as a “creative destruction”, since by innovating and setting up a new business there is a great possibility of destroying some
already existent ones. Innovation is always associated with risk-taking.

According to Michelacci and Schivardi [128], identifying and making a comparison between an entrepreneur's profit and educational level would demystify the rate and level of success. Based on Michelacci's and Schivardi's research, the higher level of education, the higher the possibility of success; an education beyond high school level already contributes to entrepreneurial success, while higher education offer even more significant benefits. Michelacci and Schivardi further argue that by entering college, individuals acquire additional skills which are vital for use within their business and they can operate more effectively than someone who does not have this academic level.

**Social entrepreneurship** differs from entrepreneurship in that it refers to the development, sponsoring and application of solutions that are relevant to social, cultural, and environmental issues [130]. The most important feature of social entrepreneurship is that it aims at generating a positive result to society; this is the main reason why it uses success metrics which differ from those of entrepreneurship. People involved in social entrepreneurship make efforts so as to achieve expansive social, cultural, and environmental goals which are usually associated with volunteerism in areas such as poverty alleviation, health care, and the development of a community. What should be clarified is that there are usually two goals that need to be achieved. The first involves improving the quality of life of a community; the second, raising funds towards achieving the desired quality of life improvements.

The widespread use of the internet has contributed to the development of social entrepreneurship, as social media allow individuals who have common perspective for a better world to communicate and cooperate effi-
ciently so as to achieve their goals. In addition, social media contributes to crowd sourcing as it is a medium that can be effectively deployed for awareness raising.

There is no general agreement about who can be considered to be a social entrepreneur [130]. Humanists, environmentalists, social activists, and other socially-oriented practitioners may be considered social entrepreneurs, however the definition is broad and may include other professionals. This is the main reason why it is not easy to determine who is an actual social entrepreneur. David Bornstein has used the term "social innovator" as an alternative term to “social entrepreneur”, to highlight the use of creative and pioneering strategies in social entrepreneurship.

Social entrepreneurship aims at a positive result to society. The primary goal is to specify a social issue that needs to be dealt with. This, however, not the single important factor in social entrepreneurship. Social entrepreneurs try to understand the bigger picture, namely a wider context of an issue that crosses disciplines, sectors, and theoretical backgrounds. They seem to have altruistic qualities and the great controversy is that according to a research very few people have the ability and skills of entrepreneurs and a socially motivated perspective at the same time [130].

There is a wide range of areas that social enterprises are associated with. One available classification includes the following: a) education b) economic development, empowerment, financial literacy and poverty alleviation c) environmental sustainability and climate Change mitigation d) animal rights, animal agriculture reduction and vegan enterprise e) food access, sustainable food systems, and hunger relief f) health, public health, healthcare accessibility, and wellness g) microfinance, microcredit, and micro lending h) racial equity & gender equity i) social justice, justice, human rights, and j) women's empowerment and women's rights.
When it comes to the Social Entrepreneurship, there are three different models which can be implemented to different circumstances and economic climates [130]: a) leveraged non-profit which uses pioneering ways to satisfy social needs, by leveraging financial and other resources, b) hybrid non-profit which aims at using profit coming from some activities in order to sustain its operations which have a social impact; they come up when there is government or market failures, since this model generates revenue and c) social business venture which aims at change people’s perspective through social means.

6.2 Design thinking and its terminology

Design thinking refers to innovative strategies that designers implement during the design process [2]. The methodology is deployed towards solving problems in a variety of sectors, both in business and social realms [3]. Design thinking combines the sensibility of the designer and approaches which guarantee that end users’ needs will be fully satisfied. Design thinking offers sustainable business strategies that focus on customers and create market opportunities [4].

Design thinking is applied towards generating innovative resolutions to problems. It is a solution-based thinking approach, having as its purpose to create a useful prospective outcome [5]. Many consider design thinking to be a scientific method for innovation. Another approach for solving problems is the scientific method [6]. This starts by introducing a hypothesis and continues with generating feedback mechanisms through which a model or theory is developed. Most of the time, the scientific method collects observational evidence based on measurable facts. This is the most significant difference between the two methods, since the design thinking approach takes into account the emotional content of the circumstances. In other words, design thinking takes into account the emotional state of
the consumer in relation to a specific problem. This is a key difference between discovering and developing resolutions. The consumer is the most appropriate person for presenting hidden and stated necessities and desires. The characteristic of emotion is completely ignored in the scientific method. Design thinking examines not only the acknowledged aspects of each circumstance, but also the ones that cannot be expressed precisely. In this way, there is a significant attempt of discovering parameters and alternate sets of resolutions that make it possible to reach one or more satisfactory targets. Because of design thinking’s iterative character, interim “solutions” can form the possible starting points of alternate paths, which enable redefining the initial problem. As a result, there is a co-evolution of the specific problem and the resolution to it [7].

6.3 Empirical study results on design methods

It was 1979 when Bryan Lawson carried out an empirical study in order to explore various problem-solving approaches between designers and scientists. He published the results after he had two different groups of students, namely architecture students during their final year and post graduate science students [8]. Lawson gave them a set of many coloured blocks and the experiment was for the students to create one-layer structures by using these blocks. There was only one instruction: the perimeter of the structure had to optimize the red-coloured blocks or the blue ones. The rules that were governing the association and the placement of the blocks were not defined.

Observing the scientists, Lawson understood that they adopted a technique of using as many different blocks and combinations as possible. Furthermore, they tried to maximize the available information about the acceptable combinations of the blocks. The students impulsively used this
**problem focused approach** in order to compensate for the lack of information on acceptable rules for arranging the blocks.

On the contrary, the architects chose the blocks with the criterion achieving the most appropriately coloured perimeter. In case that this combination wasn’t accepted, it would be substituted by another one that would be the next most desirably colored block combination. This procedure would go on until it resulted in a desirable solution. This approach is **solution-focused** [9]. This empirical study was very important, since Bryan Lawson expressed with his publication how designers think [8]. Later, it was Nigel Cross who came to a conclusion that scientists solve problems by analysis, while designers solve problems by using synthesis.

Kelley and Brown argued that the methodology of design thinking uses both analysis and synthesis. Analysis refers to a process through which an intellectual or fundamental whole is broken down into parts or components. Synthesis is the exact opposite process by which distinct components or elements are combined in order to create a coherent whole. These two approaches are considered as scientific ones and they are complementary.

### 6.4 Design thinking as a problem solving approach or process

Design thinking can be described as a problem-solving approach or, in other words, a process for solving problems.

#### 6.4.1 Design thinking as a solution-based approach

Design thinking aims at solving so-called “wicked” problems. Wicked simply means unclear. In this category not only the solutions but sometimes the problems themselves are unknown. This is a simple consequence of the fact that solutions are not obvious and cannot be reached without technical knowledge. Instead of spending time trying to come up with a solu-
tion, in this case designers have to spend their time towards clarifying a problem and defining specific requirements. The solution that emerges can be described as innovative as it seeks an optimized future outcome [14].

6.4.2 Design thinking as a creative approach

According to Baeck and Gremett (2011) [23], design thinking differs from analytical thinking, because it is a creative approach that depends upon the expansion of ideas. During the first stages of designing the aim is to go broad for coming up with new ideas. The designers who adopt this innovative approach do not rush into judging the quality of each idea. There is no fear of failing and this is the main reason why the participants feel free during the brainstorming (ideation) and the prototyping stages. Thinking outside of the box [13] is encouraged through these early phases of the design thinking process as it contributes to the introduction of solutions that would not emerge through other design methods [23]. In design thinking everyone has the capacity to be a designer.

6.4.3 Design thinking as a user-centred approach brings design into business world

Baeck and Gremett (2011) [23] argued that design thinking is more innovative than the other traditional design methodologies. They supported that design thinking diverges from other methods because it what is different. Baeck and Gremett argued that design thinking is an avant-garde approach. Design thinking is based on understanding the customer fully. Every idea and work is built through a close relationship with the customer in order to specify their actual needs. The design thinking methodology is not restricted only to design; rather, it can be deployed in any life circumstance. It is usually a means of exploring and determine problems that exist in business [23]; for this reason design thinking appears in the entrepreneurial sectors as well. It can be explained as a discipline through
which sustainable business strategies that match the customers’ needs are applied. Design thinking combines empathy for the customer’s problem, creativity so as to generate brand-new solutions, practicality, and feedback, so as to analyse a given situation and find the most appropriate solution. The solution to be developed will produce revenue, which leads to business success [23].

6.4.4 Core attributes of design thinking

In this chapter the design thinking attributes will be presented, as they were summarized by Baeck & Greemett, in 2011 [23]:

- Ambiguity
- Collaborative
- Constructive
- Curiosity
- Empathy
- Holistic
- Iterative
- Non-judgemental
- Open mind-set

These nine core attributes will be explained below:

- Ambiguity; designers learn to feel comfortable, even though there are not clarifications in the questions they raise; this means that design thinking concerns undefined problems
- Collaborative; designers learn to obey to disciplines and work as a team; this means that people participate in interdisciplinary teams and adjust effectively
• Constructive; old ideas are useful in order to step on them and come up with more successful ones; this means that design thinking is solution-based and it aims to optimized prospective results

• Curiosity; designers learn to be interested in subjects that they do not understand; in this way they have a fresh look towards these subjects and spend time by defining and shaping the problem, since the requirements are not crystal-clear

• Empathy; designers learn to share the customer’s opinion and their perspective; this means that they focus on the customer’s needs

• Holistic; designers learn to look at the big picture; this means that there are two goals that should be achieved: satisfaction of the user’s needs and business success

• Iterative; designers participate in a cyclical procedure; solutions keep improving independently of the phase they are in. This means that there are feedback loops

• Non-judgemental; designers come up with ideas regardless of their utility; they feel free; as a result the brainstorming leads to more creative results

• Open-mind-set; design thinking should be embraced independently of the sector or industry; this means that design thinking fosters “outside of the box thinking” which converts this approach into an experimental one

6.4.5 Characteristics of design thinkers

After analysing the core attributes of design thinking, it can be seen that the characteristics of the design thinkers seem to have similarities with the attributes mentioned before. It can be argued that the core attributes described above demonstrate the way design thinkers behave. In 2008, Tim
Brown from IDEO presented a paper entitled design thinking [24], in which he displayed a personality profile of a design thinker and started listing the characteristics of someone that acts as a design thinker. Furthermore, in 2009 and 2010, the Stanford d.school Bootcamp Bootleg provided “a mind-set for Design Thinkers”. Table 1 in Appendix C presents the characteristics of design thinkers [23].

To sum up, the characteristics of a design thinkers are [23]:

- They stay focused on human values and needs; they empathize, look for feedback, and apply its results in their designs
- They experiment throughout the design process; they are active “doers”, and interact with others through works of art
- They cooperate well with individuals that have different experience and background and respect their opinions; they believe that the best solutions will emerge from a variety of opinions
- The deal well with ill-defined problems; they are curious and think positively; they are holistic thinkers, who look at the big picture in relation to customer needs
- They are aware of the design thinking process in terms of aims and objectives

6.5 The design thinking process and its various descriptions

Design thinking is a new process for design. It complements earlier, well accepted design approaches. Design thinking is typically described in literature as consisting of a number of stages. This number may range from three to seven, depending on different descriptions of the approach.

Design thinking can be either linear or circular. Circular refers to the fact that the design process may include iterations that go back to the starting
point or an interim point [23], while stages may also be implemented in parallel.

6.5.1 Design methods versus design process

There is a significant difference between the terms “design method” and “design process”, even though they are often used as synonyms.

“Design methods” are rules, techniques, or instructions of the way things should be executed. Methods refer to discipline, i.e. following a specific process [23]. Several design processes are deployed in diverse contexts. Design thinking often deploys Human Computer Interaction (HCI) approaches, which focus on human experiences, or User Centered Design (UCD) approaches, which focus on usability and user characteristics of a product.

“Design process” combines design methods into a series of actions, steps, or events. More accurately, it refers to stages or phases of design.

There is no unique process that can describe design thinking perfectly. Researches present the design thinking process by using different semantics. There is no correct or wrong approach of the design thinking process. For this reason, the following discussion examines diverse design thinking approaches.

6.5.2 A review of design thinking process stages

While design thinking stages may differ depending on the group that applies the process, a key characteristic of the approach is that it starts with a brainstorming session. During this stage participants “build up” ideas [12]. There is no limit to the imagination at this stage and no rules or structure. As such, it allows participants to present ideas without stress for failure and it encourages them to follow broad resources and to “think out of the box” [13]. Due to its lack of structure or rules, brainstorming may lead
to discovery of hidden features. On the other hand, it may also lead to unclear meanings and imperfect hypotheses.

Simon Herbert [14] defined a model of design thinking process which contains seven different stages, namely, “define, search, ideate, prototype, choose, implement, and learn”. This model is considered by many to represent the original design thinking process. Through these seven steps, designers are able to identify problems, raise questions, ideate, and come up with results and an optimal solution. As mentioned before, these stages are not necessarily linear and may be implemented in iterations or in parallel. Robert McKim described this process as the “express-test cycle” [15].

Other design thinking models include a three-stage less complex triangular process introduced by Tim Brown from IDEO (2008) [24]. This model include stages for “inspiration, ideation, and implementation”.

Another suggested approach is the six-stage design thinking process by the Stanford d.school/D-school (2009) [137]. The suggested stages are: “understand, observe, point of view, ideate, prototype, and test”. Nevertheless, Stanford d.school also published one more model that contains five stages as follows: “empathize, define, ideate, prototype, and test”. The descriptions of these models were published in d.school Bootcamp Bootleg papers in 2009 and 2010 and were named “modes” [25]. The five-stage design thinking process is described by Christoph Meinel [19] and Larry Leifer [20] as: “(re)defining the problem, need finding and benchmarking, ideating, building, and testing” [16].

Another design thinking approach was introduced by Shewhart. He named the approach the “plan-do-study-act” PDSA cycle [17] [18].

According to Gerd Waloszek, UX Design expert retired SAP AG, in spite of the differences among the aforementioned design thinking approaches,
they all follow similar patterns [23]. More specifically, the following elements are evident in diverse design thinking approaches:

- Understand the problem in order to make it clear
- Observe users through personal contact of their actions in the workplace, observe physical spaces and rooms
- Interpret and analyse empirical results of the above steps
- Generate ideas, which is often also refer to as “ideate” through brainstorming; broaden the solution space
- Experiment and build prototypes which are demonstrated to the users; the prototypes refer to a limited number of ideas for solutions introduced in the brainstorming stage
- Test, implement, improve; this phase is solution-drive and aims at testing a solution and improving its performance through optimization [23]

6.5.3 The non-linear nature of design thinking

Although the description of the design thinking process is a process with clearly defined stages, this, as discussed above, does not imply linear execution of the stages. Rather, some stages may take place in parallel, introducing flexibility into the process. Prototyping may take place throughout the process as designers may wish to revisit ideas and create visual models of them in order to compare solutions. This process can inspire new cycles of ideation, prototyping, and testing [28].

6.5.4 Design thinking principles

The fundamental principles of the design thinking will be cited below [24]:

- Empathy focuses on people, aiming to understand different perspectives. Empathy aims at understanding how a user will experience a product or service [24]
• Reframing of the understanding of a given problem, which allows for different and innovative perspectives in introducing a viable solution

• Cooperation within multidisciplinary teams, which allows the integration of diverse opinions, viewpoints, characters, and mind sets, all of which are useful for solving multi-faceted problems

• Starting with a large number of suggested solutions; design thinking encourages designers to suggest ideas in a non-judgemental environment with the objective of taking into account diverse solution paths to a given problem

• Identification of solution streams, in which ideas are combined and enhanced towards reaching an optional solution

• Modelling and prototyping the most viable ideas; prototyping allows designers to explore how these ideas are accepted by users and how they address user needs; the idea is that a prototype can demonstrate desired characteristics of a solution without requiring full implementation and commitment in terms of time and funds. Prototypes are discard able

• Iteration, which allows a solution to be refined as new information comes into the picture

• Design thinking starts with a large amount of information and ideas, which are gradually streamlined towards introducing a desirable and working solution [24]

6.5.4 Popular design thinking frameworks

Some popular design thinking frameworks are [24]:
• **Heart, head and hand** is a procedure that is based on vision, emotions, and necessities. As all design thinking methods, it involves ideation, which is followed by practical solution implementations.

• **Deep-dive** is the first design thinking approach introduced by IDEO in the nineties. It was later adopted by the consulting company Deloitte. It involves processes on understanding, observation, visualization, evaluation, and implementation.

• **Stanford d.school's five-staged process**, which involves the stages of empathy, problem definition, ideation, prototyping, and testing. This process evolved from earlier approaches introduced by d.school which involved only three steps, namely understanding, improving, and applying.

• **IDEO's design thinking process**; inspired by the IDEO Method Cards addressing the stages of “learn, look, ask, and try”. IDEO’s initial approach evolved into a three-stage process, which includes inspiration, ideation, and implementation.

• **Human Centred Design (HCD)** was inspired by the need for social innovation in the developing world. It was introduced by IDEO. It is based on IDEO’s original design thinking approaches, but its terminology and structure has been simplified in order to make it more easily deployable in social innovation contexts. In this new context, the HCD acronym is interpreted as “hear, create, and deliver”. Hear refers to the need for empathy in order to address actual user needs. Create refers to ideation, exploration, and experimentation as learning processes through which a solution can be introduced. Deliver refers to the implementation of a project, and includes addressing logistical issues and overcoming challenges that may rise throughout the project life span.
• **4 D's**, a process introduced by the Design Council of the UK. They refer to the principles of discovering, defining, developing, and delivering and is based on a combination of divergent thinking, which is a process deployed for generative creative ideas by exploring a range of viable implementation paths [25], and convergent thinking, which involves answering standard questions that do not involved creative thinking [26]

• **Frog Design**; it is like the Design Council of the UK with the following difference: instead of the three D’s “discovering, designing, and delivering”, the framework uses the stages of “exploring, converging, and supporting”, the latter referring to the need to support the customer in product after the product has been delivered

• **What x 4** refers to answering the questions: “what is, what if, what wows, and what works”. It is introduced in the book “Designing for Growth” [27] by Jeanne Liedtka and Tim Ogilvie

• **The Luma System**, introduced by the Luma Institute that teaches innovation and human centered design, focuses on an approach for “looking, understanding, and making”

6.5.5 Examples of design thinking solutions

The above presentation of design thinking methods demonstrates that the approach has generated significant interest among designers as an alternative method for introducing innovative solutions even in situations where no solution appears to exist.

The frameworks may document different stages of the process, however there is an obvious similarity among them which stems from design thinking’s goal of empathizing with users in order to see how they will experience a given solution, thus allowing for viable implementations that integrate necessary features and omit non necessary ones.
Some examples of ideas introduced through design thinking can demonstrate how the process encourages “thinking out of the box” towards introducing solutions that address actual user needs.

In the context of graduate business education, students at Stanford were asked to introduce a solution to the problem of premature babies dying in India as a result of lack of incubators. This is an obviously complex issue to which no quick solution will emerge to most designers. The students were asked to apply design thinking practices. They brainstormed trying to understand the actual problem and concluded that it was the difficulty of maintaining baby body temperature to acceptable levels not only when the baby is in the hospital but also when the baby goes home with the mother. The students came up with the idea of a cheap “sleeping bag” that can be produced in large quantities and that a mother can take home after giving birth.

Another example refers to accessibility of museums by individuals that use a wheelchair and specifically finding a solution obstacles such as stairs. Most typical solutions, such as electric ramps that raise a wheelchair over the steps are cumbersome and often involve the need of assistance by another party. Using design thinking methods, one can understand that the problem is the fact that in most cases stairs are not wide enough to accommodate a wheel chair. Some museums have introduced a solution of very wide steps in the form of a continuous ramp: a wheelchair can be rolled from one end to the other of a step, which as its end turns and leads to the step above. Through this solution, individuals in a wheel chair can roll their way in the form of a snake through the entire stair case, while individuals that do not need the feature do not even notice the difference in the step design. In other words, this is a solution that works for the target users, while it is invisible to the ones that do not need it and blends into the landscape.
6.6 A closer look at the 5 stage design thinking model

Design thinking is a solution-based approach that is used in order to solve problems; it has human-centric characteristics and it is specialized in dealing with faulty definitions of problems [24]. Design thinking is an approach which can be used in everyday life, to address business issues, community issues, or global ones. In order to further provide insight into design thinking approaches, this section focuses more deeply on the Hasso-Plattner Institute of Design at Stanford (d.school) 5 stage methodology, simply because this university leads the way on teaching design thinking. The stages that will be further analysed are [24]:

- Empathise
- Define
- Ideate
- Prototype
- Test

6.6.1 Stage 1 - Empathise

This is first stage of the Stanford d.school's design thinking framework. The term “empathise”, refers to the design thinker’s effort to understand a problem deeply try to understand the problem deeply. This understanding can be a result of a number of activities, including consulting experts, observing, engaging with people who face the problem at hand and trying to look at the problem through their eyes, reviving experiences and motivation. Another way to achieve empathy is for the design thinker to immerse herself into the natural environment where the problem is manifested [28].

Empathy is a very important stage, because it leads the way to the design thinkers to understand the problem fully, and to take away ill-defined assumptions. The guidelines here are given by the users, and their real ne-
cessities. Nevertheless, there is limited time; as a result, the first stage should come to an end, after the design team has collected the sufficient amount of information, which will be very useful for the next stages implementation and the final delivery of the specific product which will solve the existent problem [28].

To empathize with users, design thinkers should act in a purposeful manner, either actively or passively [29]. Passive engagement involves observing users; active engagement involved activities such as interviews. The key is to get into the users’ shoes in order to understand deeply the problem through their viewpoint [29].

D.school Bootcamp Bootleg suggests the following methods as a way to empathise the users more effectively:

- **Adopting the state of mind of a beginner**, which refers to letting go of unconscious assumptions that the designer may have built through personal experiences. This step is important towards understand the needs of users [29]. A design thinker must be unbiased in her observation of a user’s needs. While making assumptions is a vital process of the human mind that contributes to our understanding of the surrounding world, design thinkers must constantly remind themselves that they should strive to drop personal perceptions, to not be judgmental, and to question without thinking that they already know the answer to a given problem.

- **Getting into a user’s shoes**, which refers to a design thinker experiencing a situation as a user would in order to build an understanding of user needs.

- **Ask questions**, and specifically ask “what is the situation?”, which leads to problem formulation; “how does a user experience the situation?”, which can be answered by observing body language and
expressions; “and why does a user have these experiences”, which leads to an understanding of the user’s motivation

- **Observe users**, which can be achieved by using photographs and/or videos recorded in the users’ natural environment with the objective of documenting behaviour and needs. Documentation of users allows revisiting this information later in the design process when there is a need to refresh available

- **Personal photo and video journals**; design team gives a camera to the users and persuade them to use it in their everyday life; in this way the team does not interfere in the users’ daily routine and the users feel comfortable. There are always some slight differences between the actual reality and the recorded one, but this is a secure way for the design team to have a better understanding of the users, without disturbing them, judging them or even irritate them; this record takes a specific period of time [31]. IDEO uses this method in order to create stable foundations as far as it concerns the users’ empathy

- **Conduct interviews**, which refers to engaging separate individuals with the objective of documenting their personal experiences. Interview add new information and differ from photographs or videos in the sense that they deploy specific and targeted questions; in other words they are a guided process as opposed to the unstructured nature of visual documentation tools. When well designed, the questions can capture information about users’ needs, hopes, wills, and aims

- **Engaging with non-mainstream users**, meaning users that are at the two ends of a bell curve of statistical distribution based on specific attributes, such as age, height, weight, or others. This process
allows the documentation of needs that are potentially not known to average or typical users

- **Drawing analogies** between domains, which can lead to inspiration and to solutions that a designer might not think about when studying only one specific field. The process focuses on similar aspects of diverse sectors, which further allows the understanding of how an existing solution may be adapted to address needs in a different but similar environment

- **Sharing experiences**, namely sharing information that each team member has gathered. By sharing, team members can build on each other’s’ observations to introduce a solution that integrates diverse experiences

6.6.2 Stage 2 - Define

In this stage the design team collects observation data and any other information and puts them together in a manner that simulates solving a puzzle. The purpose of this stage is to understand a problem from a human centred perspective and to define it clearly [30]. The more complete the information that designers have gathered during the empathy stage the more accurate the description of a problem will be in terms of desirable features and characteristics. Stage 1 – empathy is about analysing information, i.e. document into as much detail as possible desirable characteristics. This stage is about synthesizing, namely classifying, interpreting, an understanding collected data, which then is used in order to express a clear problem definition statement.

Defining the problem statement is a key activity of the design thinking process. Not only does it set the foundation for ideating solutions, but it also helps build optimism that a solution is possible [31]. Good problem statements have the following characteristics:
They are human-centric; a good statement focuses on people, their needs, their emotions, and their desires rather than specifications, solutions, technology, or resources.

They are wide to allow creativity; a good statement does not include expressions that point to a specific solution, methodology, or technology. They simply state the needs that must be covered in order to allow diverse implementation paths to be introduced.

They integrate constraints to allow a solution to be reached; a good statement includes some constraints because these are necessary for defining the problem at hand. Statements that are too broad pose significant difficulties in solution design.

The definition stage concludes with the documentation of a problem statement. Documenting the problem statement may be achieved by using some of the following tools:

- **Clustering ideas and data**; documenting all ideas is essential in the design thinking process. The most typical image of idea clustering is that of a “sticky board”, where each idea is written in a different paper. Collecting ideas in one place allows for connections to be established between them and providing the big picture of a problem, namely documenting all mind sets, emotions, thoughts, and stories, which is a step towards introducing a solution.

- **Mapping of users’ input**; it is about a map which consists information classified in four clusters: what users said, what they did, what they thought, and what they felt. Some of this information, such as what users said, is easy to document, while other is, such as what they thought, may be harder and involve understanding the users’ behaviour rather than words.
• **Point of view (POV) problem statement**: which defines the problem for a specific user group; this activity sets the stage for synthesizing a solution in later phases of the design thinking process. It must describe the target user group, the user group needs, and the designers’ understanding of the problem.

• **Questions that can lead to potential solutions**: the questions are designed from the observation data and are broad enough to promote innovation but narrow enough to lead to a solution, similar to a good problem statement. Questions address specific desirable features and characteristics identified as user needs. They address “how” a problem might be solved.

### 6.6.3 Stage 3 - Ideate

The ideation stage challenged designers to “think outside the box” [13] for introducing possible solutions to a clearly defined problem statement that is built on user input. This stage is defined by both innovation and creativity, which are vital for synthesising viable solutions to problems that are hard to solve [32]. Designers are challenged to go beyond obvious solutions, to bring together different viewpoints, to ask questions, and to deploy innovation in broad areas towards introducing a solution.

Activities that can ignite innovation include brainstorming, challenging assumptions, building mind maps, sketching, building storyboards, drawing analogies, provoking, organizing workshops, and more. SCAMPER is a well-accepted method that allows innovation on an existing product by looking through different lenses. The method refers to substituting, combining, adapting, modifying, putting to another use, eliminating, and reversing [35].
6.6.4 Stage 4 - Prototype

Prototyping involves the development of low cost versions that demonstrate some of the functionality and characteristics of the final product [38]. The purpose of the prototypes is to validate ideas and to see how these work in practice and how they are accepted by users.

Prototypes may be tested by the implementation team, by another team, or by representatives of the end users.

Prototypes are dispensable. In other words, the implementation team must be willing to start over if the evaluation process demonstrates that the prototype does not address user needs as expected. The low cost of prototypes allows this process to take place without hindering the overall project implementation.

On the other hand, the evaluation process can demonstrate how a prototype can be enhanced to achieve higher acceptance and how it can be improved and optimized to better address user needs. Prototypes allow design thinkers to further understand a given problem, solution restrictions, and insight on the effects of a proposed product or service as a result of seeing users interact with it.

There are two different types of prototyping [38]:

- **Low-fidelity prototyping**: this refers to basic models of a complete product or a partial solution, which is implemented not in the final material but in cheap material that is sufficient for demonstrating the desired functionality [38]. The idea behind low-fidelity prototyping is to produce quickly and with low cost a cheap, discardable version of the final product for testing purposes. Typical methods include storyboarding, sketching, and others
• **High-Fidelity Prototyping**: it refers to a version of the product that is close to the final one. While high-fidelity prototypes are more expensive to produce they offer advantages as users are more included to be engaged with a version that resembles the final product relatively closely.

Both high and low fidelity prototypes have advantages and disadvantages. Summing up, prototyping allows designers to test a product idea and to see how users interact with a prototype thus gaining insight on the usability of the final product. When prototyping, designers should keep in mind to not spend too much time as what is important is the testing of an idea or the optimization of proposed features. Prototyping can take place several times during the implementation of a product; it can be exploited every time new features need to be tested to ensure that they address user needs.

**6.6.5 Stage 5 - Test**

Testing is the final stage of the design thinking process. It involves testing of a final product or intermediate prototypes either by the implementation team or by users. The results of a testing phase may be fed back into the design thinking process, which, as stated earlier, is iterative in nature. Testing may lead to the redefinition of a problem statement, better understanding of user needs, and the implementation of a solution that addresses more accurately the desired user experience from interaction with the product [39].

Conducting an effective test is not trivial. In order to produce effective feedback, designers must keep in mind that they are testing a prototype, not a final product, and be ready to make modifications or completely discard the implementation and start again.

Testing must take place either in the actual environment where the final product will be deployed or in a controlled environment that closely simu-
lates the real world. Designers must explain to users what the prototype is about, let the users interact with the product without interference, ask users to express feelings and thoughts, observe the behaviour of the users carefully, and document reactions. This process ensures that feedback will be objective and thus useful for enhancing the product to best address user needs. Designers should not be afraid of negative feedback. It is crucial towards designing effective solutions. If users are not completely satisfied, design thinkers should search deeper to analyse what went wrong, what desires and needs were not satisfied, and what was the user's mindset in order to better define the problem and build a solution that addresses user needs.

6.7 Historical retrospective of the design thinking process


“How Designers Think” [8] was written by Bryan Lawson in 1980. The book played an important role to the development of design thinking by addressing design implementation in architecture. The book led the way for design thinking to become a wide concept applied in various sectors. Nigel Cross [43] wrote an article in 1983 that linked design thinking to general education and enabled access to design thinking independently of sector.

In 1987 Peter Rowe wrote “Design Thinking”, which addressed city planners and architects. The book analysed design thinking methodologies approaches. Rolf Faste [45], a mechanical engineering professor and the director of the Stanford Joint Program in Design [46], took McKim’s research at Stanford University on design thinking a step further [47][48].
During the eighties and nineties, he taught design thinking as “a method of imaginative action” [49]. A colleague of his, David M. Kelley, was the one who adapted design thinking in order to serve entrepreneurial purposes [50]. In 1991, Kelley set up IDEO [53], a design consultancy.

Richard Buchanan [52] published an article in 1992 entitled “Wicked Problems in design thinking”. He framed the view that design thinking addresses design issues that are hard to solve.

Appendix B provides a detailed timeline of the evolution of design thinking.
7. NATIONAL POLICIES AND PRACTICES FOR TEACHING ENTREPRENEURSHIP IN HIGHER EDUCATION

This section describes national policies and strategies towards building entrepreneurial skills in countries where the DesignIT project has partners, namely Greece, Estonia, Finland, and Portugal.

7.1 Higher education emerging challenges

Education in higher education has been restructured by the European institutions and the European Commission (EC) so as to achieve the objectives of the Europe2020 strategy, which include: the need to increase of the employment rates of individuals aged 20–64 from the current 69% to at least 75%; to decrease the early school leaving rate from 15% to 10%; and to increase the tertiary education completion rate among individuals aged 30-34 from 31% to 40%. According to Guri-Rosenblit et al. (2007) this is mirrored in the tendency to expand higher education globally during the last 50 years. Existing figures show the leap from approximately 32.5 million students enrolled in tertiary education universally in 1970 to 178 million in 2010 as estimated by the UNESCO Institute for Statistics (UIS). What is more, in accordance with the British Council (cited in Davis, 2003 and Daniel, 2009), the number of tertiary students is going to reach 263 million by 2025.

There is an increased public demand for tertiary education, further democratization, as well as a shift towards post-industrial economies which require a highly educated workforce for achieving financial growth in the globalization era. According to Schofer & Meyer (2005) and Altbach (2009) rapid technology development has further motivated access to tertiary education which resulted in higher participation rates.
According to Naidoo (2003), higher education is a significant field for the production, dissemination and transfer of economically productive and innovative knowledge and technology in today’s economies. The basic challenges that this sector faces in Europe and beyond are to drive innovation, shift priorities, and call for direct solutions. Design and implementation of innovative learning practices are of great importance. Innovation in tertiary education systems may have a fundamental impact on direct and indirect, individual and institutional actors. It can affect networking, mobility, collaboration, and research and engagement practices.

Carlsson et al. (2002) make a case that the production, diffusion, and utilization of technology are fundamental aspects of innovation and can enhance educational services, research, community engagement, and entrepreneurial mind-sets. In order to be innovative, educational institutions must:

- Understand learner needs and their evolving expectations, which include lifelong learning, flexible learning, alternative methods of learning delivery, and technology deployment in education. According to the OECD (2008), students strive to build skills and knowledge in demand in the work place. In addition to enrolling into university courses, students may choose to follow course from other reliable educational providers offered over a variety of channels, such as MOOCs
- Invest in infrastructure so that students have access to innovative tools, technology, and learning design that will allow them to build skills for the future
- Understand the fact that knowledge is shared among networks and stakeholders and build a community of academics, researchers, in-
industry, and employers that can better support students in their educational endeavours

- Take into account changes in the work place and update educational curricula accordingly in order to help link education to work

- Deploy emerging technologies for better meeting educational objectives and broadening the educational opportunities offered to students

- Take advantage of emerging learning analytics technology to tailor education to individual student needs

- Provide education that builds international acknowledged qualifications; integrate internationalization into their long term organisational strategies

- Take into account the fact that education and research is not only funded by governments but also by private organizations

### 7.2 The significance of innovative practices in higher education teaching and learning

Educational and skill development allows an individual to grow personally and professionally. There is global acknowledgment of the fact that higher education is of strategic priority and can provide skills and specialized knowledge that can lead to of a qualified workforce that is required to achieve economic prosperity and well-being of communities. Higher education is an investment towards developing human capital for driving economic growth. Today, higher education is accessible to broader audiences.

Traditional learning design does not effectively build the knowledge and transversal skills that young individuals need today in order to succeed as professionals. Nations today take measures in the form of strategies and
policies in order to provide more innovative learning approaches for building knowledge. Emerging educational design that universities strive to integrate into their practices includes active and experiential learning, problem-based learning, role-playing, portfolio development, and other methods.

However, any innovative learning design is dependent on competent teaching staff for being effectively delivered into classrooms in a manner that maximizes benefits for students. Thus, instructor training in emerging methodologies and technology is paramount for achieving high quality of education at the tertiary level.

Another important aspect is the integration of education with research and the industry. At the policy level, the EU funds research in order to actively optimize knowledge in different fields. The results of this research must be accessible to students by being effectively integrated into educational initiatives. On the other hand, universities need to collaborate with industry to ensure that knowledge built through formal curricula is in line with industry needs and does not become obsolete. Collaboration with industry will further allow universities to apply emerging educational design in real-world contexts in which knowledge can be effectively deployed to generate solutions. This collaboration will further allow students to make an effective transition into the world of work through exposure to business processes in the course of their academic studies.

Government funding of higher education has shrunk to insufficient levels in several countries. Universities cannot afford to ignore this fact. In order to alleviate funded shortages, universities need to design new economic mechanisms and pursue entrepreneurial cooperation with industry for funding, at least partially, their educational offerings. The rest of this section focuses on strategies and policies deployed in countries in which De-
signIT has project partners towards building entrepreneurial capacity in higher education.

7.3 In Greece

7.3.1 Entrepreneurship in national agendas and initiatives

Concerning the linkage between universities and entrepreneurship in Greece, research and innovation promotion are expressed and implemented in various forms, such as programs of joint action, enhancement of academic amenities, establishment and venture of new departments focused on new market trends, research projects, internships, seminars and so on, all this partly aided by European funding. There is a crucial necessity of cooperation between entrepreneurship and universities, as well as cooperation among educational institutes, so as to apply good practices and lead to the reassessment and the reestablishment of the concept of the novelty of entrepreneurship. In simple words, it means that there should be a change towards the mentality and the strategies deployed that will enable both universities and industry to cooperate remarkably and face the evolving market vigorously. As a result, every single person will fulfil their potential and people will have promising opportunities to their workplace, since they will acquire specialized and up-to-date knowledge tailored to their job position. Through the years, all this can be achieved through the following actions:

- **The General Secretariat for Research and Technology (GSRT):**
  The General Secretariat for Research and Technology [134] is a modern public service with the mission of designing and coordinating the implementation of Research, Technological Development and Innovation policy. It strengthens the activities of research and productive organizations through competitive research programs with an emphasis on economic efficiency and socially just distribu-
tion of the product. GSRT oversees research centres and technology institutes that support local communities with the necessary skills to produce knowledge and innovation. The objectives of GSRT are:

- The development and promotion of an integrated strategy for research, technology, and innovation
- The exploitation of high potential that research offers for growth, tackling unemployment and hindering the migration of qualitative scientific potential
- The transfer of innovative technologies to the country's productive organizations
- The support of actions to raise awareness in Greece on research and technology
- The supervision and funding of the country's R & D organizations
- The representation of the country to the competent bodies of the European Union and the promotion of cooperation with other countries
- The evaluation of results of research and innovation funded actions, and the constant update of research policy

A key direction for the design and promotion of research and innovation policy in 2014-2020 is the Smart Specialization Strategy (RIS3). It focuses on areas in which Greece has or can gain a competitive advantage. The emergence of priorities stems from the business discovery process that aims to identify new business opportunities for exploiting new knowledge and integrating it into value chains. The process is carried out through continuous, dynamic consultation with all stakeholders of the innovation ecosystem, in-
cluding businesses, universities, research centres, ministries, regions etc.

Priority areas for the smart specialization strategy range from agriculture and agro-nutrition to ICT, energy, and the environment, while they also include tourism, transport, materials, and life sciences. GSRT’s action aim at the development of innovative services in the above sectors, technology transfer, strengthening of research infrastructures, and building human capital. Particular attention is paid to the European dimension of research, and synergies are pursued with complementary European funding schemes such as H2020 and others.

- **The Special Service for the Management and Implementation of Actions in the field of Research, Technological Development and Innovation (SSMI RTDI):** the Special Service for the Management and Implementation of Actions in the field of Research, Technological Development and Innovation (SSMI RTDI) [135] is an independent service under the auspices of GSRT. It was established in 2008 and has as its mission the management and implementation of the actions of the Ministry of Education, Research and Religious Affairs in the areas of research, technological development, and innovation (RTDI). It is a flexible structure that is staffed with highly specialized staff with experience in co-financed actions in the sectors of RTDI. Under the NSRF 2007-2013, it has acted as an intermediate managing authority in state aid actions on RTDI in the context of operational programs "Competitiveness and Entrepreneurship" and "Regions in Transition". The organization acts as an intermediate body of operational program "Competitiveness, Entrepreneurship, and Innovation" with responsibility for the management of operations under the Single Action State Aid for Research,
Technological Development, and Innovation "Investigate, Create, Innovate", which aims at linking research and innovation to entrepreneurship and to enhance competitiveness. The action aims to meet the needs of businesses, universities, research centres, and other stakeholders in the research and innovation ecosystem, reaching as widely as possible potential beneficiaries. It focuses on selected areas of economic activity in the country and on areas of intervention where potential for entrepreneurship and research excellence is identified in accordance with RIS3 strategy at the national and regional level, with a view to modernizing, diversifying and exploiting new opportunities in the Greek economy.

The "Research, Create, Innovate" action is co-funded by Greece and the European Union, and in particular by the European Regional Development Fund, under the Operational Program Competitiveness, Entrepreneurship, and Innovation of the NSRF 2014-2020. For the realization of its project, SSMI RTDI implements the following policy axes:

- Developing and promoting innovative products, services, and processes both in the domestic and international markets, focusing on areas with competitive advantages to stimulate investment and create sustainable jobs for skilled employment

- Enhancing of business and private sector associations, universities, and research bodies to increase the added value of learning as well as technological innovation applied in the field

- Promote and manage the effective absorption of research funds
SSMI RTDI cooperates closely GSRT towards the design of strategy and the coordination of policies in research, development, and innovation.

- **National Research and Innovation Council (NRIC):** The NRIC is the state’s highest advisory body with regard to the formulation of national policy on research, technology and innovation development and supports the Commissioner for Research and Technology Research Issues Deputy Minister of Culture, Education and Religious Affairs and the General Secretary of Research and Technology on issues that fall within his remit [135]. Its mission is:
  
  o To monitor the national and international developments in GSRT and to submit relevant proposals to the Deputy Minister for Culture, Education and Religious Affairs
  
  o To submit proposals for the effective exploitation of research funds
  
  o To promote close cooperation between research and education stakeholders and the productive sectors towards introducing innovative products aiming at strengthening the international competitiveness of the country and the effort for increase in the standard of living of its population
  
  o To promote international cooperation on research and innovation

### 7.3.2 Entrepreneurship in higher education

Following is a description of courses related to design thinking that are offered at Greek universities.

- **Agricultural University of Athens** does not provide any information about design thinking process and related courses. Although
a Summer School named “GreeNET” conducted by Mrs Charitini Il-
liadou (in 2014) and cited that the aim of Green Ideas 2014 was to
make the participants be familiarized with design thinking as part of
this specific GreeNET Best Practice. Green Ideas 2014 was orga-
nized by GRNET on Monday, July 14th, 2014 at the Golden Coast
Hotel in Marathon, Attica within the context of the Environmental
Protection & the World of Work Summer School. The Summer
School was organized by EA as part of the educational activities of
GreeNET [173]. A guide was further developed; the guide aims to
Bring Green Science Education Development in European School
Communities. Furthermore, there is one more participation by the
Agricultural University of Athens in Ecotropelia Europe [172], which
awards European food innovation students. The specific university
participated with the project named “Veggie it”; the entrepreneurial
approach of the competition consisted of three steps: the first was a
formulation or maturing phase for a start-up and used design think-
ing methodologies; the second was on feasibility, and the third one
on launch or nursery phase.

- The Aristotle University of Thessaloniki engages fifth year stu-
dents of the Undergraduate Programme of Studies of the School of
Architecture of the Faculty of Engineering with a course titled “In-
sights: Fixes, Fluxes, Futures”. The course is conducted in the 9th
semester and it is an elective. The course is taught by Apostolos
Kalfopoulos and its duration is 8 hours per week [174]. The course
syllabus states: “Through the use of mediums, tools, practices and
methodologies of Architectural Design, Strategic Design, Service
Design and Design Thinking, the studio ‘Fixes, Fluxes, Futures’,
aims at designing and organizing innovative proposals of spaces
and infrastructures, experiences and services that radically change
the way in which specific categories of users their needs, wishes and multiple behaviours associated with them, are addressed”.

- **Athens University of Economics and Business**, indicates no further courses about Design Thinking process. It only displays the following Erasmus+ project and the free program below:
  
  o **Erasmus+ Projects**: Title: Social & Sustainable Fashion Entrepreneurs; actor: Athens University of Economics and Business (AUEB), Erasmus+ Link number: 2015-1-EL01-KA204-014083; duration: 24 months. The project focuses on adult education in relation to important societal issues, such as the environmental protection, the incorporation of young unemployed individuals, and the return of the production process for the fashion industry back to Europe. The project organized workshops that deployed design thinking and active learning.
  
  o **Programs**: The 5th round of the "Innovation and Design Thinking in Mobile Applications and Services" program was presented by the Athens University of Economics and Business, Samsung Electronics Hellas, the Association of Mobile Applications Companies of Greece and the Innovation and Entrepreneurship Node of the Technopolis of the Municipality of Athens – INNOVATHENS [100] powered by Samsung. A total of 91 students have already graduated from this program. This educational program is offered free of charge and addresses university graduates who are unemployed and would like to acquire digital business skills by focusing on the evolving field of mobile applications and services. This program aims at developing the skills of participants in the design and development of new services and business activities exploiting the opportuni-
ties and prospects offered in the mobile field. The program lasts 50 hours over 4 weeks and takes place at the INNOVATHENS facility powered by Samsung.

- **Democritus University of Thrace** does not declare any course which applies the design thinking principles and methodology. Nevertheless, there are publications, as follows:
  
  

- **International Hellenic University, School of Economics, Business Administration, and Legal Studies** provides an MSc in “Strategic Product Design” [103]; its duration is one year of full-time studies or two years of part time; teaching is provided once or twice a month depending on whether the student attends full or part time. In the second term of this MSc there is a course named “Product Creativity & Design Stream”; one of its contents is the Design Thinking [104]. There are no further details about the course material.

- **Ionian University, Department of Informatics** provides an MSc with the specialization: “Technologies and applications in humanistic informatics”. The program includes a course entitled "Human-
Computer Interaction”, conducted by Konstantinnos Chorianopoulos. According to its module description, this course focuses on the user’s needs, by elaborating human-centred design and interaction design. It analyses the design and development of interactive prototypes and it presents methods and techniques which are essential for the user’s evaluation [105].

- **The National Technical University of Athens** does not provide any information about applying and teaching DT process. Nevertheless, there are some publications:


- **The Technical University of Crete** provides a one-year cross-functional MSc in “Technology and innovation management”. The course is offered in cooperation with the Engineering and Management School and the School of Electrical and Computer Engineering. In the 2nd semester the curriculum includes a courses titled “Innovation Economics”. The course focuses on social entrepreneurship, namely on “business models, design thinking, and personal leadership in social ventures, role of civil society, social value, science shops, etc.” [106].


- **University of the Aegean, Department of Product & Systems Design Engineering** provides an undergraduate course titled “Stu-
“O2 dio III - Ideation”. The course takes place in the 3rd semester. One of its objectives is to improve students’ skills in order to represent their ideas in 2D and 3D space with analogue and digital tools. It also teaches students to design prototypes that satisfy given requirements. One of the recommended sources for reference is “Lockwood, T. (2010). Design thinking: integrating innovation, customer experience and brand value. New York NY: Allworth Press”. Its teaching methods are based on Studio-Based Learning and Problem-Based Learning activities [107].

Another course provided in the same department is called “Service Design”, coded 6202 (gen. 6200) [108]; it’s in the 3rd semester, as well, and it is also a core course. It teaches the principles of the emerging trends of this sector, such as public sector design, community design, social innovation design, and social entrepreneurship. The course uses the book “Schneider, J. Stickdorn, M. This is Service Design Thinking Bispublishers 2013”. The course teaches the design thinking framework [109].

The MSc on the “Design of Industrial and Interactive Products and Systems” provides a course named “Interaction Design Studio”, coded 513-2501 (gen. 513-2500); it takes place in the 2nd semester of this MSc and it is a core course. It is conducted by Modestos Stavrakis and Ioannis Xenakis. Among its learning methods and activities of: 1) presentations, 2) critique, 3) reflection, 4) design, and 5) research. In the reflection phase, the course deploys teamwork based on design thinking and problem based learning. The course also deploys a research activity, namely the Service Design Lab (SDL), whose objectives include: “Sustainability in design for services and new tools and methods for Service Design Thinking” [110]. The lab has received a number of awards:
1st Design Award & Competition was awarded to Marianna Tzachsan for her invention of Helios Eye-Wear; the exact title of her award is “A' Design Award Winner for Jewellery, Eyewear, and Watch Design Category in 2015”[111][112].

Anastasia Constantelou, Associate Professor, Department of Financial and Management Engineering, University of Aegean was one of the main participants in “CREA – A European Network of Summer Academies for the Improvement of Entrepreneurship in Innovative Sectors INFOSTRAG”; this seminar was conducted in Ermoupolis, on 7th July, 2017. This Project is funded by Horizon2020, the European Programme for Research and Innovation. It combines both creativity and ICT as tools, a start-up as a vehicle and its goal is innovation. Among the experiences and the lessons, it also provides Clash of paradigms between Design thinking and Business Thinking (modelling) [113].

Other proceedings to which the Aegean University contributed include the “Refugee Co-Lab: Using Design thinking to Integrate Refugees into Communities in Greece”. It took place on 9th May, 2017 (Europe Day); Ting Shih, CEO and Founder of ClickMedix, cooperated with “Changemakers Lab”, a Lesvos-based co-working hub, to introduce its first co-lab initiative where refugees, students from the University of Aegean, mentors from social businesses, leaders from non-governmental organizations, and heads of local government collaborated to create social enterprises with refugees, in order to develop their skills and succeed in Greece [114].
Last but not least, a design thinking workshop was carried out, in which six designers and four archaeologists “followed five routes, were part of two round tables and one design thinking workshop over five days in the University of Aegean, on the island of Lesvos, Greece”. They designed and produced six different souvenirs which are now for sale in shops on the island of Lesvos [115].

- **The University of Crete, Department of Computer Science** conducts a course named “CS- 533 Security, Privacy, and Intelligence on the Internet”, by Associate Professor Xenofontas and INSPIRE group. The course deploys design thinking methodology to introduce students to modern techniques; this aims at “cultivating the innovative thinking, research, and the ultimate objective of linking research, innovation and entrepreneurship” [116].


- **University of Ioannina** provides a course titled “Human Computer Interaction” conducted by Ioannis Fudos. The course encourages “learnability, prototyping, alternative interaction methods, and virtual reality, and prototyping tools” [117].

- **University of Thessaly** provides the courses “HY310 Education Technologies” and “HY420 Software Design and Development”, which both are carried out by Hariklia Tsalapatas. They analyse the principles of design thinking and its implementations.

- **University of Western Macedonia**, Hellenic Republic University of Western Macedonia Faculty of Education Department of Early
Childhood Education provides the following research projects by Tharrenos Bratitsis [118]:


- “Artful Leadership: developing the new generation of servant leaders through arts Programme: Erasmus + Action: KA2 - Cooperation for Innovation and the Exchange of Good Practices - Strategic Partnerships for higher education (2015-2018)”

7.4 In Estonia

Estonia takes leading position for entrepreneurial activity in Europe as a result of its high ranking in the Total Early-stage Entrepreneurial Activity - TEA. TEA estimates proportion of the nascent entrepreneurs or owner/manager of a newly set business. At the same time the population of owner or manager who lead an idea/product/service development for the employer of already existing business (EEA) fells behind the EU average (World Economic Forum, 2016) [154].

Estonia is often cited as a model for entrepreneurially oriented policy (Venessaar, U., & Loomets, P. (2006) [155]. Entrepreneurs of new businesses (TEA population) perceive innovation and job creation rate, and “business sector” services higher compared to the global average (GEM, 2017) [153]. Meanwhile, overall societal values for entrepreneurship fell slightly back. Population considering entrepreneurship a good career choice or receiving high status in the society is below the global average (64.74% against the 70.2%, and 54.22 against global level 61.60 respectively). On the same page, proportions of the population who are latent
entrepreneurs or plan to start business within 3 years are below the global average (18.14 % against 21.66 global average).

Kuttim [156] describes Estonia as an efficiency-driven economy. In this stage of development the countries increase their production efficiency and educate the workforce to adapt to the subsequent technological development phase (Porter et al., 2002). Kuttim et al., 2014 distinguishes three types of entrepreneurship education in higher education institutions: a) lectures and seminars about different topics; b) networking and coaching opportunities and c) resources for founders and entrepreneurs. Estonia as being an efficiency-driven economy offers lectures/seminars and resources to the students, and less networking and coaching opportunities [156]. However, literature does not explore the patterns how these lectures and seminars are offered. Entrepreneurial education at school stage has coefficient of 2.96 out of 5, and coefficient of 3.39 at post school stage according to GEM (2017) [153]. This indicator is higher the global and regional average (GEM, 2017).

7.4.1 Entrepreneurship in national agendas and initiatives

In 2014-2020 strategy Estonia highlighted the areas related to engineering, creativity and industry practices. The strategy does not address creative design thinking approaches that are tailored to user needs analysis and their involvement in the development of engineering practices and solutions. European Social Fund 2018-2020 plans to dedicate 51 million Euros to the modernisation of the organization of traineeship, management of work-based traineeships as well as entrepreneurship, language and workplace training.

New strategic agendas for upcoming period are still in the development. In the development of next EU Youth Strategy, Estonia claims to become the promoter of smart youth work in the EU. Youth engagement in the devel-
Development of smart solutions will help the country to identify new methods for targeting youth through evolving technologies and innovation and also support their digital competences. Solid education agendas of Estonia will be based on inclusion and equality; required competencies and values will foster job creation, entrepreneurship and innovative thinking, develop digital skills and support the development of an active community.

- **Estonian Entrepreneurship Growth Strategy 2014-2020** promotes entrepreneurship and development of new products and services. The strategy targets to promote innovative products and services through state procurements.

- **Estonian lifelong learning strategy 2020** promotes lifelong learning, human resources and competences. It targets knowledge and innovation-based society that is achieved by continuous learning, and by being proactive and creative citizen to be able to cope to rapidly changing world. Reconceptualized learning approach is one of 5 strategic goals that should develop creativity and entrepreneurship at all levels and types of education. In vocational and higher education the changes involve self-directed active learning, practicing, formative evaluation. Quality level engineering education and particularly its relatedness to practice is one of the targets of the strategy.

- **“Smart and active nation (2015-2018)” agenda of Ministry of Education and Research** sees creativity as one of the pillars to build sustainable society and nation. The agenda addresses the need to change teaching and learning approach – to develop and support each learners’ individual and social development, learning competences, creativity and entrepreneurship at all levels and forms of education. Growing number of interested young people in
engineering and entrepreneurship is defined to be one of the outcomes of the strategy.

- **The Research and Technology Pact 2015** integrates different stakeholders in research, engineering and technology and education to enable and promote career, to rise the quality of engineering at all levels and kinds of education. It calls for connecting different curricula to interdisciplinary modules, developing flexible learning paths, using common labs and learning resources, developing motivation packages for students, involving employers, enterprises and clusters in the teaching, and promoting engineering, science and technology professions. Research and technology pact coordinates and enhances the activities of various stakeholders to ensure that young people learn and work in the field of research, technology and engineering. Pact's activities are implemented in cooperation with state, local governments and entrepreneurial, educational and third sectors.

- **The Start-up Estonia programme** supports development of learning modules about entrepreneurship, spin-offs and interdisciplinary approaches using agile development methods and minimum viable prototypes. Entrepreneurship competences must be integrated into different curricula using gamified and interactive methods in teaching science and engineering subjects. Also program includes entrepreneurs' involvement in teaching process.

These strategic agendas are realized by different stakeholders from education, vocational education and higher education, as well as marketing, consulting and training companies. They mediate different training offers, as well as start-up incubators, and design houses (Estonian Design House).
7.4.2 Entrepreneurship in higher education

Entrepreneurship education is integrated in the curriculums of Estonian higher education institutions. Below we describe the courses which involves entrepreneurship and design thinking approaches according to the universities.

**Tallinn University**

In Tallinn University entrepreneurship and design thinking is mainly introduced to the students of Human Computer Interaction and Educational Technology on a master level.

**Course Name:** Interaction Design Methods

**Degree:** Master

**Credits earned:** 4 ECT

**Course description:** Course introduces students to interaction design, tools and techniques, scenario-based design, participatory design and stakeholder involvement, concept mapping, user stories, low fidelity prototyping techniques and testing the paper prototypes, user interface design patterns and prototyping tools and techniques.

The course uses design thinking as a learning approach. Participants develop design projects with prototypes.

**Course Name:** Interaction Design Methods

**Degree:** Master

**Credits earned:** 5ECT

**Course description:** Course introduces students to interaction design, tools and techniques, scenario-based design, participatory design and stakeholder involvement, concept mapping, user stories, low fidelity prototyping
techniques and testing the paper prototypes, user interface design patterns and prototyping tools and techniques.

The course uses design thinking as a learning approach. Participants develop design projects with prototypes.

Course Name: design thinking and Generative Research
Degree: Master
Credits earned: 4 ECTS
Course description: Course introduces students to the research approaches and methodologies in human-computer interaction. Course provides students with the tools to explore, record and understand people's actions, thoughts and feelings. Students gain deeper understanding of the problems in designing solutions.

The course uses design thinking as generative research approach. Participants create research plans as an end product.

Course Name: Designing Learning Technologies
Degree: Master
Credits earned: 4 ECTS
Course description: Course introduces students to interaction design, contextual inquiry, competitive analysis, learning technology standardization, scenario-based design, stakeholders involvement in the participatory design process, concept mapping, information architecture, user stories, user interface prototyping with tools and techniques, wireframes, design patterns, high-fidelity prototyping, and usability evaluation methods.

The course uses design thinking as a learning approach. Participants work in groups to develop conceptual design, prototype and test a specific
technology-enhanced learning application. The results of the design process are presented as a short paper.

Course Name: Interface and Interaction Design
Degree: Master
Credits earned: 4 ECTS
Course description: participants learn user interface design process and the roles in the design team, user modeling, scenario-based design, stakeholder involvement in the participatory design process, user interface concepts development and metaphors, user stories, information architecture and card sorting, interface prototyping tools and techniques, interaction design patterns, and usability testing methods: usability heuristics, cognitive walkthrough, think aloud protocol.
Participants develop detailed user interface prototype and test.

Course Name: ELU
Degree: Bachelor and Master
Credits earned: 6 ETC
Course description: Students from different study fields carry out a collaborative project on a topic of their interest. The goal is to foster project-work, collaboration, leadership and social skills; also to promote students' initiatives to plan and realize the projects and develop their entrepreneurship and teamwork skills.

In addition to Master level courses Tallinn University offers winter and summer schools to the interested students. Among these non-degree courses there are some focused on design and entrepreneurship:

Social Enterprises: Using your creativity and Sensibility. The course aims to develop students' systematic understanding of social enterprises in or-
nder to promote social inclusion of vulnerable people in the community in a sustainable way. The course combines entrepreneurship skills with social responsibility.

Designing wearable for health and wellbeing. Students work in groups to design low-fidelity prototypes for wearable devices that could be used for the improvement of health and well-being.

Design of serious games. Students work in teams to design new serious games from idea to working prototype

**Estonian Academy of Arts**

Estonian Academy of Arts offers two International Master programs: Interaction Design and Design and Engineering. Students are introduced to design thinking, prototyping and project-based design implementation. Participants work with industry partners in Interaction Design program. Design and Engineering is a joint program of Estonian Academy of Arts and Tallinn Technical University.

**Tallinn Technical University**

Course Name: Design Research and Innovation

Credits earned: 3 ECTS

Course description: students learn to map and analyze whole cycle of product and/or service systems, compose and run design research, background studies, inferences and decision making, creative design brief for development project.

Course Name: Design Studio courses in architecture education

Credits earned: 10 ECTS

Course description: students learn to create new innovative solutions that unite design and engineering skills with user needs. The course gives stu-
udents an experience to work in multidisciplinary teams to develop project concept, conduct and organize inclusive and user centric design and development project.

**Tartu University**

Course Name: Design Based Innovation

Credits earned: 5 ECTS

Course description: Course aims to teach design management and use of design in innovation processes. It develops collaborative skills as well as knowledge about different types of design. Course includes the following topics: use of design in society and in organization; historical development of design field; types of design; designers’ work, roles and skills; design process, and design thinking. From the management perspective it includes: design in management context; design management in small and large organizations; financial management and assessing value added by design; design management and innovation at organization’s strategic, tactical and operational level; intellectual property rights. Participants get familiar with the processes of: design audit, outsourcing design services, design brief, management of product/service project team, management of design project and assessment of its results. The course uses following methods: user centric approach, prototyping, cooperation with users e.g. co-creation, open innovation etc.

Course Name: Service Design

Degree: 5 ECTS

Course description: the course aims to enable students see the connections between design thinking, design management and service design, and develop their knowledge in service design process and related methods.
In conclusion, entrepreneurship education is widely viewed as a key competence for all students regardless of their field of specialty (OJ L, 2006). It accordingly needs to be tailored to the growing needs and interests of different fields. Jones & English (2004) propose a mix of action-oriented teaching for developing enterprising skills and behaviors. Authors highlight experiential learning, problem solving, project-based learning, creativity, and peer evaluation.

In Estonia entrepreneurship education is mostly part of formal university education. It is mostly included in technology-related courses and fields of studies. Offered courses support experiential learning and problem solving, as well as creativity and collaboration through the projects.

7.5 In Finland

7.5.1 Entrepreneurship in national agendas and initiatives

Efforts to promote entrepreneurship in education in Finland have been continuous. This section presents initiatives that took place over the past 10 years.

Entrepreneurship is defined to encompass diverse skills, including creativity, innovation, risk-taking, and the ability to plan and direct action towards achieving chosen goals. These qualities support everyday life in education, at work, in leisure activities, and in other societal activities. In recent years sustainability and recycling culture have been included into the definition as aims to be followed.

In the period 2003–2006, a core curriculum was adopted throughout the educational system. It was linked to participatory, active citizenship and was seen to be cross-curricular theme in basic education and in upper secondary schools. Entrepreneurship was the link that combined other
classes; it was evident throughout curricula. The skills and values tied to entrepreneurship are seen to be key priorities in education and training.

Universities also have their own entrepreneurship strategies, as do universities of applied sciences. Towards these aims a restructuring of higher educational institutions took place in 2010, when Aalto University was established. AALTO University was merged from the Helsinki University of Technology, the Helsinki School of Economics, and the University of Art and Design in Helsinki. However, this is not enough the university strategies need to be connected to other players in broader ecosystems (Cardwell, Louko & Kekäläinen2012) [168].

From 2009, onwards Finland has had a national strategy for entrepreneurship, titled “Guidelines for entrepreneurship education”. The ministry of Education and Culture leads it. It ended 2015.

The guidelines were prepared in collaboration with different actors from the entrepreneurial community, including government, national agencies, education organizations, regional authorities, and business organizations. The guidelines address all levels of education: from early childhood education and care to adult education as well as higher education. Their aim is to develop active citizenship, enhance creativity and innovation in education and training, create a positive entrepreneurial culture, and promote business start-up. The Guidelines have 11 objectives:

1. Networking between entrepreneurship partners is intensified at international/national regional/local levels
2. Measures for entrepreneurship primarily originate at regional and local levels
3. Regional expertise centers cover the whole country
4. Entrepreneurship has become a solid part of core curricula and a stronger part of school-specific curricula

5. Entrepreneurship is integrated more robustly into school and business strategies and development plans

6. Entrepreneurship studies are included in vocational core curricula

7. Higher education institutions have incorporated entrepreneurship in their overall strategies

8. Entrepreneurship is part of the initial training of the teachers who will be responsible for this theme

9. Increased availability of Continuing Professional Development and follow up actions related to entrepreneurship

10. Learning environments promoting networking for Initial Teacher Education and Continuing Professional Development, e.g. using virtual environments” [167]

Other projects promoting entrepreneurship were inspired from the above guidelines. Examples include:

A national project promoting entrepreneurship education in vocational and academic teacher education during 2010-14. Various organizations offer CPD including the Finnish National Board of Education and a learning concept of “Me & MyCity” was created. Me & MyCity includes teacher training, learning materials for 10 lessons and a day-long visit to their learning environment [171].

Current projects from Ministry of Education and Culture include: Cooperation between higher education institutions and business life, where the goal is to use resources from science and research efficiently and effectively for promoting the growth of Finnish education exports and Entrepreneurship Education, which aims to target and develop entrepreneurship
and entrepreneurship education at different levels of education. This programme will try to strengthen competitiveness by improving conditions for business and entrepreneurship through reforming education. The reformulation of education needs to take into account the skills required in working life. The programme's target groups are stakeholders in the education and training sector at all levels of education, education providers and developers, local, regional, and national policy-makers in the education and training sector as well as entrepreneurs and organizations that support entrepreneurship¹.

In addition to the above, The Ministry of Education and Culture participates in an international research project titled Innovation Cluster for Entrepreneurship Education. This project tries to establish how to reach the goals where every young person should have a practical entrepreneurial experience before leaving compulsory education. This goal has been set by the European Commission [171].

The Finnish government has agreed in its 2017 budget to focus on employment and entrepreneurship. Here the aim is to promote employment of the young people who are neither in work nor in training or education by helping these young people through a competence programme².

Last but not least, a women’s innovation award has been set for celebrating the 110th anniversary of women’s right to vote in Finland. The award is

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¹ New cities summit 2015: what works: Tomi Alakoski, My and MyCity

EUR 110,000 (see more in Finland: education and entrepreneurship, 2016)³.

### 7.5.2 Entrepreneurship education in higher education

Every four years higher education institutions in Finland hold negotiations with the Ministry of Education and Culture in order to agree on the common objectives for the higher education system. These common goals are derived from the strategic programme of the government. Being independent legal entities, each higher education institution is then expected to plan in more detail which actions it will take to achieve the goals that have been agreed upon. It is the task of the Ministry to coordinate the activities of individual higher education institutions.

According to Viljamaa and Moiso (2015) the promotion of entrepreneurship has been one of the aims of Finnish higher education policy for a decade [143]. In 2009, the following strategic intent was formulated by the MEC and the Ministry of Employment and the Economy in 2009: “Every higher education institution will have an approved operating method that encourages and provides skills for a career as an entrepreneur, generates innovations and creates favorable conditions for businesses to grow” [138].

Hence, promoting entrepreneurship is one of the common goals for all Finnish higher education institutions. Therefore, actions on this topic can be found in every HEIs’ strategy document. In order to update the overall state of entrepreneurship education in Finnish HEIs, the MEC conducted a study on the matter in autumn 2015. The results were published (in Finnish) in 2016 by Viljamaa (2016) [142]. Since the study of the MEC is so

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recent, it is justified to base this text strongly on the descriptions and findings of that report. I will first refer to the general observations of Viljamaa (2016) [142], and then give two more detailed examples, one representing university practices and the other one representing universities of applied sciences.

The main observations of Viljamaa (2016) [142] concerning entrepreneurship in education in Finnish HEIs, were as follows. Entrepreneurship is the main choice or master program in at least seven (out of fifteen) universities. In addition, the undergraduate studies are offered as a minor in at least nine universities. In many universities, entrepreneurship education is organized in the department responsible for business education. In doctoral studies, entrepreneurship can be studied either in entrepreneurial doctoral programs at least in three universities or, alternatively, included in the PhD study program in another field. Entrepreneurship topics have also been integrated into the teaching of the other disciplines.

All universities of applied sciences offer at least individual entrepreneurship courses. Entrepreneurship can often be studied as one of the orientation options for business education. UASs also have specialized entrepreneurship degrees, or entrepreneurship studies are part of compulsory degrees. Some universities of applied sciences have developed the practice of student entrepreneurship training: the student can, for example, make a traineeship or a thesis for their own company or, alternatively, to take business activities into other forms of study.

Another important dimension of education in supporting entrepreneurship is the pursuit of higher education institutions in the development of pedagogical practices. The aim is to utilize and develop pedagogical solutions that support entrepreneurial behavior in at least ten universities, either as a whole-course or at certain courses, for example, through project courses.
that utilize case studies. Universities of applied sciences also report on the development of pedagogical practices like learning by doing in projects. Half of the universities of applied sciences report using use pedagogical ways of encouraging entrepreneurship either cross-sectional in all education or individual courses, or certain degree programs. In addition to the pedagogical solutions that support the entrepreneurial approach, six universities and nine universities of applied sciences (out of 24) tell that they are actively developing entrepreneurial learning environments. According to the report (Viljamaa 2016) [142], there is some cooperation between universities and universities of applied sciences in entrepreneurship education.

The following table presents entrepreneurship programs in Finnish higher education.

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<tr>
<th>Classification</th>
<th>University</th>
<th>Degree</th>
<th>Integrated into curricula</th>
<th>Individual courses</th>
<th>Study module</th>
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Following are some good practice examples on teaching entrepreneurship in Estonian universities:

- **Aalto University** ([www.aalto.fi](http://www.aalto.fi))

In the multidisciplinary Aalto University, there is an entrepreneurship program that is open to students throughout all degree levels (Bachelor, Masters, Doctoral). This Aalto Ventures Program ([http://avp.aalto.fi](http://avp.aalto.fi)) is the umbrella for all entrepreneur education, and the students can pick individual courses under the AVP umbrella, or choose to study the whole minor. In the minor, main focus is on enhancing an entrepreneurial attitude, and on developing teamwork and communication skills. Individual courses provided in all fields emphasize knowledge and skills needed in fostering innovations. Aalto Business School has two degree programs in entrepreneurship: a masters program and a doctoral program.

An important dimension of entrepreneur education at Aalto is the learning environment called Design Factory ([https://designfactory.aalto.fi/](https://designfactory.aalto.fi/)). The university describes this learning environment as the most important tool to enhance international interaction around innovation and entrepreneur education and activities. Design Factory was originally an ideal physical and mental working environment for product developers and researchers. It still is that, but first of all it is a mental community. As described on the home pages of Design Factory, it “provides an environment that is suitable for experiential learning. The Design Factory approach combines discipli-
nary knowledge with design thinking and working life skills, such as collaborative working style, effective communication skills, and ability to implement theory to practice."

- **Seinäjoki University of Applied Sciences** ([www.seamk.fi](http://www.seamk.fi))

The multidisciplinary Seinäjoki University of Applied Sciences is located in a very SME-dense area in Finland. Hence, entrepreneurial education, specialized for SMEs, has long traditions in Seinäjoki UAS. Seinäjoki UAS provides individual courses on entrepreneurship, but also a degree program that is especially designed as distance learning, which allows the student to run an enterprise and study simultaneously. Entrepreneurial attitude and skills are enhanced with a concept called “entrepreneur stable”, which is aimed at students who want to develop and test their business ideas. Entrepreneurial education is also implemented in projects, and according to Seinäjoki UAS, they have developed a variety of learning environments to promote the interaction of students from different fields.

- **Metropolia UAS**

The most prominent tool at Metropolia UAS to promote entrepreneurial mind sets is the Innovation project of 10 ECTS. The innovation project is included in the curriculum of each Metropolia student. Most students complete these studies in the third academic year. Studies are often carried out as working life-oriented projects and as multi-disciplinary implementations. Methods of Implementation vary by semester and degree program. The innovation project may include, in addition to project work, theory, lectures, seminars and workshops.

The learning outcomes of the Innovation project are as follows. After completing the course the student is able to:
• developing multidisciplinary actors with practical, creative and innovative solutions, practices or services to meet the diverse needs of the metropolitan area.

• apply project and network work as well as the competence of their degree in regional or international development work.

• Make use of its own expertise in multidisciplinary experts’ collaboration and working environment

• Create a collaborative negotiating culture with other actors

• Use their problem solving, collaboration and communication skills in the community development process and decision-making

Notably, a key success factor for teaching and learning entrepreneurship in Estonia is teacher competences. Viljamaa (2016) reports the pedagogical skills of teachers being a key success factor in entrepreneurship education. Despite of that, only four universities have plans to provide training for teachers to enhance their skills to develop entrepreneurship education. Of universities of applied sciences, five report that they have taken actions to improve the entrepreneurial competencies of teachers. Especially the universities of applied sciences also utilize business cooperation in teaching, so that students have the opportunity to exchange ideas with business representatives.

7.6 In Portugal

Portugal has an early-stage entrepreneurial activity rate\(^4\) of about 8.2%, which is in accordance with the average of European countries - 8.4% -

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\(^4\) “Percentage of 18-64 population who are either a nascent entrepreneur or owner-manager of a new business.”
and ranks 44 in the Global Entrepreneurship Monitor\(^5\) (GEM, 2016) 2016 rank, which includes 65 countries. According to GEM, this rate has grown over the years, from 4.4% (2010) to 9.95% (2014). However, in recent years the rate has registered a continuous decrease in value: 9.5% and 8.2% in 2015 and 2016, respectively.

The improvement registered from 2010 to 2014 has mainly to do with the “implementation of the economic and financial adjustment programme” (GEM, 2013). Indeed, with the economic crises and the consequent high levels of unemployment many Portuguese turned to entrepreneurship.

In addition, since 2004 GEM experts have increasingly reported consistent improvements in entrepreneurship framework conditions (GEM considers 12 aspects and rates them from 1-5, 1 being highly insufficient and 5 highly sufficient). Portugal has highly qualified professionals and the adequate infrastructures to support entrepreneurial activities. Besides, it ranks 6\(^{th}\) within the European countries for post school entrepreneurial education and training\(^6\) and 9\(^{th}\) for basic school entrepreneurial education and training\(^7\) and for research and development (R&D) transfer\(^8\). “Significant efforts have been made to cut red tape, by making greater use of online platforms, among other things” (GEM, 2016).

\(^{5}\) \url{http://www.gemconsortium.org/country-profile/100}

\(^{6}\) “the extent to which training in creating and managing SMEs is incorporated within the education and training system in higher education such as vocational, college, business, schools, etc”.

\(^{7}\) “the extent to which training in creating and managing SMEs is incorporated within the education and training system in primary and secondary levels”.

\(^{8}\) “the extent to which national R&D will lead to new commercial opportunities and is available for SMEs.”
However, on the negative side, Portugal presents three underdeveloped aspects that are still rated as “insufficient” by GEM experts. The social and cultural norms, as well as the internal market dynamics aspect continue to be negative factors for the development of entrepreneurial activities. The government policies on taxes and bureaucracy is the most underdeveloped condition in Portugal, registering a value of 1,8, the closest to “highly insufficient”.

“On the positive note, in recent years, entrepreneurship has also become deeply ingrained in the vocabulary of Portuguese policy makers as a way of solving unemployment issues, promoting innovation and driving SME development. More than 63% of adults consider entrepreneurship as a good career choice, reflecting the rising impact that entrepreneurship is having among adults there” (GEM, 2016).

Despite the improvements that regard the entrepreneurship panorama, Portugal only rates 4 in one of the aspects considered by GEM – physical infrastructures -, which means that there is still work needed to be done. According to Almeida (2016), Portugal needs to take on strategies that help business development, especially with regard to bureaucracy and education, particularly in primary and secondary education.

Pimpão (2011) stresses the role of higher education in the country’s entrepreneurial spirit, stating that universities should stimulate and convey the importance of entrepreneurship to students, and it is also through the students that the success of this teaching is verified. According to the author, the learned entrepreneurial process is reflected and proven through behaviors and attitudes and these will be based on what is the entrepreneurial activity – in short, “the creation of new businesses or new enterprises is due to the entrepreneurial attitude of an individual, which can be learned in a higher education institution” (Pimpão, 2011).
7.6.1 Entrepreneurship in national agendas and initiatives

At a national level, and particularly since 2010, the Portuguese government has defined strategies and launched a series of programs that aim to boost entrepreneurship:

- **The Programme of Support for Entrepreneurship and Creation of Employment (PAECPE)**, launched by Employment and Vocational Training Institute (IEFP) in 2009, which allows young entrepreneurs (to 35 years old) to receive up to 200,000 euros per company through credit lines (Microinvest and Invest+) granted by banking institutions, providing the full unemployment subsidy in one instalment and technical support in the creation and consolidation of entrepreneurial projects.

- **The Strategic Program for Entrepreneurship and Innovation +E +I**, from 2011, which aims to stimulate entrepreneurship and innovation in Portugal through new policies based on needs and results and with strong involvement of civil society, therefore assuming an holistic perspective of such themes.

- **Passport for Entrepreneurship** launched in 2012 by IAPMEI (the Portuguese Agency for Competitiveness and Innovation) aims at helping young entrepreneurs to develop innovative entrepreneurial projects that are still at the concept phase, by providing technical and financial help – access to mentoring through the country’s National Network of Mentors and to other technical assistance; a monthly studentship of about 700 euros for a period of between four to 12 months.

- **The Youth Invest Programme** launched by IEFP in 2015 aims to help young unemployed entrepreneurs (18 to 30 years) to create their own companies. The initiative provides financial support cover-
ing up to a maximum of 75% of the total eligible investment in the new company, as well as technical support to help in the development of new skills.

- **Ignition Programme**, launched in 2012 by the Portuguese government’s venture capital firm Portugal Ventures, aims to invest 20 million euros a year in high-tech start-ups. The programme partners with a network of 48 organisations that include incubators and other business development providers. Projects selected can benefit from a capital investment of up to 750,000 euros, covering up to maximum of 85% of the total funding needs of each project.

- **Start-Up Portugal**, launched in March 2016, aims to support and create a new entrepreneurial ecosystem in Portugal that attracts new national and foreign investors to co-fund startups, as well as promoting them in international markets. The programme will offer a start-up voucher which will provide university students who are completing their courses or that have recently graduated with a monthly subsidy to start their own businesses. The Momentum Programme will offer young graduates that have benefited from a social action grant incubation space and a monthly allowance.

In general, these programs are positive to the development of entrepreneurship in Portugal. By the end of 2015, Passport for Entrepreneurship had received more than 3,500 applications, corresponding to more than 2,000 business ideas. The Ignition program, as of the end of 2014, invested 25 million euros in 43 start-ups (which had grown to 60 start-ups by May 2016).

According to GEM (2016), PAECPE programme has had some success in supporting the unemployed to create their own businesses. Between 2010 and 2012 the PAECPE programme gave out 7,940 grants totalling over
8.8 million euros and 4,423 loans totalling 10.5 million euros and between 2009 and 2013 the programme benefited 1,705 businesses that created 3,973 jobs. Besides, in another evaluation, 57% of the programme’s beneficiaries reported that if it wasn’t for the programme they would not have been able to start their own business, while the same evaluation also found that the survival rate of those assisted was about 90%.

However, “the programme utilised just 57% of its budget between 2009 and the end of 2013, suggesting that it was difficult to find enough entrepreneurs to fund. It said that restricting the programme to only unemployed persons effectively limited the potential beneficiaries. In addition, the low interest rates offered by the programme might also have dissuaded banks from playing a bigger role in the programme” (GEM, 2016).

Despite some success, Portugal continues to experience one of the highest levels of youth unemployment in Europe – 29.9% in April 2016. In addition, between 2012 and 2013 the percentage of adults involved in early-stage entrepreneurial ventures experienced a bigger increase among those aged 35 to 44, than it did for those aged 18 to 24 or 25 to 34, according to GEM data9. According to Redford, many of the difficulties that persist regarding the development of entrepreneurship in Portugal are due to the high-risk aversion of the Portuguese culture.

The will to take into account entrepreneurship is a statement of the Portuguese government, which is currently translated in the many programs aimed at entrepreneurship. This tendency seems to be maintained in the future, indeed, one of the objectives of the Portuguese Education and Training 2020 strategic framework is to promote creativity, innovation and entrepreneurship.

9 http://www.gemconsortium.org/data
Despite the general positive panorama of entrepreneurship in Portugal, the scenario differs when considering entrepreneurship education programs. The latest National Strategy for Entrepreneurship Education (Plano Nacional de Educação para o Empreendedorismo - PNEE) dates from 2006-2010 and was implemented at some secondary level schools. Thus, at the moment, there is no specific national program or strategy for teaching entrepreneurship, there are only guides from the European Commission and the Ministry of Education mainly aimed at teachers whose goal is to promote entrepreneurship in schools.

### 7.6.2 Entrepreneurship education in higher education

Following is a list of formal curricula on entrepreneurship in Portugal.

<table>
<thead>
<tr>
<th>Higher Education Institution</th>
<th>Focus</th>
<th>Degree</th>
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</thead>
<tbody>
<tr>
<td>Instituto Politécnico de Beja – Escola Superior de Educação</td>
<td>Social Development and Entrepreneurship</td>
<td>Bachelor</td>
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<tr>
<td>Instituto Politécnico de Beja – Escola Superior de Tecnologia e Gestão</td>
<td>Social Development and Entrepreneurship</td>
<td>Bachelor</td>
</tr>
<tr>
<td>Instituto Politécnico do Porto - Instituto Superior de Contabilidade e Administração do Porto</td>
<td>Creativity and Business Innovation</td>
<td>Bachelor</td>
</tr>
<tr>
<td>Instituto Politécnico de Beja – Escola Superior de</td>
<td>Community development and Entrepreneurship</td>
<td>Master</td>
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<tr>
<td><strong>Instituto Politécnico de Lisboa - Instituto Superior de Contabilidade e Administração de Lisboa</strong></td>
<td>Management and Entrepreneurship</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Instituto Politécnico de Santarém - Escola Superior de Gestão e Tecnologia de Santarém</strong></td>
<td>Entrepreneurship</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Instituto Politécnico de Viana do Castelo - Escola Superior de Tecnologia e Gestão</strong></td>
<td>Entrepreneurship and Innovation in Food Industry</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Instituto Politécnico do Porto - Instituto Superior de Contabilidade e Administração do Porto</strong></td>
<td>Entrepreneurship and Internationalization</td>
<td>Master</td>
</tr>
<tr>
<td><strong>ISCTE - Instituto Universitário de Lisboa</strong></td>
<td>Entrepreneurship and Cultural Studies</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Universidade da Beira Interior</strong></td>
<td>Entrepreneurship and business creation</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Universidade da Beira Interior</strong></td>
<td>Entrepreneurship and Social Innovation</td>
<td>Master</td>
</tr>
<tr>
<td><strong>Universidade de Coimbra</strong></td>
<td>Social Intervention, Innovation</td>
<td>Master</td>
</tr>
</tbody>
</table>
Table 2. Higher education degrees in Portuguese public institutions, table retrieved from Pimpão (2011).

<table>
<thead>
<tr>
<th>Institution</th>
<th>Program Offered</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculdade de Economia</td>
<td>Social Intervention, Innovation and Entrepreneurship</td>
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</tr>
<tr>
<td>Universidade de Coimbra - Faculdade de Psicologia e de Ciências da Educação</td>
<td>Innovation and Entrepreneurship</td>
<td></td>
</tr>
<tr>
<td>Universidade do Algarve - Faculdade de Economia</td>
<td>Entrepreneurship and Innovation Economics</td>
<td>Master</td>
</tr>
<tr>
<td>Universidade do Minho</td>
<td>Molecular Biology, Biotechnology and Bio Entrepreneurship in plants</td>
<td>Master</td>
</tr>
<tr>
<td>Universidade do Minho</td>
<td>Entrepreneurship in Technology and Information Systems</td>
<td>Master</td>
</tr>
<tr>
<td>Universidade do Porto - Faculdade de Economia</td>
<td>Innovation and Technology Entrepreneurship</td>
<td>Master</td>
</tr>
<tr>
<td>Universidade do Porto - Faculdade de Engenharia</td>
<td>Innovation and Technology Entrepreneurship</td>
<td>Master</td>
</tr>
<tr>
<td>Universidade de Lisboa - Instituto Superior Técnico</td>
<td>Technology Change and Entrepreneurship</td>
<td>PhD</td>
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</tbody>
</table>

According to Redford (2017), education for entrepreneurship in Higher Education Institutions (HEIs) was promoted and implemented mainly from the beginning of the 21st century, although the first courses to include the theme came only in the 1990s. It is, in a way, possible to point out “the year of 2003 as the moment of affirmation for the education of entrepreneurship in Higher Education, leaving a clear mark in the existing educational offer - in the academic year 2004/2005, about 27 entrepreneurship
degrees were in operation”. Since then, HEIs have continued to develop their offer, which nowadays is mainly associated with postgraduate studies. (Redford, 2017). To date, it is still not compulsory in the Portuguese educational system to consider entrepreneurship in curricular plans.

According to Pimpão (2011) in the academic year 2010/2011, there were about 27 degrees of entrepreneurship conducting or not to academic degree, being that the majority of the courses are Masters (78%), four editions Postgraduate and only one was PhD.

Currently, according to data collected by Almeida (2016), Portugal has 26 degrees that concern entrepreneurship, of which 4 are related to courses non-conferring of academic degree (Higher Technical Professional Education or Technological Specialization Courses (CET); 3 are bachelor's degree (1st cycle), 17 are masters (2nd cycle) and 2 are doctoral, most of the courses are taught in the region of Porto and Lisbon, by public schools.

| Higher education degrees in Portuguese private institutions (Bachelors, Masters and PhD) |
|----------------------------------|----------------------------------|-----------------|
| Higher education Institution     | Focus                            | Degree          |
| Universidade Europeia            | Entrepreneurship and Innovation Management | Master          |
| Catolica Lisbon Business & economics | Management with Specialization in Strategy & Entrepreneurship | Master          |
| Universidade Fernando Pessoa     | Creativity and Innovation        | Master          |
| Universidade Catolica Portuguesa | Technology Change and entrepreneurship | PhD             |

<table>
<thead>
<tr>
<th>Focus</th>
<th>Degree</th>
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<tbody>
<tr>
<td>Master</td>
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<td>Master</td>
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<td>PhD</td>
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</tbody>
</table>
Table 3. Higher education degrees in Portuguese private institutions, table retrieved from Almeida (2016).

<table>
<thead>
<tr>
<th>Institution</th>
<th>Degree</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instituto Superior de Administração Interna</td>
<td>Entrepreneurship and SMEs Management</td>
<td>Higher Technical Professional</td>
</tr>
<tr>
<td>Escola Superior de Tecnologia e Gestão da Guarda</td>
<td>Entrepreneurship Tecnics</td>
<td>CET</td>
</tr>
<tr>
<td>Escola Superior de Estudos Industriais e de Gestão</td>
<td>Accounting and Entrepreneurship Tecnics</td>
<td>CET</td>
</tr>
<tr>
<td>Instituto Universitário da Maia – ISMAI</td>
<td>Organizational Accounting and Entrepreneurship</td>
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</tr>
</tbody>
</table>

Table 4. Courses non-conferring of academic degree private education, table retrieved from Almeida (2016).

The balance of the last fifteen years is thus positive and is characterized by a growth of education for entrepreneurship HEIs, who have recognized their added value for the training of students. However, when comparing the development between academic year of 2004/2005 and 2015 there seems to be little improvements: from 27 degrees in operation in 2005 to 26 in 2015.
Informal Curriculum

With regard to other forms of education, there are a number of organizations that have an increased importance in entrepreneurship education including Junior Achievement (JA) Portugal and the Platform for Entrepreneurship Education in Portugal (PEEP). On the other hand, informal education in Portugal often occurs in training over the course of a career or even after attending a more formal course (GEM, 2016). This approach is often adopted in training actions by business centers/centers, business incubators or in acceleration programs and / or business ideas competitions.

Perhaps the most significant actor on informal entrepreneurship education is the National Association of Young Entrepreneurs (ANJE)\textsuperscript{10}. The association provides training and has many projects that foster the entrepreneurship spirit: Portugal Fashion; SME Training; ANJE Tech Entrepreneurship; Entrepreneurship Portugal; Entrepreneur Shop; Enterprising Young Women For New Companies; Get Out; Think Global; Portugal Innovation Project, and more.

One of its most distinctive initiatives is the Academy of Entrepreneurs, implemented in 1997, and since developed together with universities and employment institutions, it has the purpose “to mobilize Portuguese young people to the need for a culture of initiative and risk” (Saraiva, 2013) through actions such as Young Entrepreneur Award, the Entrepreneurship Trade Show, the Ideas Competition and the “Entrepreneurship in Motion” road shows.

HEIs have been working on entrepreneurship education in a double perspective. First, in its relationship with the enterprises network and the crea-

\textsuperscript{10} http://www.anje.pt/en/
tion of business. Second, and more recently, the dissemination of cross-curricular skills integrated into curriculum and extracurricular activities (Redford, 2017).

Thus, and having in mind both courses of action, it is noteworthy that the majority of Portuguese HEIs now provide non-formal initiatives that mainly consist in workshops, conferences, competitions, networking and capacity building sessions and start up programs aimed at students, teachers and researchers. Among the institutions that promote such initiatives, one can mention: Universidade Nova de Lisboa; Universidade de Aveiro; Universidade do Porto (Entrepreneurship Club; iUP25k competition); Universidade de Lisboa; Instituto Politécnico do Porto; Instituto Politécnico de Viana do Castelo; Universidade de Coimbra (Model2Market; Made in Coimbra); Universidade da Beira Interior; Universidade do Minho, among others.

It is important to name the Poliempreende11, a competition developed by the Polytechnic Institutes and Schools of Polytechnic Higher Education, whose purpose is to contribute to the promotion of entrepreneurship and creation of new companies, as well as to the promotion of innovation and students' curriculum enrichment. The competition includes a regional and a national phase, as well as a Entrepreneurship Workshops in order to provide potential entrepreneurs with skills essential to the development of their project. The regional competition is promoted in each of the Polytechnic Institutes, with a view to choosing the best project, and the winner will represent his institution in the national competition, which will award the three best projects.

Following is a summary of entrepreneurship programs in higher education in Portugal:

11 http://www.poliempreende.com
In the academic year 2010/2011, approximately 338 higher education entrepreneurship courses were taught in Portugal, of which 86 were of an optional nature and the remaining ones mandatory (Pimpão, 2011).

<table>
<thead>
<tr>
<th>University</th>
<th>Curricular Unit</th>
<th>Methodologies</th>
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<tbody>
<tr>
<td>Universidade de Aveiro</td>
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<td>Theoretical-Practical(TP)</td>
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<td>• Business plan</td>
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<td>Entrepreneurship</td>
<td>Theoretical-Practical(TP)</td>
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<td>Tutorial (OT)</td>
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<tr>
<td>Universidade de Aveiro</td>
<td>Project management and entrepreneurship</td>
<td>Theoretical-Practical(TP)</td>
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<td>• case studies</td>
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<td>Entrepreneurship on science</td>
<td>Learn by doing</td>
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<td>Design thinking</td>
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<td>Story telling</td>
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<tr>
<td>Faculdade de Ciências da Universidade de Lisboa</td>
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<td>Direct experimentaiton</td>
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<td>K2B projects</td>
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<td>Institution</td>
<td>Course</td>
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<td>Theoretical-Practical (TP)</td>
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<td>Direct experimentation K2B projects</td>
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<td>Universidade Nova de Lisboa</td>
<td>Starters academy</td>
<td>Practical approach</td>
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<td>• Business plan;</td>
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<td>• Simulation game</td>
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<td>Faculdade de Economia da Universidade do Porto</td>
<td>Entrepreneurship</td>
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<td>Social Innovation Practices</td>
<td>Theoretical-Pratical (TP) Tutorial (OT)</td>
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**Table 5. Curricular Unit’s Methodologies, Data retrieved from the institutions’ websites.**

According to Saraiva (2013), entrepreneurial education results mainly from determination, investment, openness to new working methods and an innovative attitude on the part of all educational agents. However, education systems have not always aimed at stimulating the development of entrepreneurial skills. Despite this reality, the entrepreneurship education panorama shows signs of change.
In fact, many Portuguese universities have been including entrepreneurship courses in their curricular offers through the years. These curricular units are mainly optional and taught with a theoretical-practical (TP) approach, that is to say: expository methods and the elaboration of a practical task, that usual consist in the making of a business plan and may also include case studies analysis, debates and discussion within the class. This is mainly the case of Universidade de Aveiro; Universidade do Porto; Universidade da Beira Interior and Universidad de Coimbra. Some universities also use an oriented tutorial approach (OT) alongside the TP, as a complementary teaching methodology.

Although the previous methodologies seem to be the common rule, there are HEIs implementing new ways of fostering entrepreneurship education in their curriculum. In this context, the Faculdade de Ciências da Universidade de Lisboa\textsuperscript{12} stands out.

The curricular unit “Entrepreneurship on science” is taught by making use of learning by doing methodologies and thus “help students explore entrepreneurship based on innovation as a means to foster the (economic and social) appreciation of the scientific and technological knowledge generated on this campus” (FCUL, 2018). Furthermore, creative and disruptive thinking, based on design thinking methodologies, are used to stimulate students as well as teaching outside the classroom context, that is to say, exposing students to the real world through meetings and practical visits to different realities. Moreover, the course makes use of story telling and the sharing of cases of success and failure in the first person.

Besides these approaches, the curricular unit “Innovation and entrepreneurship” and the “entrepreneurship” course make use of direct experi-

\textsuperscript{12} https://ciencias.ulisboa.pt/pt/empreendedorismo
mentation and the K2B as tools to reach the overall objectives of the discipline and thus promote entrepreneurial skills in students.

Finally, the “Business Project” course unit, taught in the 2nd semester, allows all students of masters or integrated masters to enroll, and has the objective to develop scientific projects in a business context, forming multidisciplinary teams of Sciences and Finance (partnership between FCUL and ISCTE-IUL).

The Universidade Nova\(^\text{13}\) also follows a line of innovative methodologies in entrepreneurship education that it materialized in their “starters academy”, a course offered to all university students in their second semester. The curricular unit aims to provide the basic entrepreneurship and business management tools necessary for students to create a startup. The approach is practical and includes the use of EntrepSim - a start-up simulator - and a business plan making.

The Escola Superior de Ciências Empresariais do Instituto Politécnico de Viana do Castelo [ESCE-IPVC]\(^\text{14}\) is also an example worth mentioning, due to their innovative project “The Leaders for the Future”. The project goal is to incubate students business ideas at their facilities, providing technical and logistical support and counting with different experts, professors and stakeholders (banks, incubators, trade associations), ultimately presenting the business ideas to potential investors (Rodrigues & Barreto, 2016). This is an individual project and is part of the training provided in the undergraduate course curricula units and it is continuously developed over the three years of each degree. Thus, the individual projects begin

\(^{13}\) http://www.unl.pt/empreendedorismo/empreendedorismo-na-nova

\(^{14}\) Escola Superior de Ciências Empresariais do Instituto Politécnico de Viana do Castelo [ESCE-IPVC]
with the development of a business idea, during the 1st academic year, and ends with the completion of a business plan in the third school year.

In what regards the informal teaching of entrepreneurial skills, the scenario differs. As mentioned before, the informal curriculum in Portugal is strongly based on workshops, conferences and thus the general tendency is to provide training on basic concepts, using an hands on approach.

Even though the panorama seems to be changing, it is verified that most of the curricular units directed to the entrepreneurship teaching endow a practical theoretical methodology with the use of two traditional methods of evaluation: exam and task elaboration. According to Testas (2013) in “Portugal prevails the school supported by a predominantly academic and programmatic curriculum (..) where only the curricular or learner component stands out”. Particularly in the entrepreneurship education case, it is essential that the traditional expository teaching method is substituted by a “dynamic and evolutionary method” (Testas, 2013).

Rodrigues & Barreto (2016) point to the fact that the entrepreneurship courses in Portugal are mainly taught in business faculties, which might not be as adequate as one would think. In the authors words, “innovative and viable business ideas are more likely to arise from technical, scientific and creative studies”.

Recently, the researcher Ana Daniel developed a study\(^\text{15}\) that analyzed the suitability of non-traditional teaching methods, more specifically design thinking, in the stimulus of entrepreneurial behavior, where experimentation and practice assume a preponderant role and the teacher adopts the role of mentor of the learning process. One of the conclusions of the researcher is that "there are indications that formal education does not stim-

\(^{15}\) \url{https://uaonline.ua.pt/pub/detail.asp?c=38797}
ulate entrepreneurial skills and perhaps even suppress them” – states the researcher. This new information provides a completely new perspective over the subject.

In conclusion, higher entrepreneurship education continues to rely on traditional methods of teaching, and it is extremely restricted to areas such as business and economics. Although several authors point to the fact that the Portuguese educational system is inadequate for stimulating entrepreneurship, in recent years there has been a positive evolution in the progress of courses and programs on entrepreneurship at different levels of education, especially in higher education.

Testas (2013) goes further, and points out that entrepreneurship in Portuguese higher education presents some obstacles both on the part of students and on the part of teachers and researchers. As for students, there is a lack of skills, there is difficulty in obtaining financial support and there is no motivation to undertake it. In relation to teachers and researchers, there is a lack of a culture that links education to the business world and the market, lack of skills, difficulty in accessing finance, and lack of motivation (Testas, 2013).

According to Redford (2017), “there is important work to be done to change mindsets and shift the path of our productive effort towards greater competitiveness, innovation and entrepreneurship as keys to future growth. More than defining areas of intervention, it is important to understand how to develop skills, principally regarding those needed to reconcile the development of fundamental abilities in more traditional areas of education with those related to technological and non-cognitive, soft skills that relate directly to the capacity to learn and acquire entrepreneurial capability”.

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Thus, the challenge for Portugal is to build an inter-disciplinary approach, making entrepreneurship education accessible to all students, adapting the methodologies to its needs and thus transition from the traditional teaching methodology towards innovative ones.
8. DEPLOYMENT OF ICT IN ENTREPRENEURSHIP HIGHER EDUCATION

This section discusses how ICT is deployed currently in higher education institutions in Greece, Estonia, Portugal, and Finland. The discussion aims to identify the current situation on exploiting technology in educational contexts with the objective of establishing an innovative service for enhancing the current practices on entrepreneurial education, enriching learning experiences for students, better reaching educational objectives, and linking education to industry.

8.1 In Greece

ICT is deployed in education in Greece at all levels as a means of supporting the teaching and learning process. In higher education, ICT is deployed, however this is done in a more traditional manner. The following tools are deployed by most higher education institutions:

- Learning content management systems. Through these systems students and educators can share content, submit projects, collaborate in teams, follow announcements, communicate through forums, and more.

- On-line registrar services, through students can register to courses and educators can submit grades

- On-line evaluation services, through which students can anonymously evaluate courses they take with the objective of ensuring continuous improvement of instructional practices, course organization and content through actual feedback

In relation to more innovative approaches, such as the deployment of serious games or simulations, their deployment is on a per course and per instructor basis. Each instructor is independent in teaching a course. The
instructor may decide on the inclusion of ICT in various forms as a complementary learning tool.

Following are some examples of the deployment of ICT in teaching entrepreneurship in Greece:

- **Technology in education course**, Department of Electrical and Computer Engineering, University of Thessaly. The course is an elective in the 3rd year of studies and focuses on how ICT can be deployed to enhance educational practices, including entrepreneurship education. During the course students have the opportunity to deploy and evaluate ICT tools designed for educational purposes. In the context of the DesignIT project, students will deploy the DesignIT services when working in teams for introducing ICT-enhance pedagogical solutions towards enriching educational practices and best reaching educational objectives.

- **Software engineering project management course**, Department of Electrical and Computer Engineering, University of Thessaly. The course focuses on how to best manage the software development process, starting from coming up with the concept, identifying user needs, designing a viable solution for customers, managing available resources and time, evaluating solutions, and maintaining a product or service after delivery to the customer. The course has a strong focus on designing products and services that address user needs. In this respect, design thinking approaches are very relevant. The course currently deploys related agile design approaches that have as an objective to best address customer needs by making customer representatives members of the implementation teams. In agile design, the requirements are drawn through close collaboration between the customer and the implementation team,
and they may evolve throughout the project implementation period either as a result of a customer not being completely aware of needs or as a result of an evolving business environment. During the course the students use ICT for managing the software design process. Related tools include Trello®, Pivotal Tracker®, and others. Notably these tools do not focus on design thinking but mostly on agile design. As a result, the course participants stand to gain from effective deployment of tools such as the ones proposed by DesignIT.

- **Game design course**, Department of Electrical and Computer Engineering, University of Thessaly. The course focuses on the deployment of gamification approaches in the design of services or products that address specific needs. The course focuses on how gamification can be deployed in diverse sectors, ranging from learning, to entertainment, medicine, healthy living, advertising, persuasion and social impact, and more. During the course the students develop games and deploy gamification principles for building products for broad sectors. The students build those games and environments by using tools such as Unity®.

In purely entrepreneurial contexts ICT, and more specifically gamification, is not broadly deployed. As such, DesignIT will address a gap in educational processes by introducing ICT-based solutions that promote the development of entrepreneurial skills, with a focus on design thinking, thus benefitting both educators and students.

### 8.2 In Estonia

Estonia is one of the most highly digitalized countries in the world [186]. Well-established X-road infrastructure offers over 3000 e-services to its citizens and businesses. Services include signing contracts remotely, pay-
ing for public transportation, (mobile) parking, online voting, bank transactions, digital prescriptions from the doctor (also remotely), online tax declaration, eSchool system, creating of a new company online within a few minutes, applying for government aid, (e.g. maternity leave pay), etc. Wireless internet is almost everywhere in Estonia, and almost always free and speedy. Restrictions on internet content and communications in Estonia are among the lightest in the world and the public mind-set towards a digital society is positive.

Information and communication technology (ICT) is developed horizontally through other sectors. ICT-driven innovation in various sectors has been selected as one of the three main focus areas for smart specialization in Estonia [187]. Knowledge-intensive entrepreneurship is promoted that requires creativeness, entrepreneurship, and design thinking competences [188].

The Estonian lifelong learning strategy [189] guides the development of the educational arena in Estonia and serves as the basis for the government to make decisions on educational funding. Estonia offers the prime opportunity to combine the various elements towards a coherent implementation of a lifelong learning system. The use of digital learning resources will help making studying more engaging and will expand opportunities in lifelong learning. It is stated that if the general population is well equipped with technology skills and more capable of innovation, it will help to increase productivity in the economy.

More than two decades the Information Technology Foundation for Education (HITSA) has supported the use of information technology means and possibilities in the study process promoting digital competences, digital learning resources, and innovative learning approaches. Digital competences are related to learning outcomes at school and university curricula,
and educators’ digital competences are a requirement for professional qualification. Estonia has followed ISTE competence framework and is now moving towards adopting DIGCOMP2.0 [190] and DigCOMPEDU [191]. The higher education schools have well developed digital infrastructures. The Estonian Education and Research Network [192], which is a subdivision of the HITSA, guarantees the development and stable functioning of the information technology infrastructure for research and cultural institutions. Schools have free wireless internet access in all locations, students can use open school wifi and EduRoam. Schools infrastructure includes computer labs. It further includes innovative teaching technology such as tablets, wearables, and more. Most of the classroom settings are provided with projectors; however the lecturers have to carry their own laptops in most cases to present. Some classes have interactive whiteboards, but these are not often used. Students usually attend lectures with their own devices - laptops, tablets, smartphones and netbooks are becoming pervasive. Most teachers apply active digital collaboration techniques in the classes where the “Bring your Own Device” approach is central. Schools use e-learning environments provided centrally by HITSA (Moodle) or developed and maintained by the schools (eDidaktikum.ee). The lecturers have freedom in using different learning environments - so google drive tools, Google classroom, Edmodo, Eliademy, different project environments (Trello, Asana, Slack), Skype and Zoom, but also social media channels like FB groups, wikis and blogs are frequently used for formal and informal learning.

Most of the students at bachelor level already come to study with high level digital competences, since schools start teaching digital skills as a separate subject already in the first stage of study and approximately 50% of schools teach digital skills as a separate subject in the second and third stages of study [193]. On the other hand, there is a large group of general
education schools that do not offer any separate digital study courses in any stages of study that creates digital divide and disadvantages for students. At master studies level many students are over 40 years old; their digital competences may not be as high as at bachelor student level.

New learning approaches are very much promoted in entrepreneurship. Project-based and problem-based methods are deployed in interdisciplinary offerings. Estonian higher education schools are probably better manned with educational technologists to support teaching ICT skills than schools in any other countries. One of the major problems the Estonian higher educational system is facing is an aging teacher population. The average age of Estonian teachers is one of the highest among OECD nations. This also affects the digital transformation, since older teachers are less prone to adopt new practices with digital tools. Deeper digitally enhanced learning approaches that involve project-based learning, authentic learning, and more are becoming more and more popular. However, the possibilities offered by blended learning, and more specifically the flipped classroom method, seem to be slightly overlooked. Flipped classroom approaches should be promoted as a special initiative by the MoE or HITSA. This would involve the provision of engaging digital learning material, namely video content, teacher training, and the deployment of software applications that would give teachers feedback on which students have mastered the content prior to class or not. The creation of open-source material would also be very helpful for this initiative. Making classroom flipping a common practice would put the usage of class hours in focus and be a great stimulus for teachers to rethink their roles.

8.3 In Finland

In Finland ICT is used in all levels of education. Most used it is in the higher education, namely in universities and universities of applied sciences.
The Teachers Trade Union (OAJ) published in 2016 an investigation, which discusses the use of ICT and different devices in all levels of education but I will concentrate on the higher education. The government strategy called digiloikka (digileap) pushes increasing use of digital means in education. However, the OAJ investigation points out that using digital tools or ICT in general is not a solution. Sometimes we should leave ICT and execute things together in real world. They also mention that OECD investigation from 2015, Students, Computer and Learning: Making the Connection, stated that PISA results did not get better with increased ICT use. In short, ICT should be used when it is relevant and worthwhile, not because government strategies underline it.

Below is listed ICT and device usage presented in the Teachers Trade Union (Hietikko, Ilves and Salo 2016) review [182]:

**How often students use ICT:**

- University: ~80% every day, ~15% during a week, 5% during month
- University of applied sciences: ~83% every day, ~15% during a week, ~2% during month

**Teacher own estimation on their skills to pedagogically wise use the ICT:**

- University: ~28% very good, ~48% quite good, ~22% somewhat weak, ~2% weak
- University of applied sciences: ~30% very good, ~48% quite good, ~21% somewhat weak, ~1% weak

**Teachers who have digital device in use from their employer:**

- University: ~62% yes, ~38 % no
- University of applied sciences: ~89% yes, ~11 % no

**Digital learning material, which is in use:**
• University: ~92% self-made materials, ~50% materials created in the institution, ~72% free materials, ~15% commercial material

• University of applied sciences: ~88% self-made materials, ~65% materials created in the institution, ~82% free materials, ~25% commercial material

As the above numbers present the situation considering ICT and its use is good in Finland. The challenge is on how to use the tools well in pedagogical sense and how to be confident enough not to use ICT when it is not needed. Sometimes, the decision not to use is harder because of the general pressure from media, EU, government and so forth.

Following there are two course examples where design thinking and ICT are used smoothly.

• **AALTO University, Creative Sustainability - Master of Arts 2017-2018.** The International Master’s Programme in Creative Sustainability (CS) is a joint master’s degree programme at the School of Arts, Design and Architecture, School of Business and School of Engineering. Challenges are global and local. Themes are chosen so that the complexity of future scenarios require strengthening the multidisciplinary approach and the inter-linkage of environmental, economic, socio-cultural aspects in education. The programme has a multidisciplinary learning platform in the fields of architecture, business, design, built environment. Student teams are composed from different fields for achieving multidisciplinary teams. It increases understanding of different backgrounds. The students are encouraged to recognize and learn methods, tools and practices of other disciplines. The distinction between digital and not is not made because the aims is to learn to use the right tools and practices. The teams create new sustainable solutions for human, ur-
ban, industrial and business environments. The learning outcomes of the course are:

- Students learn to utilize knowledge on novel sustainable technologies and socio-cultural approaches for reaching collaborative solutions.

- Students learn to use analytic and systemic thinking for creating holistic understandings about complex situations in society.

- Within design thinking students learn to apply creative problem solving methods and tools when defining the problem, generating ideas and obtaining solutions. Students will use design thinking and participatory approaches as problem solving tools. They will understand values and responsibilities of design discipline related to political, societal and business contexts. They will get accustomed to the Stanford Design Innovation Process.

- Students learn approaches for creating sustainable business models and enhancing business ethics using corporate responsibility.

- Students also learn to manage multidisciplinary teamwork and communicate in versatile industrial, urban and business environments.

- Various ICT tools (design-, communication-, process-, programming- and management tools) are used to ensure the process, collaboration and outcomes. (see: http://me310.aalto.fi/).
In Metropolia university of applied sciences courses called MINNO® are an example of design thinking and ICT use. MINNO® Innovation project means a collaborative team project that solves authentic problems by innovating a novel, practical and concrete solution. It is often a 10 ECTS project. The challenges are provided by industry, society and also by research institutes such as AALTO for solving parts of challenges they are investigating broader research projects. Below is an example of a course, which is also used in DesingIT project.

The “Innovation” course includes students from 4 studying programs: media engineering, industrial management, communications (or some other study line, during the years, this has varied) and information technology. The course has real customers who present an idea for the students. The students select the topics that interested them most. After the students select their favourite topics, the teachers check that the teams are built so that all studying programs are represented in every team. This way the teams get interdisciplinary composition, which is seen to provide wider perspective for their teamwork. The teams start to design and plan what the topic can provide, what could the tool/practice/service to be designed for the users to solve the presented problem based on the customer’s idea. The customers that propose the design challenges can come from industry, small and medium sized companies, organisations, associations or for example from EU-projects. The design idea is developed into a working prototype with a business plan and market analysis. The course is a project course spanning three months and worth 15 ETCS and last for one semester – usually autumn semester from September to mid December.
There are approximately 50 (2017 exceptionally 70 students) students forming 11 multidisciplinary teams and four teachers (representing all the studying programs). Each student team has 3-6 students. The teams develop: idea canvas, personas, scenarios, mock-ups, prototypes, user stories, business plans, marketing strategy and software architecture to come up with an application and business in use for real users supported by the representative from company, or industry or associations. The students are introduced to the practices, methods and tools (also digital tools) used in business and application development during lectures by visiting lecturers coming from real working settings. Students are provided with pre-structured work documents that include domain specific conceptualizations. These documents guide and scope students’ work on their solutions and analysis of related problem spaces. During the design and development phases the students teams produce: user stories, software architecture, mockups, prototypes, sales pitches, and weekly team progress reports presented to the company representative to whom the teams are creating the solution to a design idea. The above documents with other team products are discussed during the once a week steering group sessions. The steering groups consists of 1-2 teachers and 1-2 customer representatives. They are held weekly, and last between 15-45 minutes. The goal of the steering groups is to support the teams to address all relevant aspects of business planning, software development and acquiring users (and business revenue) for their application.

The course follows the project-based learning and problem-base setting. The setting can be seen in student teams designing, developing and executing a product to a customer. Because of the tight
teamwork and provided templates that push towards collaboration, it can be said that the course also has features from trialogical learning approach (Paavola and Hakkarainen 2005) in its emphasis on iterations of shared artefacts (such as mock-ups, wireframes, experimentation plans, usability testing, business plans etc.), collaborative work and cross-fertilization. The cross fertilizations is visible in various level, such as: the team members come from different studying disciplines, there is communication and work executed beyond institute and company borders and student teams have to contact the end-users of the products they develop [185].

8.3 In Portugal

Emerging technologies as learning tools are not used extensively in higher education in Portugal. A study conducted by Universidade do Algarve, showed that there is a relation between the deployment of serious games as learning educational tools and the following:

- Jobs in knowledge intensive activities
- Levels of educational qualifications
- Electronic governance (e-gov)

Unfortunately, research results showed that Portugal has the lowest levels in the European Union regarding the three above aspects. Moreover, Portugal’s low performance overall compared to other countries may be due to the low levels of those three aspects.

Another study by Universidade Aberta showed how rare is the use of serious games in higher education in Portugal. This is because most games are not translated to Portugese and also teachers’ lack of initiative. However, students support that using such educational tools could have pedagogical benefits.
Fortunately, there are a few of the existing serious games that are already used and applied in Portuguese higher education. There are, however, some that are used as supporting tools, but most of the times are not formally integrated in the curriculum. Some of them are:

Physical prototyping: at the Integrated Master Degree in Industrial Engineering and Management at Universidade do Minho a physical simulation game was developed using Lego® Mindstorms® NXT building blocks to design a production system and addressing the assembly of a product.

eCITY: this game stimulates the integration and continuous exploitation of Problem Based Learning in secondary education, exposing learners to how knowledge from diverse subjects, such as mathematics, physics, and technology is realistically applied in real world complex engineering problems.

Gaball: this is a game that seeks to address the reinforcement of EU Micro and SME’s managers’ skills in the process of internationalization to internal and external markets through electronic business platforms. The project addresses final year higher education students that have an interest to become entrepreneurs and are planning to start up their own companies.

Cesim Glogal Challenge: this is a business simulator used in the Enterprise Management degree at the Universidade do Algarve. It integrates various areas of management and facilitates the development of diagnostic, analysis, and decision making skills in the context of overall management.

Physical simulation games: at the Instituto Superior de Engenharia do Porto a study “compared two different game approaches to lean training: a simulation game based on a single realistic manufacturing platform, involving production and assembly operations, and a digital serious game that replicates a production environment that demonstrates the potential of
lean tools”. The results showed that “both approaches promote trainee motivation and knowledge acquisition and suggest that they can be used as support to achieve more effective learning results”.

As far as e-learning is concerned, “Governação & Práticas de e-Learning em Portugal”, which is a recent study, has shown an upward tendency in e-learning and b-learning, which are distance training practices. In higher education institutions, there is evidence of good practice in progress but, except for the case of Universidade Aberta, higher education institutions that offer certified e-Learning courses are negligible in number. The majority of higher education institutions offer platforms such as Moodle, Formare, or Blackboard to support classroom learning. The cases where universities develop online courses for students studying at a distance are less frequent.
9. SERIOUS GAMES

Serious games are defined as games designed for a purpose other than entertainment. Serious games focus on pedagogical design and aim to build specific skills in a target group. Some elements of entertainment and competition are integrated into the game with the objective of drawing the players’ attention and promoting engagement with the learning process. A good serious game design ensures that have fun while at the same time they develop knowledge and competences. The deployment of serious games in learning constitutes is a widespread new skill building approach which has already been used by a variety of contexts by international organizations. Some examples of organizations that deploy serious games for training are the U.S. Department of Defence, the U.S. Department of Homeland Security, NATO (North Atlantic Treaty Organization), more.

Serious games are often used as independent solutions for training candidates for developing particular skills. Nevertheless, they can be used in combination with the already existent teaching methodologies so as to improve the benefits of the developed skills.

DesignIT can be considered as a tool which fosters the development of design thinking skills and inspires both students and educators to apply the design thinking methodology in order to solve problems efficiently and through a brand-new prism, which is human-centric. As a result, students get prepared so as to enter the entrepreneurial and social-entrepreneurial workplace qualified.

9.1 Serious Games. What are they all about?

Different terms are being used in literature to describe games that have been built for learning; de Freitas (2013) [146] argued that it may be hard to distinguish the difference between games that are developed for leisure
and for learning; she further argued that user can have fun while engaging with games built for educational purposes.

Furthermore, games built for entertainment are often deployed in the classroom for learning purposes. One of the reasons why some criticize the effectiveness of applying serious games in the classroom may be the fact that individuals may confuse games built for entertainment with educational games. Allowing students to relax from the lesson and entertain themselves through leisure games is not what educational games developers have in mind. Serious games should not be considered as a break from teaching and learning; rather game-based learning enables students to learn and have fun at the same time, without having the need of taking a break. According to Gauntlett (2007) [119], the environment of a play is non-judgmental; this makes it more likely for users to foster surprising and innovative ideas.

The first computer games developed by universities aimed at building science skills. The widespread introduction of game engines has resulted in broad availability of editing tools and toolkits that support the creation of computer games; furthermore, developers have the flexibility of using mixed interfaces and various ICT tools towards game design and development.

9.3 Gamification

Gamification is a methodology to insert gameplay elements and techniques in non-gaming settings so as to enhance user engagement with an activity, product or service. By embedding suitably fun and addictive features into an existing system or process, designers address the users’ intrinsic motivations so they enjoy doing that activity or using that product or service. As such, gamification optimizes a system or process design in relation to the user’s feelings, motivations, and engagement. In short, as
games have the ability to keep people engaged for a long time, gamification expects to transfer that ability into other realms of life, by exploring the mechanisms that promote that engagement.

The intrinsic user motivations are usually referred to as Core Drives. There are several models trying to classify these drives but one of the most commonly used model is the Octalysis one, by Yu-kai Chou [152].

- **Epic Meaning & Calling**: This drive makes the player believe that he/she is doing something really worthwhile with a great value for the Society and this makes him/her dedicate a lot of his time and effort into an activity

- **Development & Accomplishment**: This is the internal drive of overcoming challenges and making progress. Challenges must be significant for the player to feel that he/she should be rewarded and recognized

- **Empowerment of Creativity & Feedback**: This drive relates to users being engaged in a creative process where they have to repeatedly figure things out, try different combinations, receive feedback and acknowledge the achieved results

- **Ownership & Possession**: This drives users that are motivated by the feeling of owning something which normally drives them to wanting to own more

- **Social Influence & Relatedness**: This drive incorporates all the social elements (positive and negative) that motivate people, from companionship to competition and envy

- **Scarcity & Impatience**: This is the drive of wanting something because it is hard to get and owning it gives status and recognition
• Unpredictability & Curiosity: This drive leads users into wanting to find out what will happen next (like in watching movies or reading novels)

• Loss & Avoidance: This core drive is based upon the avoidance of something negative happening

9.3 Classification of digital games for learning

Digital games can be categorized as follows:

• **Educational computer games.** These are video games that can be deployed for learning. It is possible that their designers did not aim at education, but these games can provide students with learning experiences and they help students achieve learning outcomes.

• **Online games.** Massively multiplayer online role play games (MMORPGs), massively multiplayer online real-time strategy (MMORTS), and massively multiplayer online games (MMOGs) are online games whose usage is widespread, since their first appearance as multi-user dungeons / dimensions (MUDs) during the 1980s. The aforementioned games contain either text-based environments or complex graphics, and virtual scenarios; many users play these games concurrently

• **Digital simulations.** Virtual reality (VR) systems present a real-world scenario depiction on a computer. There is a close link between simulations and digital games. Simulations can be deployed for learning. They constitute immersive environments which can be designed for training or skill building purposes in diverse contexts, e.g. astronauts’ training, medical training, and more
• **Serious games.** This term refers strictly to instructional video games. Serious games may be computer applications that present learning scenarios with specific educational goals. They incorporate elements of gaming, such as missions, scoring mechanisms, difficulty levels, social recognition of accomplishments, and more. These features enable users to acquire skills, knowledge, or attitudes helpful in real life. According to Michel and Chen, during the 1990s and the multimedia revolution, the “edutainment” term became very popular and promoted “education through entertainment”. The definitions of edutainment and serious games seem to be one and the same. The term “serious games” was coined by Serious Game Initiative in 2002 in the USA. There is a variety of definitions on serious games. One of them is that a serious game aims primarily at education, rather than exclusively entertainment (Michael & Chen (2006). Apart from the diverse definitions of these games, one thing is certain, the fact that these games can induce a “flow experience”, an enjoyable experience, and a state of being focused on achieving goals. Users feel satisfied while playing serious games, and the engagement with games can lead the acquisition of knowledge even in a “stealth mode” [148]. As opposed to the traditional teacher-centred learning approaches, serious games adopt learner-centred approaches, and foster experiential learning; students have the opportunity to live concrete experiences through active experimentation.

9.4 Deployment of serious games in diverse contexts

Games are multidisciplinary by default. They display the aspect of play, and provide knowledge effortlessly by using a direct link between the real world and a “microcosm” of the game, in which users are immersed. Th
concept of microcosms was originally introduced by Minsky and Papert [145][144]. Microcosms are environments that constitute an abstract definition of the real world that includes only the necessary information that allows the user to experiment within a domain. They include objects, objects, artefacts, representations, and simple rules that govern the interactions of the above. They can be explored in an “open-ended” way by learners. Microcosms as a simulation and a learning environment are deployed in diverse contexts. Microcosms can provide scenario-based learning opportunities. They encourage role-play and have the potential of enriching learning by encouraging users to explore, discover, and synthesize knowledge.

While serious games and simulations have broad applications, they are particularly widespread in education, medicine, business training, and the military.

An example of a serious game deployed in the military is VICE (Virtual Interactive Combat Environment). It provides realistic scenarios in which soldiers get their own station and a large video screen and they come face to face with a variety of circumstances. Soldiers use Xbox-like controllers built into their weapons and in this way they control everything that happens. The game collects information in real time, which can be subsequently reviewed by a sergeant overlooking the training process. Upon completion of gameplay, users receive feedback which furthers their preparation to act on actual training grounds.

In relation to the medical sector, serious games can be deployed in different ways: either to train professionals or to promote healthy and safe behaviour among patients. Virtual reality, simulations, and serious games can be extremely useful in this context either because they improve learning outcomes in a safe environment that does not endanger patients. Fur-
thermore, medical training through games helps contain educational costs, as it is cheaper than experimenting on cadavers or mannequins.

In relation to medical staff training, serious games play a significant role as educational tools in surgical residency training programs even if they do not yet constitute the norm in medical curricula. Among the most promising developments that have emerged is serious games for knee replacement surgery procedure education and training. A serious game for this purpose was created by Sabri et al. in 2010 [121] and focuses on total knee replacement or total knee arthroplasty (TKA), is a surgical procedure through which the painful arthritic knee joint surfaces are substituted with metal and polyethylene components.

In relation to patient training for a healthy and safe lifestyle, examples of related educational games include ones that train patients on how to live with diabetes. The French team of Dr. Aurore Guillaume surveyed the development of three serious games. Affaire Birman [122] is a serious game in which the user build skills related to diet and nutrition, insulin injection, and physical activity; the game was designed especially for children and teenagers with type 1 diabetes and with multiple a daily injection regimen. Méli-Mélo Glucidique [123] is a quiz-form serious game developed for building the dietetic knowledge of a patient. It focuses on the intake of carbohydrate. Timeout [124] is a serious game developed for teenagers and adults with type 1 diabetes that receive pump treatment. These three games are 2D web-based games.
Emergency management, corporate and government training is another significant sector that has inspired serious games developers. Related serious games include a range of scenarios that concern a number of different tasks and circumstances, such as different types of crisis management; e.g. terrorist attacks, biohazards, health care policy issues, city planning, disease outbreaks, and budget balancing (Michael & Chen, 2006) [147]. For example, the AUGGMED (Multi-agent counter terrorist training in mixed reality environments with automated serious game scenario generator) platform is designed to address learning objectives that include the acquisition of problem solving, analytical and decision making skills. The AUGGMED platform incorporates tools which provide trainers with a set of learning objectives and enables them to define their own scenarios, monitor training sessions, interfere in real-time in order to change
the scenario and evaluate trainees' performance [125]. The game introduces three different scenarios. Scenario 1 involves a terrorist attack (gun men) at a generic UK airport. Scenario 2 involves suspicious parcels/explosion at an underground train station in Barcelona (released in 2017). Scenario 3 involves gun men and a cyber-attack at a passenger port terminal in Piraeus (it will be released on February 2018).

Figure 2. AUGGMED serious game scenario generator, retrieved from [125].

In relation to business training, ENTRExplorer is a serious game for Immersive Entrepreneurs; it is a 3D serious game and it is developed by the Economic Policies Research Unit from the University of Minho (Portugal). Its target group is the general public. Its purpose is to prepare entrepreneurs to build new skills which are essential so as to run their future business enterprise successfully. In other words, it emphasizes in educating people about entrepreneurship principles [151].
Another very important category of serious games is awareness raising games. These games focus on important social issues such as depression, suicide, poverty and more and aim to raise the sensitivity of the public. They further aim to train professionals, e.g. educators, on the detection of warning signs of individuals at risk, e.g. of suicide.

In this category, Elude is a serious game which has been developed in order to raise awareness about depression [149]. It informs on the seriousness of the illness by modelling depression. It is designed for deployment in a clinical context as part of a psycho-education package to increase friends' and relatives' understanding towards individuals who suffer from depression and to raise awareness on what the beloved ones of individuals with depression, namely their parents, children, and partners are going through.

The game takes place in different places, each of which is related with different kinds of mood. For example speaking of the “normal mood”, the player finds themselves in a forest where they should find passion in objects so as to find happiness and overcome every obstacle [163].

Snow World is a virtual reality serious game. It is developed to help patients who suffer from high burns. It alleviates their pain since it occupies patients during painful wound cleaning or physical therapy. Furthermore, it distracts them from remembering their original injury and this alleviates the pain, according to MRI scans. It is developed by the University of Washington (main researchers: Hunter Hoffman and David Paterson) and it helps highly-burned patients to change their behaviour towards the difficult situation they have been through [164].
9.5 Serious games for design thinking

This section describe serious games that have been developed specifically for building design thinking skills.

Genigames is a web-based game developed by Sciplay in cooperation with the Concord Consortium and Michigan State University [85]. Sciplay modified the Geniverse software. The game aims at enabling students to breed fictional dragons and find solutions to specific problems, in a virtual lab. The project was funded by the National Science Foundation (REESE
program). It focused on studying whether the students’ incentive, involvement, and learning is influenced by providing some game-based design features to the existent Problem-Based-Learning science curricula. Genigames applied some changes in the Concord Consortium’s dragon breeding software; more specifically, it inserted three gaming features: a strong story-telling, a countable aim which should be achieved by students, and a characteristic for a team antagonism. This research took place in New York City high school classrooms with a target group of students who studied genetics. It was also applied at the New York Hall of Science. In this case, the target was students representative of groups that are underrepresented in science education. The project further involved a consulting committee that assessed the project and consisted of experts in genetics, learning sciences, cognitive science, and gaming. Information published on project results high light its playmatics role on educational development and design thinking, however it presents no further details on building design thinking knowledge and skills.

Figure 6. Genigames as a design thinking serious game [85].
The Future Energy Chicago game [86] focuses on energy consumption. It is a music installation. The partners of the project are the Museum of Science and Industry and Potion Design. The target audience learners aged 9 and over. This process takes one hour and aims at lowering the level of future Chicago energy.

Figure 7. Future Energy Chicago, retrieved from [86].

An interactive Simulation Lab is actually the epicentre of Future Energy Chicago. This lab challenges teams to re-visualise the energy landscape of Chicago and come up with new ideas of optimizing it [87]. Each team tries to maximize the benefits of energy use by switching to a coordinated series of mini-games and focusing on the offset of their options and their impact.

Future Energy Chicago is the MSI's newest permanent exhibition. It challenges the target audience to learn about the proper use of energy in terms of cost and environmental protection. It is a fast-paced simulation game that enables teams to provide solutions in order to make Chicago a more viable city. Teams build design thinking skills and have much fun in the process [86].
This simulation lab makes use of real energy data and presents the way that energy is used in the everyday life. The game is continuously updated in order to reflect the current conditions and prices.

![Image of Future Energy Chicago Simulation Lab](image.png)

**Figure 8. Future Energy Chicago Simulation Lab, retrieved from [86].**

After the end of each round the score is updated. The goal is to beat the final high score by achieving sufficient overall energy savings. The creators emphasize the playmatics role of the game, its educational objective, and its promotion of design thinking.

Some of the mini games of Future Energy Chicago are presented below:

- **Future House [87]:** teams can act as energy consultants and provide the most effective energy options by using “x-ray vision”, spot the sources of wasted energy and optimize the houses. Future Houses contains Smart Homes [88]

- **Future Car [89]:** teams act as automotive engineers; they make new cars by putting together components which provide energy efficiency. They also participate in Energy Road Rally and make a connection between their fictional cars and the real ones. Future Car con-
sists of Advanced Automobiles [90], and Automotive Technology [91]

Figure 9. Future Car by Future Energy Chicago, retrieved from [89].

- Future Neighbourhood [92]: teams act as urban planners; they provide the neighbourhood with the essential facilities in order to enable its citizens to walk instead of using means of transport, which also involves the application Walkable World [93]
Future Transportation [94]: teams act as transportation planners; they take a panoramic view and spot the places where there are traffic jams and waste of energy. They build a more effective energy network. Future Transportation contains the game Smart Networks [95]

Future Power [96]: teams act as power engineers who provide a wide range of power options to Chicago. The game helps learners understand the need of minimizing greenhouse gases and promotes cleaner energy. Teams experiment in order to find the right balance. Future Power includes the game The Grid [97], which refers to wind and solar grids converted into electrical grid aiming at developing storage technologies to save energy and use it when the alternative grids are not in use (e.g. when there is no sun or the weather is not windy); the second element of Future Power is Power Sources [98], which demonstrates that if teams upgrade both buildings and houses the level of wasted energy will be dramatically reduced, the energy effectiveness will increase, and there will be no need of building new power plants
10. THE DESIGNIT SMALL SCALE STUDY ON BUILDING DESIGN THINKING SKILLS

The basic “end-product” of the project will be a "serious game", namely a game which will promote learning in an entertaining way. It is addressed to higher education students, so as to prepare them to get evenly into the world of work; this will happen through their exposure within higher education learning activities to grasp the concept of design thinking, and implement it.

The DesignIT serious game presents the following educational objectives:

- To enable students who attend higher education to come face-to-face with the design thinking practices
- To get students ready in order to enter evenly in the entrepreneurial and social-entrepreneurial fields, by building design thinking skills, and experience which lead them to their future career advancement
- To develop creative thinking, critical thinking, responsibility for learning, and learn to act collaboratively; the aforementioned are fostered by the proposed design thinking learning solution
- To foster brainstorming, which is an essential factor of succeeding in dealing with problem-solving procedures
- To encourage students to ideate and act as if they were professionals; this is supported through role-playing situations, which challenge students to introduce solutions in their daily problems
- To teach them how to cooperate and do teamwork successfully, by being exposed to the design profession, at the same time
To build connections between higher education and professional design fields, and modernise scholar curricula in order to be aligned with the real workplace requirements

The DesignIT learning goals help address the New Skills for New Jobs [158] initiative objectives and specifically the necessity of minimizing the gap between skills sets, and social cohesion; speaking of the skill sets, they are available to those on demand by the industrial promotion of viable financial growth through the improvement of human capital; these skills promote the employability, and the social cohesion. They are connected with the PISA and ET2020 objectives in relation to building transversal competencies which help learners excel in the academic sectors and at work, independently of subject area (PISA 2015) [157].

The high level objectives of the serious game will be:

- To guide higher education students to build skills, in order to understand the design thinking process and its principles, which is students-centred

- To build skills of implementing the design thinking process, and each of the stages effectively, in context of projects

- To encourage students to think “outside-the-box”, namely in an entrepreneurial way of providing sustainable solutions that meet the customers’ needs precisely

- To support students as far as it concerns the adoption of user-centred approaches when it comes to the design of solutions that address real world consumers’ requirements

- To foster students to be civic-minded and active members of society by finding viable solutions which are described with social consciousness
• To foster the portability of the aforementioned skills from educational contexts to real-case situations

• To connect the learning objectives of DesignIT to higher education curricula focusing on design thinking principles in countries in which the DesignIT consortium has partners (see O2)

The design of DesignIT will take into consideration the following:

• The ongoing context in higher education in order to include entrepreneurial, and social-entrepreneurial processes, based on the design thinking approach, into formal and informal activities

• The directions of higher education curricula, aiming at lessons which can be optimized through the design thinking process

• Technical infrastructure which is provided in higher education institutes, in the participants countries, for making a good use of ICT-improved learning solutions

• Both the educators’ and students’ learning motivation

• The design thinking skills and a variety of others (creative thinking, critical thinking, innovation, teamwork, and so forth) demanded by the entrepreneurial realm for employing higher education students after the successful accomplishment of their studies.

The DesignIT gamified learning environment will be multi-platform and will operate on popular operating systems and devices. This feature will enable the development of the game not only in formal classrooms but also in blended learning contexts which can combine classroom teaching, visits to businesses, and a variety of external activities.
9.1 A small scale study on identifying student needs on building design thinking skills

The DesignIT team carried out plenty of activities which intended to generate and gather beneficial feedback collected by the stakeholders and more specifically by students who will be potential users of the DesignIT serious game after the project will have been completed and released. Since the beginning of DesignIT, there has been a conscious effort of understanding both interests and requirements of the potential users in order to strengthen the methodologies applied in DesignIT through the proof-of-concept gamified learning environment and supporting educational material and resources. This section intends to put a spotlight on the ideas and suggestions of students and future users.

The activity involved a questionnaire based study that targeted higher education students and aimed to document their expectations from the implementation of the proposed gamified learning solution that integrates design thinking.

In Greece, the activity took place at the University of Thessaly and more specifically during the course “Educational Technologies” (Course ID HY310); this course is integrated in the academic curriculum of the Department of Electrical and Computer Engineering. It is an elective undergraduate course, relevant to the subject area of Applications and Foundations of Computer Science, and is offered during the 5th semester, namely the 3rd year of the studies. It includes 4 hours of lecturer’s attendance per week and three different assignments, all of which have direct connection with the design thinking methods, the design thinking principles, and the five-staged design thinking implementation.

In Finland, the activity engaged students at Metropolia University that are involved in design thinking processes in the context of related courses on
design. The students are often engaged in building solutions to real world products in collaboration with industrial partners of Metropolia University.

In Portugal, the activity involved graduate students engaged in serious games activities, who were asked to provide their insight on how to best design and implement an application that promote creative mind sets on design thinking.

In Estonia, the activity involved undergraduate students at Tallinn University engaged in activities related to social change.

Following is a discussion of the results of the questionnaire based study.

### 9.2 Summary of study results

This section introduces a presentation of the actual study results and provides an analysis of the information gathered.

The study started by documenting some statistical information on the users. It should be noted, however, that the questionnaires were filled in anonymously in order to protect the identity of respondents. The following charts demonstrate the distribution of the age (
Figure 11) and academic background (Figure 12).

Figure 11. Participants’ ages.
Next, the questionnaire asked the students if they were aware of product development courses at their institution. Product development, which may also involve but not be limited to software development, is targeted in this question as it is often linked to design thinking approaches.

The majority of the participants (43.3%) are aware of the existence of relative courses, which means that they have practically been involved in product development and methodologies processes during their studies so far.

Subsequently, the questionnaire asked the students what learning methodologies are mostly deployed at their institution (Figure 14). The wide majority of students responded that traditional instruction by lectures is used (33%) followed by lab work (26.2%).

In relation to the quality of technical infrastructure at their institutions, almost half of the participants (47.1%) rate the technical infrastructure of
their universities’ lab as “sufficient” and a significant 35.7% as “very good” (Figure 15).

Figure 13. Participants’ responses on the offering product development courses at their universities.
As far as design thinking approaches and practices is concerned, 120 participants (45.6\%) state that they already know what this term refers to, but only 97 participants (36.9\%) have been involved in the development of products and/or software using agile principles and methodologies in the past (Figure 16, Figure 17).

In relation the benefits of the design thinking approach students responded that it is a “creative approach which is based on expansion ideas” (19.5\%), “thinking outside the box” (19.2\%), “encourages empathy, openness to new ideas, and it’s non-judgemental” (15.6\%), “user-centric approach which focuses on the users and their needs” (15.4\%) and “uses analytical thinking” (12.6\%) are linked to design thinking (Figure 18, Figure 19).
Figure 16. Participants’ familiarity with design thinking approaches and practices.

Figure 17. Participants’ awareness regarding design thinking.
Figure 18. Participants’ opinions on which elements are related to design thinking.

Figure 19. Participants’ opinions on which elements are related to design thinking.

In relation to whether their institution offers courses related to design thinking, almost half of the participants (40.3%) responded that they don’t really
know if their university offers a specially designed course that focuses on design thinking approaches. Even though 32.3% answered positively, only 27.8% have been involved in a related course, while 72.2% have never attended any of these (Figure 20, Figure 21).

**Figure 20.** Participants’ responses on whether their university offers courses related to design thinking approaches and practices.
Figure 21. Participants’ response on whether they have attended courses on design thinking.

In relation to whether they have attended any short courses or seminars on design thinking outside of their formal curricula, most students responded that they have not (68.4%) while only a minority have done so (31.6%) (Figure 22).
Figure 22. Participants’ responses on whether they have attended seminars or other informal training related to design thinking.

In relation to available training opportunities for building wide skills, students responded that attending undergraduate education courses is the most popular choice (17.7%), while formal courses and workshops (17.1%), online communities and networks (16.8%), postgraduate courses (14.3%) and conferences (14.2%), come very close in the preference list. The least preferred option seems to be mentoring activities (6.6%) (Figure 23).
In relation to what practices of design thinking should be included in formal curricula, the majority of the participants (42.6%) seem to agree that active learning scenarios inspired by real life circumstances are the most appropriate way of learning about design thinking processes, while, as expected, hands-on games and digital games come second in the preference list (30.4%). Luckily, few participants (a total of 14.9%) value the efficiency of traditional teacher-oriented, drill and practice activities (Figure 24).
In the following questions the study focused on students’ awareness of serious games and gamification. In relation to awareness of the terms, 36.1% responded that they are familiar with term, while a mere 33.1% declare small familiarity, and 30.8% respond that they haven’t heard of the term before (Figure 25). It also seems that those who already have a clear idea of what a serious game is appreciate the educational impact of such tools and the percentages regarding the benefits are equally distributed as it is clearly shown in the following graph (Figure 26).

Most students responded that they have been exposed to serious games in the context of learning (66.2%) (Figure 27). Finally, students are equally divided on whether the activities at their university are innovative (Figure 28).
Figure 25. Participants’ awareness of the term “serious games”.

Figure 26. Participants’ awareness of the potential benefits of serious games in learning.
Figure 27. Participants’ responses on whether they have used serious games in university courses which are relevant with the computer science.
Figure 28. Participants’ response on whether they have participated in innovative learning activities in university.
11. **LEARNING REQUIREMENTS DEFINITIONS**

DesignIT aims to prepare students to enter the world of work by building essential entrepreneurial skills, and specifically skills related to design thinking. The project aims to build student familiarity with the principles of design thinking and promote the capacity of students to be innovative and respond well to change. At the practical level, DesignIT will expose them to practical application of the process stages as these have been described earlier in this report. Through DesignIT, students will learn how to communicate effectively with users and to empathise in order to understand how user will experience a specific product or service. Students will learn to define problems clearly and effectively, to brainstorm in order to ideate as many solutions as they can, to prototype, and to test solutions by deploying them with actual users. Some of the stages may be repeated more than once. Students will simulate the design thinking process until the deliverable meets customer needs.

In addition, the DesignIT gamified learning environment will help students develop some qualities and competences which will contribute to their career. Students will become better prepared to face future risky situations at their workplace simply because they will have obtained the experience of dealing with difficult issues that at a first glance seem unsolvable. Through the DesignIT learning environment students will be exposed to non-trivial scenarios. DesignIT will provide the practical experience and it will also make available oriented knowledge, which aims to optimize student transition into their future workplace. Through specific learning scenarios, students will get the actual feeling of taking on responsibilities, being exposed to the real design profession, and support their ideas which lead to their design.
The following sections introduce learning requirements for students as well as educators. The requirements are documented in the IEEE standard format.

### 10.1 Learning requirements for students

<table>
<thead>
<tr>
<th>ID: LR-S01</th>
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<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>Familiarity with the design thinking methodology and its practicality.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Students will understand the principles of the design thinking process; they will grasp the main ideas of design thinking and will be prepared to solve difficult issues in their future workplace, mostly related with entrepreneurship and social-entrepreneurship.</td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>Design Thinking is a worthwhile, creative, effective and up-and-coming methodology, which is argued that can be implemented in a wide range of professions. DesignIT will be the linkage between design thinking theory and its applicability.</td>
</tr>
<tr>
<td><strong>Dependence:</strong></td>
<td>None.</td>
</tr>
<tr>
<td><strong>Interdependence:</strong></td>
<td>LR-P02, LR-P03, LR-P10.</td>
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<th>ID: LR-S02</th>
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<tr>
<td><strong>Title:</strong></td>
<td>Balanced exposure to industrial and entrepreneurial processes.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>DesignIT enables higher education students to be familiarized with industrial and the entrepreneurial</td>
</tr>
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processes in a balanced manner. Scholars understand that the most effective knowledge is one build through experience and active learning, which fosters students to learn on their own. Students build capacity for flexibility and adaptability towards situations which require advancement.

<table>
<thead>
<tr>
<th>Justification:</th>
<th>Industry and business is a rising sector that requires high level qualifications. DesignIT must provide higher education students with the proper qualifications in order to succeed. DesignIT will simulate the design thinking process challenging students to apply it in diverse contexts.</th>
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<tbody>
<tr>
<td>Dependence:</td>
<td>LR-S01.</td>
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<tr>
<td>Interdependence:</td>
<td>LR-P02, LR-P03, LR-P04, LR-P10.</td>
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<th>ID: LR-S03</th>
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<tbody>
<tr>
<td>Title:</td>
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<tr>
<td>Description:</td>
</tr>
<tr>
<td>Justification:</td>
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will be forced to make crucial decisions in their future careers and DesignIT challenges them to make decisions early on, during their academic studies. DesignIT is developed to simulate situations that constantly demand critical thinking.

<p>| ID: LR-S04 | Title: Knowledge development. |
| ID: LR-S04 | Description: Through DesignIT, students become active knowledge builders. Throughout the design thinking process they learn to empathise and they collect information and use it in combination with their existent knowledge in order to create new one. |
| ID: LR-S04 | Justification: Design thinking methodology is applied in the DesignIT gamified learning environment. As a result, students are equipped with the ability of building brand new knowledge by using the users’ requirements. Their personal experience is connected with the information they collect towards building new knowledge that helps them become effective professionals. |
| ID: LR-S04 | Dependence: LR-S01, LR-S02, LR-S03. |
| ID: LR-S04 | Interdependence: LR-P04, LR-P07, LR-P08, LR-P09, LR-P10. |</p>
<table>
<thead>
<tr>
<th>ID: LR-S05</th>
<th>Flexible thinking and adaptability to change.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>In DesignIT scenarios, students come face-to-face with individuals who deal with difficult issues. They should be ready to listen to them, record their experiences and their complaints, and provide them with viable solutions. Nevertheless, students will be exposed to situations where the design will not be clear from the beginning. The requirements may change throughout the implementation process. Students should be flexible to change. They should accept the challenge and adapt in order to satisfy their customers.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Scholars understand that in the entrepreneurial workplace nothing is fully predicted. As a result, they have to be adaptable, visionary, and always find a way to overcome difficulties and move on. Thinking positive is a way of succeeding and students should learn to embrace change.</td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>LR-S01, LR-S02, LR-S03, LR-S04.</td>
</tr>
<tr>
<td><strong>Dependence:</strong></td>
<td>LR-P02, LR-P07, LR-P08.</td>
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<p>| ID: LR-S06 | Efficient teamwork, building relationships with the customer, and collaborative learning. |</p>
<table>
<thead>
<tr>
<th>Description:</th>
<th>This serious game includes scenarios in which students learn how to exist together with others so as to accomplish a specific goal. Furthermore, they learn to communicate with customers effectively in order to empathise with them. What is more, through all the aforementioned, they participate in collaborative learning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justification:</td>
<td>In the entrepreneurial sectors most of the tasks require efficient teamwork since the workload is large and impossible to be executed by a single individual. DesignIT enables students to experience diverse situations, be receptive to others’ idea, and think out of the box. In relation to customers, students learn to emphasize with them and their demands. Since customers are the recipients of the end-product, they should be fully-satisfied. DesignIT fosters collaborative learning since students try to explain one another their ideas, they brainstorm, and they integrate new knowledge through cooperation.</td>
</tr>
<tr>
<td>Dependence:</td>
<td>LR-S01, LR-S02, LR-S03, LR-S04, LR-S05.</td>
</tr>
<tr>
<td>Interdependence:</td>
<td>LR-P08.</td>
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**ID: LR-S07**

<table>
<thead>
<tr>
<th>Title:</th>
<th>Student responsibility for learning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Students are in continuous contact with customers in order to understand customer needs. The information obtained through this interaction should be further...</td>
</tr>
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</table>
discussed among students as they apply the various stages of the design thinking approach. Students are responsible for their collaboration, their discussions, and the outcomes of their solutions.

Justification: DesignIT makes the students responsible for learning. They choose the way they want to interact with the customers; moreover, they choose the methods they want to implement through every design thinking stage. They become familiar with design thinking and how this applied. Given that design thinking is an active approach, students undertake responsibility for their effective participation in related active learning activities.

Dependence: LR-S01, LR-S02, LR-S03, LR-S04, LR-S05, LR-S06, LR-S07
Interdependence: LR-P04, LR-P06, LR-P07, LR-P08, LR-P09, LR-P10.

ID: LR-S08
Title: Support ideas that lead to their design.
Description: Students learn how to make their case about ideas and solutions that they suggest. They become self-confident and get prepared for the fact that others maybe adopt their opinion or reject it. They learn not to be afraid to express their viewpoints and be courageous.

Justification: This is a very significant qualification for their future
career since they will be prepared to develop a reasoning in order to persuade others that their viewpoint is more beneficial; this does not cancel the spirit of collaboration, but it sets the foundations of a healthy conversation among students as well as between students and customers. This trait is essential in entrepreneurial realms.

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<thead>
<tr>
<th>ID: LR-S09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title: Introduction to design processes.</td>
</tr>
<tr>
<td>Description: Via this DesignIT gamified learning environment, students prepare to deploy broad design processes. Design thinking is an approach that is implemented in real-world design scenarios. Students learn how design thinking works and through design thinking get exposed to design processes in general.</td>
</tr>
<tr>
<td>Justification: DesignIT gives the students the opportunity of experiencing the industrial and the business sector. They learn about the five stages of the design thinking process by implementing them in practical situations. This experience is essential for entering the workplace. It builds self-confidence through active participation.</td>
</tr>
<tr>
<td>Dependence: LR-S01, LR-S02, LR-S03, LR-S04, LR-S05, LR-S06, LR-S07,</td>
</tr>
</tbody>
</table>
### Interdependence:
- LR-S08.
- LR-P04.

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<thead>
<tr>
<th>ID: LR-S10</th>
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</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>Learning in a supportive and harmonious environment.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Students feel secure in virtual learning environment and game-based learning processes. They have the opportunity of experimenting and learning in a virtual context that simulates the real world. There is no risk of poor judgements or underachievement.</td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>DesignIT encourages students to develop self-confidence and self-control. They understand the difficulties they will face in their future career; they become mature in terms of staying focused in the face of difficulties.</td>
</tr>
<tr>
<td><strong>Dependence:</strong></td>
<td>LR-S01, LR-S02, LR-S04, LR-S05, LR-S06, LR-S08, LR-S09.</td>
</tr>
<tr>
<td><strong>Interdependence:</strong></td>
<td>LR-P01, LR-P06.</td>
</tr>
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### ID: LR-S11
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<tr>
<td><strong>Title:</strong></td>
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<td><strong>Description:</strong></td>
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</tbody>
</table>
issues and after synthesizing the necessary information, they can ideate without being judged about their ideas.

**Justification:**
Creative thinking is a key qualification in entrepreneurial realm; The DesignIT gamified learning fosters innovative thinking and allows the students to ideate as much as possible; having no fear of poor judgement, the best solutions can emerge for the end-product.

**Dependence:**
LR-S04, LR-S08, LR-S10.

**Interdependence:**
LR-P05, LR-P08.

---

**ID: LR-S12**

**Title:**
Preparation of their transition into the workplace environment and promotion of employment.

**Description:**
Students need to be guided towards building design thinking skills that will equip them effectively to their future transition in their workplace.

**Justification:**
Students feel ready to start their career, not only by having experienced a simulated working environment and many possible scenarios, but also by overcoming difficult situations which cause them stress and anxiety in real-time. Furthermore, they learn from a young age the necessity of employment; they grasp the idea that having a career means to be responsible, punctual, decisive, open-minded, adaptable, and commu-
<table>
<thead>
<tr>
<th><strong>ID:</strong> LR-S13</th>
<th><strong>Title:</strong> Running on all platforms.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> This serious game can be used in the popular platforms.</td>
<td></td>
</tr>
<tr>
<td><strong>Justification:</strong> Practicality is one of the most important factors which leads to success; DesignIT is portable and can be used without any obstacles. When they feel that they need to take a break, they can play this game and can entertain themselves and develop skills at the same time.</td>
<td></td>
</tr>
<tr>
<td><strong>Dependence:</strong> None.</td>
<td></td>
</tr>
<tr>
<td><strong>Interdependence:</strong> LR-P10.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ID:</strong> LR-S14</th>
<th><strong>Title:</strong> Exploitation of synergies.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> DesignIT deploys synergies between the higher education community and the entrepreneurial sector in order to provide students with content that addresses to real-life contexts.</td>
<td></td>
</tr>
<tr>
<td>ID: LR-S15</td>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>Justification:</td>
<td>DesignIT and digital technology in general offers opportunities to modernize higher education practices through complementary to existing curricula activities. In addition, DesignIT can contribute to the modernization of curricula through the introduction of innovative design thinking approaches into entrepreneurship education.</td>
</tr>
<tr>
<td>Dependence:</td>
<td>LR-S01, LR-S02, LR-S04, LR-S07.</td>
</tr>
</tbody>
</table>

| Title: | Inspiring students to become active and civic-minded via social-entrepreneurship. |

| Description: | DesignIT teaches design thinking principles in a way that raise their awareness towards social issues. Students get informed about social issues that they otherwise might ignore because of their young age. They become sensitive and try more to find the best solution in order to help people in need. |

<p>| Justification: | Students play an active role in the society; by brainstorming they struggle hard in order to succeed in dealing with social problems. The design thinking process does not only teach them how to build solutions, but also how to empathise and have the desire of helping individuals or groups in need. This challenges them to be sensitive and active members of society doing their best to contribute to the well being of their communities. |
| Dependence: | LR-S01, LR-S04, LR-S06, LR-S07, LR-S13. |</p>
<table>
<thead>
<tr>
<th>ID: LR-S16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong> Providing viable solutions towards real market and social needs.</td>
</tr>
<tr>
<td><strong>Description:</strong> A gamified learning environment challenges students to apply end to end the design thinking process until they reach an effective solution. Students learn how to see a problem to completion.</td>
</tr>
<tr>
<td><strong>Justification:</strong> DesignIT takes students through the five stages of the design thinking process, supplies them with the appropriate design thinking skills, and empowers them to become independent and come up with the best solution for each social issue in discussion. Students understand the necessity of providing viable solutions through their communication with the customers; students feel that they are successful, helpful members of society. They become active citizens by addressing social and business issues.</td>
</tr>
<tr>
<td><strong>Dependence:</strong> LR-S06, LR-S07, LR-S11, LR-S15.</td>
</tr>
<tr>
<td><strong>Interdependence:</strong> LR-P05.</td>
</tr>
</tbody>
</table>

### 10.2 Skill building requirements for instructors

In addition to targeting students, DesignIT targets educators. It informs educators of the importance of design thinking as an innovative entrepreneurial methods and provides them with good practice guidelines in order to support them in the introduction of design thinking into classrooms.

Following is a description of skill building requirements for educators:
<table>
<thead>
<tr>
<th>ID: LR-P01</th>
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</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>Ability to integrate new methodologies into courses.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Educators build a plan for teaching a course and strive to stay with a foreseen timeline. They are in need of building their capacity to apply emerging methodologies, such as design thinking, in order to better prepare students to enter the world of work.</td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>Instructors are in need of good practice guidelines on how to best integrate design thinking methodologies. DesignIT addresses this need by providing instructional support content.</td>
</tr>
<tr>
<td><strong>Dependence:</strong></td>
<td>LR-P02, LR-P04, LR-P05, LR-P10.</td>
</tr>
<tr>
<td><strong>Interdependence:</strong></td>
<td>None.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: LR-P02</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong></td>
<td>Raising awareness of the need for integrating ICT into higher education in alignment with the needs of the entrepreneurial and social-entrepreneurial sectors.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Educators can benefit from the deployment of ICT, and more specifically serious games in the context of the educational offerings. These methodologies allow students to learn in an active manner that will allow them to learn throughout their career, staying at the cutting edge of innovation for their sector.</td>
</tr>
<tr>
<td><strong>Justification:</strong></td>
<td>Educators need to inspire students to be open-minded and receptive to new tools or approaches that exploit ICT</td>
</tr>
</tbody>
</table>
as a learning tool. Furthermore, educators need to empower students to experiment in virtual environments that simulate the work place. This approach helps students to become prepared for their future career and to be adaptable to change.

| ID: LR-P03 |
| Title: Understanding the necessity link theoretical knowledge to business practices. |
| Description: Educators should perceive that learning approaches based theory are fundamental. At the same time, theoretical teaching should be accompanied with practical applications linked to real world needs in order to lead to a deeper understanding of acquired knowledge. |
| Justification: DesignIT facilitates the applicability of the newly developed knowledge and promotes awareness among students that in their future careers they will be challenged to apply knowledge developed during their in actual scenarios. In other worlds, DesingIT empowers students to deploy knowledge towards introducing solutions to real world problems. |
| Dependence: LR-P05, LR-P09, LR-P10. |
### Interdependence:
| ID: LR-P04  | Description: Educators are in need of building their capacity to develop high level knowledge in demand in the workplace by engineering graduates. They are in need of employing emerging pedagogies, strategies, and technology towards enriching educational experiences for their students and better addressing learning objectives in line with industry needs. |
| ID: LR-P05  | Justification: Design thinking approaches offer broad educational benefits as they engage students in practices that empower them to address the needs of end users when designing solutions to business or social issues. DesignIT introduces an active learning framework which, combined with a gamified learning service, builds the skills of students to be highly effective as solution designers. |

### Dependence:
**LR-P01, LR-P05, LR-P07, LR-P08, LR-P10.**

### Interdependence:
**LR-S02, LR-S04, LR-S07, LR-S09.**
### Description:
A vast majority of educators keep on using their old and success-proven methodologies and stay focused on them. They may be reluctant to deploy new and innovative approaches, which usually integrate technology. As a result, their methods may lag behind students' modernised interests, and this may contribute to the students' lack of focus in their studies. Educators are in need of building their self-confident and skills towards deploying emerging learning design in order to turn their existing well developed practices to exceptional ones.

### Justification:
DesignIT enables educators to have a better insight of what students need to learn and experience in order to succeed in their future careers. The proposed gamified learning framework for building design thinking skills breaks the mould and exploits state-of-the-art technologies within innovative active learning approaches. Students learn that they should be creative and innovative in order to synthesize viable and successful solutions in their businesses.

### Dependence:
- LR-P01, LR-P02, LR-P03, LR-P04, LR-P08, LR-P10.

### Interdependence:
- LR-S11, LR-S16.

<table>
<thead>
<tr>
<th>ID: LR-P06</th>
</tr>
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<tbody>
<tr>
<td><strong>Title:</strong> Cultivating critical thinking among educators.</td>
</tr>
<tr>
<td><strong>Description:</strong> Educators are responsible for providing their students with the best and most efficient learning methodologies</td>
</tr>
</tbody>
</table>
with the objective of empowering students to acquire the appropriate knowledge for succeeding in their future careers. In order to build effectively student skills, educators are themselves in need of critical thinking skills.

| Justification: | Educators decide which learning approaches are suitable for the students' needs and introduce students to enterprising patterns. Design thinking is a methodology that promotes critical thinking among both students and educators by encouraging analysis of user needs, definition of problem statements, and synthesis of effective solutions. |
| Dependence: | LR-P02, LR-P08, LR-P09, LR-P10. |
| Interdependence: | LR-S03, LR-S07, LR-S10. |

**ID: LR-P07**

**Title:** The need for career advancement, satisfaction, and capability of innovating in the classroom.

**Description:** Educators, like every other professional, are in need of making continuous progress in their careers. Career satisfaction is important as it is a motivating factor for educators to stay active in their profession and to strive to enrich their skill sets and teaching. Building professional knowledge throughout their careers is key to career satisfaction for educators, as is of course for other professionals.
<table>
<thead>
<tr>
<th>Justification:</th>
<th>Educators should understand that self-development provides them with a variety of advantages. Through DesignIT, they will understand the need of their continuous development. They will broaden their horizons, and their students' as well, since educators' success is reflected on student success. By deploying emerging active learning design combined with gamified learning approaches, educators will develop of sense of career development and satisfaction as a result of delivering high quality education to their students.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependence:</td>
<td>LR-P02, LR-P04, LR-P08, LR-P09, LR-P10.</td>
</tr>
<tr>
<td>Interdependence:</td>
<td>LR-S04, LR-S05, LR-S07.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID: LR-P08</th>
<th>Creating a know-how exchange network for educators.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>DesignIT supports and promotes the development of a community of educators through which participants can exchange good practices towards collectively building their skills.</td>
</tr>
<tr>
<td>Description:</td>
<td>In terms of introducing emerging pedagogies and technologies into instructional practices, educators can greatly benefit from exchange of knowledge with peers and the sharing of successful practices. Through sharing they can become aware of what works best in given educational situations. They can further exploit knowledge offered by others and elaborate ideas to adapt them to diverse learning scenarios. DesignIT</td>
</tr>
</tbody>
</table>
promotes the development of good practices as through the proposed gamified learning framework educators and students will have the opportunity to review and evaluate the ideas of others towards finding optimal solutions that best address the needs of end users.

Dependence: LR-P02, LR-P04, LR-P05, LR-P06, LR-P07.

Interdependence: LR-S04, LR-S05, LR-S07, LR-S06, LR-S11.

<table>
<thead>
<tr>
<th>ID: LR-P09</th>
<th>Evaluating students’ newly developed knowledge in correlation with educational goals.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Educators are in need of evaluating the results of emerging educational design in terms of best addressing specific educational objectives.</td>
</tr>
<tr>
<td>Description:</td>
<td>Educators will use DesignIT in relevant courses. They will encourage students to apply new knowledge in practical situations inspired by real world problems. The effectiveness of students’ solutions will be an indication of the level of success of the proposed design thinking methodology as a means for better addressing today's business and social challenges. Information gathered through the proposed gamified learning framework related to student engagement will further act as feedback on whether the proposed design thinking approach achieves the desired levels of student motivation and participation in the learning process.</td>
</tr>
</tbody>
</table>
The environment may also be used as a self-evaluation tool for students, who will be able to view information on how their ideas impacts others.

### Dependence:
- LR-P02, LR-P03, LR-P06, LR-P07.

### Interdependence:
- LR-S04, LR-S07.

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<thead>
<tr>
<th>ID: LR-P10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong> Educators’ skills development on integrating design thinking into their practices</td>
</tr>
<tr>
<td><strong>Description:</strong> By applying design thinking in their courses, educators exploit emerging design patterns to modernize their instructional practises in order to make them more attractive and effective for the students. Through design thinking educators reach students more effectively, empathise with student needs, and provide them with the valuable knowledge in demand by the industry.</td>
</tr>
<tr>
<td><strong>Justification:</strong> The DesignIT gamified learning environment for building design thinking skills empowers students to become effective designers and to build in demand entrepreneurial skills. It underscores the importance of human centric solutions and of processes that ensure that user needs are effectively addressed in service or product design. It empowers students to be creative thinkers, which is an important skill towards addressing the significant challenges that humanity faces, including poverty, unemployment, effective natural resource management, access to education and health services</td>
</tr>
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</table>
for all, and other emerging issues of the 21st century.

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<tr>
<th>Dependence:</th>
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<td>LR-P01, LR-P02, LR-P03, LR-P04, LR-P05, LR-P06, LR-P07</td>
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<tr>
<th>Interdependence:</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR-S01, LR-S02, LR-S04, LR-S07, LR-S12</td>
</tr>
</tbody>
</table>
12. **LEARNING DESIGN APPROACHES FOR BUILDING DESIGN THINKING SKILLS**

This section provides an overview of learning approaches that are relevant to the development of design thinking skills. The section first discusses how design thinking is deployed in business in education. It then analyzes problem-based, case based, and constructionist learning frameworks that will be integrated into the DesignIT learning methodologies, which are presented in the following section.

11.1 **Deploying design thinking in business and in education**

Design is applied in broad sectors, ranging from science to art and humanities. Design is a solution-based approach, which provides problem shaping, synthesis, and the development of appropriate solutions that fit in the world’s requirements [53].

11.1.1 **Design thinking in business**

Design plays a key role in the entrepreneurial sector, either for developing innovative business solutions or for teaching industry professionals how to apply innovative methods in their practices. Tim Brown (CEO of IDEO), argues that design thinking leads to a competitive advantage, which enables professionals be “masters of the art” [55].

In the past designers were only engaged in the latest stages of the product development processes, in order to make look more attractive, easier to use, and fit for sale. Design served the needs of materialism for many years, but this changed thanks to design thinking. Design thinking creates a harmony among technical applicability, attractiveness, and financial sustainability; design thinking skills enable businesses to connect their brands with innovation, creativity, and release their products faster in market [55].
### 11.1.2 Design thinking in education

Design thinking is deployed for re-engineering educational curricula to best address student needs [56]. According to Razzouk (2012), there are three ways for design thinking to be implemented in education: 1) as a problem-solving method to help administrators deal with issues of the institutions; 2) to educators to build more creative lesson planning; and 3) to inspire students to build design thinking skills.

The link between design thinking and education is analysed in research [57]. Some initiatives include:

- The REDLab group, from Stanford University’s Graduate School of Education [58]

- The Hasso Plattner design thinking Research Program’s, a cooperative program between Stanford University and Hasso Plattner Institute from Potsdam, Germany [59]

- SPJIMR, a top B-school in India [60]

Furthermore, design thinking addresses the needs of educators, who seek to modernize their teaching practices. Design thinking can introduce innovation in the classroom, engage students, and lead to the achievement of educational objectives.

Given the benefits of the design thinking approach, several universities and colleges organise workshops, courses, degree programs, or supplementary training for students in the area of design thinking [73]. Some are: Stanford University, University of Kentucky (dLAB), Radford University (provides an MFA, Master of Fine Arts in design thinking), Johns Hopkins University Carey Business School, and the Maryland Institute College of Art (both provided a MBA/MA in 2012 that addresses to design leader-
ship). Following are some examples of the deployment of design thinking at the tertiary level:

- **Practical guidelines for design thinking at universities without proper facilities**: design thinking can also be applied to universities which do not have the appropriate equipment, such as tools, facilities, and environments. Design thinking sessions can succeed when there is even a Shoestring Budget [67][68]

- **AIGA** [69]; this is a professional association on design. AIGA consists of volunteers who are passionate with design. They developed a movement, named “DesignEd K12”, which promotes design thinking. Volunteers visit schools and motivate students to use design thinking as a problem-solving method. These volunteers either mentor students who seem to be interested in designing or motivate them to take part in design thinking projects; in this way they learn how to use design thinking process and AIGA organises a design network, which includes students, designers, and professionals in education [70].

Despite the development of the design thinking spread in universities and schools, there are still some important obstacles, which make it difficult for schools to apply the design thinking process, one of the is the accountability; this means that many educators believe that successful education can only be the result of following standard curriculum. This fear of innovation and creativity is a main obstacle of the design thinking implementation in education. Another obstacle is the widespread belief of the academic community that design thinking is a process that belongs only to enterprising companies [72]. What is more, some educators lack of awareness, or confidence in order to start using new
methods of teaching; last but not least, in many schools there is no institutional support and no guidance.

### 11.1.3 Design thinking in teaching and learning through ICT

There is a wide range of difficulties that educators and students face in educational contexts that deploy ICT as a learning tool [73][74]. Design thinking can help educators that deploy ICT to succeed in their educational initiatives [74][75][76][77]. Through the design thinking lens, teaching with ICT can be viewed as deploying and evaluating a variety of solutions towards finding the most suitable one [77][78]. The search for beneficial, ICT-powered learning offerings may engage not only educators but also other stakeholders. Design thinking can offer benefits in this process, as it promotes empathising with students and educators, designing, and evaluating prototypes of learning processes until educational objectives are met.

### 11.2 Problem-based Learning (PBL)

Problem-Based Learning (PBL) focuses on trial-error and investigation processes which enable the user to deal with complicated real-case scenarios. Problem-based learning was first described by Anderson (1977), who argued that learners should be in a simulated environment within a realistic context so as to acquire knowledge in an effective way. Through problem based learning, students can learn from peers. They can also consolidate knowledge through a discussion that may following learning sessions. Research (Barrows, 1986, Savery & Duffy, 1995) [178][179] defines PBL as a successful methodology in higher education, which offers advantages as follows:

- It focuses on problems of a particular thematic area.
- It involves open-ended problems that foster creative thinking
• It supports not one single answer, but a variety of answers to a given problem

• Students have the chance to feel as researchers and real problem-solvers in an active mode.

• Students as problem-solvers cooperate with others and organise teams through which they identify the key problem and they come up with effective solutions.

• Teachers are the supporters of the learning process, by encouraging learners and motivating to do research.

In PBL teachers do transmit knowledge. Rather, students are engaged in a process through which they discover the knowledge themselves through the following steps:

• Learners focus on a specific problem

• Learners brainstorm to define the parameters of the problem

• Learners define the problem itself

• Learners build a primary model through brainstorming and by using their experience, thus activating knowledge

• Learners identify the necessary information they need for working on the given project

• Learners learn how to reason

• Learner build a coherent action plan which provides the appropriate solution; the action plan may involve researching the Internet, libraries, databases, or interviewing individuals

• Learners come together and exchange information as well as to collaborate on the problem
Finally, learners present and discuss their solution and review what they have learned from the process.

PBL promotes lifelong learning through the process of inquiry and “construction of knowledge”; such constructivist approaches emphasize equally cooperative and self-directed learning under the coordination or a “more experienced other” (Bodrova & Leong, 1996) [180].

11.3 Constructivist learning

Constructivist learning is an approach to teaching drawing from the work of Dewey, Montessori, Piaget, Bruner, and Vygotsky among others. Constructivism shifts behaviourist educational models to education-based on cognitive theory. The cornerstone and epistemological assumptions of "constructivist learning" are:

- Learners construct knowledge in real terms every time they get involved in “hands-on”, active learning contexts.

- Learners build their knowledge; every step they make can be considered as a symbolism to their own representation of action.

- Knowledge comes from interaction, collaboration and the effort to (self – other) adjust knowledge.

- Knowledge is “invented” by learners every time they look for people who are experienced in the specific context.

11.4 Case-based learning, experiential learning, active learning

Case-Based Learning (CBL) is an approach is similar with PBL; it has to do with factual-based problems that are introduced in the classroom and fires up discussion and analysis; the situations the students face are realistic, and they learn how to discuss, analyse, explore ways of facing a given problem. This approach is also applied in law, medical sciences, and
business school, and CBL is also a subcategory of artificial intelligence [79]. Teachers play the role of the facilitator and are the ones who encourage students to keep on with this process; students try to build a solution by identifying the exact problem, use their background knowledge, experience, and principles, and combine the above with the given story. They get familiarized with understanding the characters of each story, asking questions, standing-up for their opinions, and trying to compromise in order to get to a solution. Furthermore, they learn how to prepare strategies in order to analyse the given data and come up with solutions. Last but not least, CBL is a student-centred methodology which teaches students how to acquire decision skills, build self-confidence, and prepare themselves to deal with problems.

**Experiential Learning**: this approach is far from the traditional learning approaches; it supports that students can learn something effectively, not by learning it by heart, but through actual participation. It is linked to active learning. According to Aristotle (350 BCE), "for the things we have to learn before we can do them, we learn by doing them" [81]. Experiential learning encourages students to take part in the process of acquiring knowledge; students build analytical, decision-making, and problem-solving skills.

**Active Learning**: this is a very innovative learning approach, as well, invented by the English scholar R W Revans (1907–2003) [181]. Active learning practitioners advocate that students learn effectively when they take part in the learning process, instead of listening to educators passively; students should learn how to read, write, discuss topics, and take part in solving existent problems. Active learning is related to the three pillars of the learning process, namely Knowledge, Skills, and Attitudes (KSA). Analyse data and information, synthesize a solution, and explain their solution to others. Students learn to do things, and think about what they are doing [82]. This approach can be characterised as learner-centred. Describing
the nature of active learning, it can be argued that it is “purposive, negotiated, reflective, complex, critical, engaged, situation-driven, and it lies upon a constructivist framework”. Last but not least, there are many effective active-learning exercises, which will be mentioned only by name, due to brevity: classroom discussion, learning cell, think-pair-share, short written exercise, student debate, collaborative learning group, small group discussion, reaction to a video, class game, gallery walk, and learning by teaching.
13. THE DESIGNIT PEDAGOGICAL LEARNING FRAMEWORK

Tim Brown the CEO of the design agency IDEO is often mentioned to be the establisher of design thinking. However, the roots of design research on design thinking issues date back to 1960 (Simon 1969) and 1980 (Schön in 1983) [161][163][164]. Thus, we have wanted to establish a framework that takes into account the research executed before as well as the well-known IDEO and Stanford university design thinking methods.

The developed framework is a combination of three dimensions: Practice, cognitive, and mind set (see Hassi & Laakso 2011 and 2011a) [162]. Practice dimension is important because it provides the means for methods and practices. It is closely related to what occurs in companies currently. Our approach has adopted tools and lean service creation canvases from design companies such as Futurice and Gofore. Theoretically this dimension builds on human-centred approaches (Norman 2010), thinking by doing (Schön 1983) and collaborative work style (Paavola & Hakkarainen 2014, Seitamaa-Hakkarainen & Hakkarainen 2001, Rylander 2009, Brown 2009 and Sato et al 2010).

The cognitive dimension stands on the research of thinking manners – especially on the research of creative thinking. Our main basis is on abductive reasoning (Paavola 2015, 2015a, Lockwood 2009, Dew 2007) and hands on research on thinking and doing by Seitamaa-Hakkarainen et al (2014). Abductive reasoning provides means to understand how to support creative activities in an appropriate environment.

Ideation, creative thinking or in other words coming up with ideas out of the box requires the following activities and characteristics:

- Searching anomalous, surprising, or disturbing phenomena and observations.
• Detecting details, little clues, and tones.

• Continuous search for hypotheses and understanding their presumptive nature.

• Aiming at finding what kind or type of explanations might be viable for scoping the challenge

• Aiming at finding ideas which can be explained or rather be experimented if they work

• Searching for “patterns” and connections that fit together to make a reasonable unity.

• Understanding and paying attention to the process of discovery – its different phases. (Paavola 2014)

The last dimension mindset, means the way/orientation/ attitude problems and challenges are approached. The orientation includes characteristics such as: being able to stand uncertainty, willing to learn from mistakes and being emphatic. These characteristics are learnable. (Cooper et al. 2009, Drews 2009, Hassi & Tuulenmäki 2012 and Mattelmäki & Battarbee 2002).

Pedagogical approaches that exercise problem-based learning, project-based learning and inquiry-based learning are well fitted into design thinking mentality (Dym et al. 2005). These learner-centred approaches increase students’ awareness about good design processes but the courses need to be designed to include: generation of ideas/solutions, receiving support e.g. “on-going feedback about the feasibility of various solutions by providing multiple and varied opportunities to design and create prototypes, experiment with different ideas, collaborate with others, reflect on their learning, and repeat the cycle while revising and improving each time” (Razzouk & Shute 2012: 343). In our design process of the game, we have kept these guidelines as our backbone for the game.
Next, DesignIT project’s phases of designing the game for design thinking early stages of scoping, field studies, analysis, ideation and validation of concept are described as an example of our framework.

**First phase** was the kick off meeting. Members of the project described how they understood the topic of design thinking and what the goal should be for the serious game. After which, we discussed what kind of constraints, values and gaps there might be in creating such a game for students and teachers (see e.g. Tran 2017 and IDEO 2013). The sharing of thoughts, discussing on constraints and assumed game ideas lasted 2 hours. Discussion on how the game was seen to be used pedagogically lasted another 2 hours. Participants of the sessions varied from 6 to five out of which 4 persons teach in regular bases in higher education.

The activity to share understanding and scoping the topic is important for the creative and abductive thinking. As mentioned above, being able to contextualize and use indices (find clues) is essential (Paavola 2014). The session of discussion amounted into two documents drafting the potential idea of the game to be created – a draft concept of the game.

**Second phase** consisted on detecting gaps and constraints we had found in the phase one and which needed further investigation. We could have used the Data Canvas (number 3 in lean service creation: https://www.leanservicecreation.com/canvases) from Futurice to document our gaps and what data we have and miss. However, we had strong consensus of the data needed. Thus, we proceeded directly to the field study for gaining information on students needs. We executed short (10-15 min) interviews with 24 students for understanding their attitudes towards different kinds of games and needs on how to support design thinking in the early phases. We selected users by their availability but more importantly we attempted to interviews those students who belong to the extremes –
they play game a lot or they do not play games at all (see Futurice Lean Services and Tran 2017). Our previous experiences showed that early phases were the most critical. This was confirmed during the interviews. The outcomes from notes were documented into excel to be able to categorise the comments directly.

In summary, the main issues we wanted to know is what kind of game would be good from students’ perspective. The game they preferred was something that supports, guides and provides feedback for them. It allows completing tasks that are needed and go forward in their team projects. They (20 of 24) preferred mobile games to simulation games, especially over desktop simulation games. Requirements specifically mentioned were: Help and guidance for selecting appropriate methods to be used in the fieldwork; The students wanted to receive feedback through the game, on how they have done in the field studies, in analysing data from the field and so forth; The game should be simple, not too many choices or preference setting – a clear path to go; A chat bot to help in “emergency” situation, or if chat bot is too hard to create a channel to an expert who could answer questions; Students who had played serious simulation games did not have positive experiences (note this might be one reason why these particular students did not want a simulation game), since “the things did not stay in the mind”, and “it felt useless”. The actions executed in the phase 2 conform to IDEO approach of phase one, step two (prepare research: elect research participants, prepare for fieldwork (IDEO 2013:29).

In the Third phase, a new workshop and brainstorming session was organised with teachers for organising information acquired in the interviews and to further design the game in selected courses at Metropolia UAS. Session lasted 3 hours. In the first hour participants got acquainted with the material and organised it, second hour was used to draw sketches of the potential flow of the game and the third hour was spent on cleaning the
drafts so that they could be used as tangible material in workshop with students. The outcome can be found from: 
https://drive.google.com/open?id=1Xp2lWs6hOWpHuDjcX1g5Zq01R0o0opCg

While working on the game idea and flow of the game, it was noticed the game features were described but not the gamified aspects of the game. Thus, we needed a workshop where we could acquire insights on what kind of gamified features and functions students see worthwhile and engaging. Before starting the workshop design, we wanted to visit a workshop organised by Futurice to get inspiration on how the companies execute design thinking (see the guidelines provided by IDEO 2013:29 in using design thinking especially the phase 1 and step two prepare research: identify sources of inspiration, e.g. by learning from experts). This phase also complies with the iterative and collaborative work processes for knowledge creation (see Paavola & Hakkarainen 2014, Seitamaa-Hakkarainen & Hakkarainen 2001). Learning together and explaining ones thinking, namely expressing thinking processes, are known to be beneficial in design work (Hassi, Paju & Maila 2015 and Razzouk & Shute 2012).

Fourth phase consisted on getting inspired by participating a workshop organised by Futurice. Futurice is a design company who provides design thinking, service and application design. Futurice has offices in Helsinki, Berlin, London, Tampere, Stockholm and Munich. It was founded in 2000, has 400+ employees from 22 countries. In last 8th years the profitable growth – Year Over Year growth is 30%.

In the workshop, the early phases of design thinking were covered using various lean service creation canvases (Sarvas, Nevalinna & Pesonen 2017). The workshop presented the current methods and tools creative companies use. We also learned that the future direction is increasingly
towards lean service creation with design thinking attitude. Service design is increasingly taken as means for sustainable societal transformation (Sangiorgi 2011). The future direction, tools and methods adhere to what other companies such as Gofore exercise. Gofore is situated in Helsinki, Jyväskylä, Tampere, Munich and Swansea. It was founded 2002, has 350+ customers. Both companies are potentially willing to validate the game developed in the DesignIT project from business perspective – how accurately it represents their working methods, and would they see students learning essential skills when using the game.

Based on what we learned in the workshop, we planned a workshop for students to contribute to the game design, especially in designing the gamified aspects of the game. Next, we will describe the workshop and summarise the results of it.

**Fifth phase** consisted of planning and executing the workshop, organising workshop results and communicating these to the project. The workshop was organised in similar manner than the one we took part in Futurice. Two student teams (4 team members per team) were selected to take part in the workshop. The teams were randomly selected. The workshop had the flow of the game (se phase 3) drawn in black board and printed in an A3 canvas. The black board presentation had, in appropriate places of the game flow, the lean service creation canvases that were planned to be used in the course. The canvases used were: Canvas 3 (Data) in data collection, Canvas 5 (Insight), Canvas 6 (Ideation), Canvas 7 (Concept and value proposition), Canvas 8 (Profiling concept) in ideation, designing the concept and Canvas 9 (Fake advertisement) and Canvas 10 (Validation) in validation. Students were explained the flow of the game and that we would like them to comment the flow and especially invent game features that they think would help them to be engaged and learn. The students were asked to use post-its for describing the game elements and other
ideas/comments and place them to the backboard into the spot where they thought the elements should be (see figure 1).

Figure 29. The canvases and flow of the game are presented in tangible form that allows easy movement around. The zoomed parts displays some of the post-its placed by the students.

Briefing and asking clarifying question was executed on the spot in the workshop. We did not want to keep the students too long away from their courses, which a separate briefing would have demanded. Two teacher researchers were guiding the workshop and collecting the data. Notes and photos were taken as well as sample audio recordings of the lengthier discussions between students. The workshop lasted about 2 hours. The workshop setting was similar to IDEO, design thinking for educators: learn from users (2013:35) settings are. However, we attempted to go beyond learning from users by engaging users so that the users would design elements for us. We paid attention to such issues as: enabling users’ physical movement, providing tangible objects and actions as well as easy pointing, namely, to easily use indices. These issues help sharing of ideas and understanding each other, which enables successful workshop (Bau ters 2017) [159].
The data, namely, post-it comments were collected and categorised into the game flow. The categories emerging from the data are: discard (these comments were going beyond the current game), general (these comments were the game rules/components out of which the game structure forms), fieldwork reviews (components how to execute the peer review of fieldwork items) and reviews of canvases as well as providing points for the validation canvas. Together when similar comments have been merged, we received 31 ideas how to gamify the design thinking early processes of scoping, learning in the field, analysing field results, ideation and validation of concept. The game flow and the students’ ideas are presented in the figure below and can be accessed from the link:

https://www.draw.io/#G1vCdF3Lb0WIX5bZLy68h38Ch2hVpvMnmD
Figure 30. The flow of the game and student comments is displayed. Green boxes indicate the actions executed in the system; grey boxes indicate the actions exercised partially in the system and elsewhere; orange boxes indicate the actions executed outside the system. Click to zoom and see in details.
The comments from students were (in no particular order of preference):

General game structural ideas:

- Provide certain amount of points in the start of the game so that these can be used in the game.
- Losing game for not recognising problems (problem log)
- Buy (using points) access to other teams’ canvases for inspiration
- Points can be used to buy ideas, expert opinion, support etc.
- Buy access to experts
- Create a problem log in which problems of the idea/challenge are listed. Points provided by amount of found problems and how many were solved.
- Knowing order of teams, but not the exact score (who is in front of you).
- Sell your data to other teams to get points
- Help other teams in order to get points
- Add mini games and contests for the teams
- Points managed by phases, different phases to have different amount of points
- Size of the team affects the way points are gained
- Users need enough points to move to the next phase/level of the game
- Results illustrated by colours, based on different parameters
- Points per module/level based on the time team needs to finish them

Gamification related to fieldwork:
• Pre-defined area for field research - progress/insight graphic illustration - support for selecting field research methods - guidance

• Chat bot (experts) also help with choosing the suitable canvas

• Some canvases are forced to be used, while others can be selected by the team.

• Rankings based on the reviews, some parts can go bad, some go good.

• Recommendation by peers what parts to use of the data

• Feedback needs to say how things are good.

• Deadlines to upload the data, canvases and then visible to all

• Peer evaluations visible.

Gamification related to validation:

• Gain points by making own images instead of using existing ones when filling in the canvases especially the fake advertisement canvas

• Create own logo instead of existing one

• Using social media to promote idea and validate it, would give additional points.

• Finding sponsors or potential partners gives extra points.

• Fake advertisement canvas judged by other teams - order excluding your own canvas.

• Most nice/working canvases nominated

• Extra points of making a reflection as extra argumentation of the validation part.
Assessment ideas provided by the student go well with those suggested by researchers. Characteristics that show expertise in design work are according to Razzouk & Shute (2012: 338): ability to "mentally stand back from the specifics of the accumulated examples and form more abstract conceptualisations related to the domain expertise" [...] to recognise underlying principles rather than focussing on the surface features of problems"; [...] "question their own requirements, summarize information of the problem into requirements and partially prioritise them and do not suppress first solution ideas." Razzouk & Shute (2012: 344-355) continue suggesting to use evidence centred design from AERA (http://rer.aera.net) for designing valid performance-based assessments of 21st-century skills. ECD is said to be suited for assessments, which involve complex problems and dynamic, interactive environments. In addition, Seidel & Fixson (2013) argue that for novice teams the brainstorming should be tied closely with tangible objects, fieldwork or prototypes that allow having effective workshops. They also explain that reflection work best in the early phases but not in later ones where it tends to be an obstacle for proceeding in iterative fast prototyping manners.

The next phases are narrative description of the game and storyboard of the game, which we aim to validate with students. Then we proceed for low fidelity prototypes (see e.g. Tran 2017). An aspect that we need to take into account is appropriation. Meaning that every object of design (also our game) has to become part of existing ecologies of devices and tools, which are in the target groups' everyday lives. Already in testing phase of the game we can create strategies for appropriation so that the after the project is finished the use will continue and evolve. Even if the use would be something, we have not foreseen. (See Bjögvinstsson, Ehn, & Hillgren 2012) [160].
CONCLUSIONS

This report displayed the DesignIT methodological learning framework which focuses on contributing to the development of higher education student skills related to the design thinking process and its implementation. The framework is based mostly on Problem-Based Learning approaches (PBL), but it is also affected from Case-Based-Learning (CBL), experiential, and active learning that is implemented through serious games. The aforementioned combination aims to expose students to the design thinking process in practice, resulting in building design thinking skills for students of the higher education. The proposed framework takes into consideration the actual needs of students and educators in the higher education sector in relation to building skills that are in-demand by the entrepreneurial and social-entrepreneurial sectors. This framework acts as the basis for the development of the DesignIT learning game for building design thinking skills, which corresponds to intellectual output 2 of the DesignIT project.
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APPENDIX A: THE DESIGNIT QUESTIONNAIRE

We would like to welcome you to this DesignIT questionnaire. This is all about exploring your academic background as far as it concerns the Design Thinking approaches. Your contribution will be very important to this project. This questionnaire requires only 10 minutes of your time.

How old are you?

- 18-20
- 21-23
- 24-30
- 31-35
- 36-45
- 46-55
- 56-65
- 65+

Next
Designit Questionnaire

What is your academic background?

- Postgraduate (MSc)
- Doctoral (PhD)
- I'm currently studying at University (please refer the year) Year:

Next

Designit Questionnaire

How many courses are related to software/product development processes and methodologies in your university?

- 1-2
- 3-5
- 5+
- I don't really know

Next
DesignIT Questionnaire

Which is the preferred method of “knowledge creation” in your university’s courses? (you are able to choose more than one answer):

- Mostly traditional teaching/lecturing
- Mostly lab-based learning-by-doing activities
- Use of simulation software
- All the previously mentioned practices in blended ways

Next

DesignIT Questionnaire

Could you please rate the technical infrastructure (hardware, software, etc.) of your university’s laboratories?

- 0-unacceptable
- 1-poor
- 2-sufficient
- 3-very good
- 4-excellent

Please comment

Next
Designit Questionnaire

Are you aware of the Design Thinking approaches and practices? *

- Yes
- I think I've heard it before but I'm not quite sure what it really stands for
- No

Next

Designit Questionnaire

Design Thinking is an approach which fosters creative strategies designers utilize during the process of designing... *

- Yes
- No, not really

Next
Designit Questionnaire

According to the previous statement, which of the following statements do you think are related to the principles of Design Thinking (DT)? (you are able to choose more than one answer)

- DT is a solution-based approach which is usually applied in “wicked problems” (problems that are not well-defined)
- DT is a creative approach which is based on the expansion of ideas
- DT is a user-centric approach which focuses on the users and their needs
- DT doesn’t encourage iteration, curiosity, and constructivism
- DT encourages empathy, openness to new ideas, and it is non-judgmental
- DT uses analytical thinking
- DT fosters “thinking outside the box”
- DT can succeed only when the problems are well-defined

Next

Designit Questionnaire

Does your university offer a specially designed course that focuses on Design Thinking approaches and its practices and/or (software) development practices?

- Yes
- No
- I don’t really know

Next
Have you ever attended any?

- Yes
- No

Next

According to your personal viewpoint, have you ever attended a short course/seminar associating with Design Thinking and/or (software) development practices in your free time?

- Yes
- No

Next
What options are available in your country, as far as it concerns the training of software designers/engineers on the adoption of modern practices?

- [ ] Formal courses/workshops
- [ ] Graduate education courses
- [ ] Postgraduate education courses
- [ ] Conferences
- [ ] Individual or collaborative research
- [ ] Online communities/networks
- [ ] Mentoring
- [ ] None
- [ ] Other (please specify)
Designit Questionnaire

According to your viewpoint, which typical practices for Design Thinking should be included in the formal curriculum?

- Traditional instruction (teacher oriented)
- Traditional drill and practice activities
- Active learning scenarios inspired by everyday life incidents
- Hands-on games/constructive activities
- Digital games/applications
- Learning by doing play
- Other (please specify)

Next

Designit Questionnaire

Are you aware of the term “serious games”?*

- Yes, I know exactly what this is about
- Yes, but I’m not sure what it actually stands for
- No, I have never heard of it

Next
Serious games are digital games designed specifically for promoting playful learning and addressing specific learning objectives (Learning through entertainment). According to your viewpoint, which of the following are potential benefits of the serious games? (you can choose more than one answer).

- [ ] "risk-free" simulations of real life scenarios
- [ ] Experimentation (through role-playing)
- [ ] Digital skills development
- [ ] Collaborative skills
- [ ] Creativity
- [ ] Decision making
- [ ] Entrepreneurship
- [ ] Other (please specify)

Have you ever used serious games in university courses which are relevant with the computer science? 

- [ ] Yes
- [ ] No

Next
Designit Questionnaire

Have you ever participated in innovative learning activities in your university?

- Yes
- No

Submit

Thanks for taking my survey!