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

573965-EPP-1-2016-1-SE-EPPKA2-CBHE-JP

Enhancing innovation competences and entrepreneurial skills in engineering education

(INNOCENS)

The INNOCENS Project

Huaan Fan

Royal Institute of Technology (KTH), Stockholm, Sweden

October 2019

The INNOCENS Project

Introduction to The INNOCENS Project

INNOCENS is a Capacity Building project, funded by the Erasmus+ Programme of the European Union. It concerns development of the higher education sector within the society at large.

The project aims to enhance engineering students's innovation competences and entrepreneurial skills in order to support socio-economic development in Armenia, Belarus, Georgia and Kazakhstan. The specific objective is to develop and deliver general courses on innovation and entrepreneurship, introduce innovation pedagogy and competence assessment in teaching and learning, establish 8 innovation centres to support engineering students and staff members in commercialisation of innovation ideas.

The project consortium consists of 19 partners, with Royal Institute of Technology (KTH) in Sweden as the coordinating institution (grant holder). The project has been carried out during a three-year period, from 15/10/2016 to 14/10/2019, with a total budget of 968 567 EUR.

This introductory chapter will give an overview of the project: why this project has been persued, what key components the project consists of, how the project has been implemented and what results have been achieved.

1 Project rationale

Since the end of the Cold War, the world has experienced a profound transformation characterized by globalization of capital, goods, production, market and people. Globalization has lead to emergence of global supply chains and powerful multinational corporations, and consequently increased competition in human resources and research& development. Innovation has thus become a key tool in the global competition.

There are many challenges facing the world today. To finance high living standard and high level welfare systems, developed countries in Europe have to rely on innovation to maintain their economical competitiveness. For emerging countries like China and other Asian countries to move on the value chain, they have to be more innovative to transform labour-intensive, simple manufacturing into high-tech and high-value products and services. In resource-rich countries like Kazakhstan, innovation may lead to new business and new industries, reduce the dependency on oil and gas and create a more diversified national economy. In almost all countries, there is a need to create jobs and employment opportunities for citizens, especially the youth. While many traditional industries may have difficulty to grow significantly, new innovative ideas have the potential to new business opportunities and enhanced economical growth. The success stories of tech companies like Google and Facebook, and the e-commerce giant Alibaba are only a fewer examples of successful innovations.

After the break down of Soviet Union, Armenia, Georgia, Belarus and Kazakhstan all started a transition process from a centralized society and planning economy to democracy and market economy. In the earlier years of the new millenium, these countries experienced fast economic growth. However, since 2008 this positive trend has erupted due to domestic reasons and external factors like global financial crisis, collapse of oil and gas prices and economic slow down in emerging countries.

In Kazakhstan, low oil and gas price has damaged the oil and gas dominated economy with national currency devaluated by more than 300% in the last decade. In Armenia, GDP growth has slowed down

from pre-crisis double digits to merely 1,6% in 2015, with high unemployment rate for the general population and in particular for youth below 28. Similarly, high GDP growth in Belarus has quickly turned into a national currency crisis, due to domestic policy mistakes coupled with international crisis.

The present situation in the four partner countries calls for urgent structural reform including reforms in socio-economical policies, labour market as well as educational policy. All countries may need to increase the efficiency of large state-owned enterprises and at the same time, encourage creation of small and medium-sized enterprises (SME) to support economic recovery and job creations.

Europe has also experienced economic challenges, as a consequence of globalization and increased competition from low-cost emerging countries. A commonly accepted European strategy is to strengthen the knowledge triangle of education, research and innovation in order to facilitate a new knowledge-based digital economy. Such a new economy will produce new, competitive products and services and create new jobs and welfare for the societies. This strategy can be applicable also for the four partner countries. It can be even more important for these countries, as a solution to the present economic difficulties. In Kazakhstan, the former President Nazabaev launched "National Program on Industrial Innovation" in order to increase the country's competitiveness. In 2011, Armenian government decision No 23 adopted "Strategic Programme for Scientific Development", in which Objective 4.3 is "development of innovation infrastructure".

Unfortunately, higher education in partner countries is not well prepared to meet the needs of the countries's economic recovery. Although higher education has been at quite high level in these countries and has provided many qualified specialists for existing industries, universities have still not sufficiently understood their role in developing new, innovative enterprises. Because of Soviet influences, scientists are not actively involved in research-based business activities and scientists with successful business activities are not recognized and encouraged sufficiently by the societies.

Although there are many economics or management programmes in the partner countries, entrepreneurial knowledge and skills are not taught to the wide population of engienering students in partner countries. Consequently, most engineering students have limited or no knowledge on how to turn a new idea into a viable business. This situation has greatly limited the potential of engineering students in the society.

As an attempt to find solutions to the above challenges, the INNOCENS project consortium has been formed with 19 partners from 7 countries, including 11 universities, 4 public agencies, 3 private enterprises and 1 non-governmental organization (NGO). The main objective of the INNOCENS project is to enhance innovation competences and entrepreneurial skills in engineering education in the 4 partner countries, Armenia, Georgia, Belarus and Kazakhstan.

In concrete, the project aims to address the following issues:

- what kind of competences university students should have in order to be more innovative?
- how teaching and learning can be improved to provide students with such competences?
- what kind of knowledge and skills can turn our students into good entrepreneurs?
- How universities can help teachers and students to commercilize their ideas and become successful entrepreneurs?

Answers to the above questions will be sought through different types of project activities, such as staff training on innovation and entrepreneurship, introduction of general courses on innovation and entrepreneurship to university students independent of study programmes; establishment of innovation centers where teachers and students can receive professional support to evaluate, validate and develop rough business ideas into viable startup business.

2 Project organizations and management

2.1 Project consortium

The INNOCENS project consortium consists of 19 partner organizations, with Royal Institute of Technology (KTH) in Sweden as the coordinating institution (grant holder).

Partner organization	*Abbreviation*	*City*	*Country*
1. Royal Institute of Technology	KTH	Stockholm	Sweden
2. Turku University of Applied Sciences	TUAS	Turku	Finland
3. Polytechnic University of Valencia	UPV	Valencia	Spain
4. National Polytechnic University of Armenia	NPUA	Yerevan	Armenia
5. National University of Architecture and Construction of Armenia	NUACA	Yerevan	Armenia
6. Ministry of Education and Science	MoES_am	Yerevan	Armenia
7. Scientific Educational Reforms Foundation	SERF	Yerevan	Armenia
8. Yerevan Telecommunication Research Institute	YeTRI	Yerevan	Armenia
9. Georgian Technical University	GTU	Tbilisi	Georgia
10. Batumi State University	BSU_ge	Batumi	Georgia
11. Ministry of Education and Science	MoES_ge	Tbilisi	Georgia
12. SMART Consulting	SMART	Tbilisi	Georgia
13. Belarusian State University	BSU_by	Minsk	Belarus
14. Brest State Technical University	BrSTU	Brest	Belarus
15. Ministry of Education	MoE	Minsk	Belarus
16. Almaty University of Power Engineering and Telecommunications	AUPET	Almaty	Kazakhstan
17. Taraz State University	TarSU	Taraz	Kazakhstan
18. Bologna Process and Academical Mobility Center	BPAMC	Nur-Sultan	Kazakhstan
19. ND & Co	NDCo	Almaty	Kazakhstan

Each partner organization has a local project team (LPT) with key staff members, headed by the Local Project Coordinator. Huaan Fan from KTH has been the Project Coordinator for the whole project.

2.2 Project Management Board (PMB)

The InnoCENS project is managed by the Project Management Board (PMB) consisting of the project coordinator and all local coordinators at partner institutions. PMB is the highest decision-making body of the INNOCENS project. Its task is to initiate, plan, coordinate, manage and quality control all project activities throughout the life time of the project.

Members of the PMB (i.e. local project coordinators) are listed below.

Huaan Fan,	Royal Institute of Technology (KTH)
Tarja Åberg	Turku University of Applied Sciences (TUAS)
Luis Angel Ruiz, Israel Griol Barres	Polytechnic University of Valencia (UPV)
Varazdat Hovhannisyan	National University of Architecture &Construction of Armenia
Ruben Aghgashyan	National Polytechnic University of Armenia (NPUA)
Robert Suqiasyan	Ministry of Education and Science of Armenia (MoES)

Aram Stepanyan	Scientific Educational Reforms Foundation (SERF)
Mher Markosyan	Yerevan Telecommunication Research Institute CJSC (YeTRI),
Otar Zumburidze	Georgian Technical University (GTU)
Gaioz Partskhaladze	Batumi Shota Rustaveli State University (BSU)
Tea Tarielashvili	Ministry of Education and Science of Georgia (MoES)
Shorena Gongladze	SMART Consulting
Sergey Hvesenya	Belarusian State University (BSU)
Vladimir Golovko	Brest State Technical University (BrSTU)
Sergei Kasperovich	Ministry of Education of the Republic of Belarus
Madina Alyarova	Almaty University of Power Engineering & Telecommunications»
Elmira Faizova	Taraz State University (TarSU)
Amantay Nurmagambetov	Bologna Process and Academic Mobility Center (BPAMC)
Nurlan Jiyenbayev	ND & Co, Ltd

PMB has had three annual PMB meetings during the project period:

1st meeting:	September 2017	Turku, Finland
2nd meeting:	July 2018	Minsk/Brest, Belarus
3rd meeting:	June 2019	Tbilisi/Batumi, Georgia

2.3 International Advisory Board (IAB)

IAB consists mostly of external stakeholders from both public and private sectors. The tasks of the IAB is to strengthen university-business cooperation to promote innovation and entrepreneurship in partner countries, monitor project progress, review project results and give advices to the project consortium. IAB members are listed in the following table.

Members of the International Advisory Board (IAB)

Name	**Organization**	**Email**
Professor José Millet Roig	Vice-rector Polytechnic University of Valencia, Spain	jmillet@eln.upv.es
Mr David Songulashvili	Member of the Parliament Economic Policy Committee, Georgia	dsongulashvili@parliament.ge
Mr. Bagrat Yengibaryan	Director Enterprise Incubator Foundation, Yerevan Armenia	b.yengibaryan@eif.am
Ms. Zhanna Mustafayeva	Ministry of Investments and Development, Department of innovation technology policy Kazakhstan	zh.mustafaeva@mid.gov.kz mustafaeva87@mail.ru
Mr Aliaksei Vakulchyk	Director LLC BabyStroy, Mogilevskaya street 4, 220007 Minsk, Belarus	vakulchikaa@gmail.com

During the project period, IAB has had three annual meetings:

1st meeting:	September 2017	Turku, Finland
2nd meeting:	July 2018	Minsk, Belarus
3rd meeting:	June 2019	Tbilisi, Georgia

3 Project implementations

During the three project years, a lot of activities have been carried out to achieve the project objectives. Main activities are outlined below.

3.1 Questionnaire surveys among enterprises, students and universities

The aim of the surveys is to investigate present situations in the partner countries in the field of innovation and entrepreneurship, extract valuable information to analyse entrepreneurial ecosystems and to identify likely challenges and improvement needed.

Three main stakeholders have been surveyed:

- Enterprises: To evaluate their role in their regional entrepreneurial ecosystem and their relationships with universities.
- University students: To evaluate their entrepreneurial skills, difficulties, needs and if they are willing to undertake their own businesses now or in the future.
- Universities: To evaluate their present entrepreneurial activities and their role in the regional entrepreneurial ecosystem.

The surveys have been conducted online and for some stakeholders, also manually using paper forms. Number of answers are listed in the table below.

The number of answers per country and stakeholder group

	Belarus	Armenia	Georgia	Kazakhstan
Enterprises	20	19	70	31
Students	275	184	278	283
Universities	2	33	12	17

Main finds from the questionnaire survey of stakeholders are as follows:

1) Companies in general think that the university is not a good source for entrepreneurial talent.
2) Many companies don't know if universities are providing trainings on entrepreneurship and business development to its students. We need better external communication (Job fairs, Business chairs…).
3) Team building is a key skill to be focused on and a general need identified in the 4 countries.
4) Funding is the most popular excuse.
5) Creativity, design, ability to innovate are key skills hardly ever mentioned in the surveys.
6) Many students are interested in learning more about innovation and entrepreneurship but now, they are NOT able to identify a person in their university that would help them in the creation of a startup. We need also better internal communication of the I.C.s
7) The entrepreneurial rate is still very low in general (Average 2 new companies in the last 3 years).

3.2 Staff re-training

Staff re-training has been provided mostly for partner university staff. Some staff members from non-university partner organizations have also been involved in retraining activities.

3.2.1 Training of trainers on entrepreneurship

This training course is organized by Polytechnic University of Valencia (UPV) from March 26 to April 8, 2017. 24 participants from 4 partner countries have attended the training course, with 2 persons from each partner country university and 1 person from each non-university partner. The training course is designed mainly for those staff members who in the near future will provide entrepreneurship training at home universities, who will develop and deliver 2 new courses (Innovation systems, Entrepreneurship for engineers) and who will be involved in the establishment of innovation centers.

Topics of the training and lecturers are listed below:

Israel Griol Barres	Team building, founder's dream, deals, mentoring, lean startup, market segmentation, financing, elevator pitch
Oscar Morant	Business model generation
Maria Marquez Gomez	How to create a spin-off at a university?
Majo Gimeno	Competitions, value propositions
Nestor Espinosa	Branding

During the training course, participants have also study visit to UPV's innovation center (IDEASUPV), as well as private business incubators in Valencia.

3.2.2 Study visits on Swedish innovation systems

This event took place on June 1-10, 2017, and was hosted by Royal Institute of Technology (KTH) in Stockholm. The event aims to introduce partner country staff in Armenia, Belarus, Georgia and Kazakhstan on the Swedish national innovation systems. Through lectures and site visits at different organizations, visitors have received first-hand experiences on how Swedish national and regional government agencies, universities, science parks and business incubators work together to create a innovation-friendly environment to support innovation and new business development.

A number of speakers from different Swedish organizations have been invited to speak on various topics related to innovation and entrepreneurship in Sweden:

Henrik Friden, Swedish National Agency for Innovation Systems (Vinnova)	National research and innovation policy
Maria Lindqvist, County Administrative Board of Stockholm	Swedish innovation strategies at national and regional levels
Emelie Johansson, KTH Business Liaison	Collaboration for innovation
Hans Westlund, Professor of Urban and Regional Studies, KTH	Entrepreneurship for regional development
Lisa Ericsson, Head of KTH Innovation	Introduction to KTH Innovation: organization and business development model
Terrence Brown, Professor of Entrepreneurship and Innovation, KTH	Technology-based entrepreneurship and entrepreneurship for engineers
Bruce Lyne, Industrial management, KTH	IPR strategy and the innovation process Partnering as a means to speed commercialization
Per Thulin, Program Director, KTH	KTH's master programme "Economics of innovation and growth"

Partner country staff have also visited several Swedish institutions working on innovation and entrepreneurship:

- KTH Innovation Office
- Business Lab of Stockholm School of Business (SSB)
- Uppsala Innovation Center (UIC)
- Startup People of Sweden (SUP46)
- Kista Science City

3.2.3 Workshops on innovation pedagogy and innovation competence assessment

The first workshop on innovation pedagogy was hosted by Turku University of Applied Sciences (TUAS) in Finland. The workshop took place on September 12-19, 2017. Each partner university from Armenia, Belarus, Georgia and Kazakhstan has sent three teachers to the workshop.

The workshop started with Introduction to innovation pedagogy by TUAS staff members. Participants also made study visit to TUAS Machine Technology Center to see "innovation pedagogy in action". The workshop involves group discussions and reflections on innovation pedagogy. During the workshop, partner country staff also made preparations for implementation of innovation pedagogy in one of their regular courses.

The 2nd workshop focuses on innovation competence assessment. This workshop took place in November 2017 at Belarusian State University in Minsk. The workshop started with discussions on assessment in higher education:

- What kind of assessment are in use in partner country universities?
- What we can measure?
- Who makes the assessment?
- How assessment could be made to gain more reliable results?
- Processes and tools to assess innovation competences
- EU agenda for assessment of learning outcomes
- Organizations for student-centered assessment

The most important part of the workshop is for partner university staff to learn the **FINCODA Innovation Competence Assessment Barometer**, developed by Turku University of Applied Sciences together with several other EU universities. The FINCODA barometer can be used to assess students's innovation competences, using 34 behavior indicators classified into 5 competence dimensions:

- Creativity
- Critical thinking
- Initiatives
- Teamwork
- networking

3.2.4 Workshop on innovation competences in curricular design

The aim of this workshop is to discuss how to improve university curricula by introducing innovation competences as learning outcomes of the educational programmes.

The workshop was hosted by Taraz State University in Kazakhstan in April 2018. The workshop began with three talks on curricular design focusing on innovation competences, transversal competences and learning outcomes-based teaching and learning. Partner university staff had group work where one existing educational programme (at master or bachelor level) has been analysed to create an Innovation Competence Matrix (iMatrix). With iMatrix, one tries to define a set of innovation competences and how these competences can be obtained in different courses of a bachelor or master programme.

3.3 Introducing general courses on innovation and entrepreneurship

Socioeconomical development in partner countries are in urgent needs of innovative entrepreneurs who are capable of finding new business ideas and creating viable enterprises. There are economics programmes in many universities which are teaching entrepreneurship. However, entrepreneurial skills are not taught to students in general engineering programs. Consequently, most engineering students in partner countries have limited or no knowledge on how to validate a rough business idea and turn it into a viable business, how to build a team, how to finance a startup, etc. This situation has greatly limited the potential of engineering students to commercialize their knowledge.

Human history has already taught us the importance of knowledge, education and research. In almost all engineering programmes, we are already teaching future engneers basic knolwedge in mathematics, physics, chemistry and biology. In modern times, we also discovered that skills in information technology such as programming and basic knowledge in economics, law, environment are also necessary for modern engineers. Today, in order to educate qualified engineers in knowledge-based societies with globalized, competitive labour market, we strongly believe that **basic knolwedge in innovation and entrepreneurship should also be a part of any modern university curriculum**, independent of the subject fields of study.

As an important component of the INNOCENS project, syllabus for two general courses, *Innovation systems*, and *Entrepreneurship for engineers*have been developped.

Syllabus of course ”Innovation system”

Learning outcomes	After completing this course, the students should : 1. understand the importance of innovation for socioeconomical developmnet 2. be aware of key factors and indicators defining the innovation environment 3. have insight on national innovation policy and improvement needed in order to improve the national innovation environment 4. understand different types of IPR and skills to manage IPR 5. be familiar with diffeent types of commercialization of research and business ideas 6. be able to find suitable professional support in entrepreneurship and business development	
Syllabus	1	Importance of innovation for socioeconomic development - economical theories on innovation-driven economical growth - globalization and knowledge-based digital economy - challenges of modern societies and the need for innovation
	2	Innovation indicators and international innovation ranking - key factors influencing innovation performances - innovation indicators used by WIPO, EIS and others - international ranking and good practices
	3	National innovation strategy and policy - business-friendly environment - rule by law and good governance - innovation-friendly regulations and taxation - ICT investment and infrastructure - financial support to innovators and entrepreneurs - government-university-business partnership for innovation
	4	Human capital and intellectual property rights - Importance of IPR for economic growth - Types of IP: patents, copyrights, industrial designs, trademarks, etc - IPR analysis and strategy
	5	Innovation process and management
	6	Professional support in innovation and entrepreneurship - science (technology) parks, innovation clusters and local ecosystems - incubators and accelerators - innovation for regional development
	7	Innovation and entrepreneurship in higher education - curricular development focusing on innovation competences - courses on innovation and entrepreneurship - commercialization of research results: technology transfer, licensing, spin-offs and startups - the role of university innovation offices - student entrepreneurship activities
	Project work including report-writing and seminars	
	1	Analyze the innovation environment in one specific country and identify problem areas in need of improvement
	2	Case study of a particular startup company (or entrepreneur) and identify the key factors behind the success (or failure) of the company (or entrepreneur)
Course literature	Bessant and Tidd (2015). Innovation and entrepreneurship. John Wiley & Sons. Peter Drucker (2015). Innovation and entrepreneurship. HarperCollins (2015). Daria Tataj (2015). Innovation and entrepreneurship, a growth model for Europe beyond the crisis. Tataj Innovation Daria Golebiowska-Tataj (Sept. 2015) Carayannis, Samara and Bakouros (2014). Innovation and entrepreneurship - Theory, Policy and Practice (Innovation, Technology, and Knowledge Management). Springer (Nov. 2014)	

Syllabus of course "Entrepreneuship for engineers"

<table>
<tr><td>Learning outcomes</td><td colspan="2">After completing this course, the students should be able to:
- Understand the Fundamentals and specifics of Entrepreneurship
- Know the International and National legislative basis of the Entrepreneurship
- Understand the business ethic
- Know the procedures to develop an idea and startup a new technology-based company
- Develop the ability to translate a business idea into marketing and financial plans
- Communicate and Negotiate With Potential Business Partners and Other Stakeholders.
- Understand and systematically explore business environment and partnership
- Understand and systematically explore basic processes in business modeling
- Understand and systematically explore the important elements in managing companies and developing its human resources.</td></tr>
<tr><td rowspan="10">Syllabus
(List of lessons)</td><td>1</td><td>Inspiration and Fundamentals of Entrepreneurship</td></tr>
<tr><td></td><td>- Introduction to Technology Entrepreneurship and Technology Ventures;
- Attributes and Myths of Technology Entrepreneurs;
- Engineers as Entrepreneurs;
- Mindset of the Entrepreneur and Entrepreneurial Leader;
- Creating and Selling the Entrepreneurial Value Proposition;
- Specifics of business and startups;
- Team Building (students will work on specific business ideas chosen by them by creating teams among themselves).</td></tr>
<tr><td>2</td><td>International and National legislative basis in the area of e-ship</td></tr>
<tr><td></td><td>- Legal Forms of Entrepreneurial Activities
- Intellectual Property Law
- Contractual Law
- Taxes and Taxation
- Business Ethics And Negotiation</td></tr>
<tr><td>3</td><td>Idea Generation and Feasibility Analysis</td></tr>
<tr><td></td><td>- Entrepreneurial Idea Generation and Feasibility Analysis;
- Technology Commercialization Potential;
- Paths and Barriers from Idea to Market;
- Assessing and Presenting the Opportunity.
- Customer development
- Problem-Solution fit
- Business model generation
- Validation plan</td></tr>
<tr><td>4</td><td>Assignment - Case Study And Analysis. (Students will work on specific business ideas chosen by them (by creating teams among themselves). They should show why they think that their idea will be successful. They should compare their idea with already existing businesses. They should analyze why particular company /having similar idea like their/ is successful or not successful etc.).</td></tr>
<tr><td>5</td><td>Business Planning and Execution</td></tr>
</table>

		- Business Structuring, Strategy and Management; - Business modeling and business planning; - Financial Analysis and Projections; - Market and Competitive Analysis; - Presenting a Clear, Concise, and Compelling Message (Opportunity); - Intellectual Property Strategies for Technology Companies; - Marketing, Sales and Distribution Strategies; - Investment and Financial Strategies; - Accessing to funding; - Venture Growth and Value Harvesting.
	6	Project - business plan development
		Finalize the ideas in a Business Plan - Articulate the goals of the new venture, develop a plan on how to reach to your customer, how to sell and pitch your offering, and determine the development time and resources needed to establish the company. - live presentation of the project in the shape of an elevator pitch.
Course literature		*Books on all the essential topics of entrepreneurship with some excellent case studies.* - Launching New Ventures: An Entrepreneurial Approach, by Kathleen Allen (Cengage Learning, 2015). - Technology Ventures: From Idea to Enterprise, 4th ed., by T. Byers, R. Dorf, and A.Nelson. (McGraw-Hill Press, 2015). - Technology Entrepreneurship, T. Duening, R. Hisrich & M. Lechter (Elsevier, 2015). - Innovation & Entrepreneurship, 3rd ed.", J. Bessant & J. Tidd (J. Wiley & Sons, 2015). - The Start-Up Owner's Manual, by S. Blank & B. Dork (K&S Ranch Publishers, 2012). - Preparing Effective Business Plans, 2nd edition, by B. Barringer (Pearson Press, 2015). *Books highlight the concept of the Business Model Canvas:* - "Business Model Generation, by A. Osterwalder & Y. Pigneur (J.Wiley & Sons, 2010). - "Value Proposition Design, by A. Osterwalder, Y. Pigneur, G. Bernarda, and A. Smith (J.Wiley & Sons, 2014).

The above syllabus have been adapted by the 8 partner universities to better fit the regulations and competence profiles of the relevant programmes at specific partner universities. During the period 2017-2019, these two courses have been offered to selected study programmes at the 8 partner universities.

It is expected that these two courses will be offered to other study programmes at partner universities in the future. One option is to offer the courses as elective courses which can be chosen by students in any study programmes. There is also a possibility to merge the two courses in one single course which might be more feasible from the view point of programe design and scheduling.

3.4 Experiment on innovation pedagogy

Traditional higher education focues on the difusion and tranfering of knowledge from teachers to students in a teacher-centered process. To meet the requirements of global competitions in knolwedge-based societies, students must be more innovative in their self development and in their

professional life. At Turku University of Applied Sciences (TUAS) in Finland, scientists have classified the innovation competenecs into the following 5 types or *dimensions*:

Ceativity
Creatical thinking
Initiatives
Teamwork
Networking

To support students in the development of above innovation competeces, the foundamental philosophy and mindset of higher education must be re-oriented. Curriula, teaching and learning should focus more on students's innovation competences, not only focus on established knowedge and well-known facts. This can be achieved through promoting active learning by students, and promoting teaching and learning in collaboration with enterpeises and the business world so that students can better learn how to learn new things, how to analyse complex problems and find solutions.

At Turku University of Applied Sciences (TUAS), many new pedagogical methds for active learning have been practised through years. Some of these methods are listed below:

Co-teaching with business people
Project hatchery
Innovation camp
Gamification
Problem-Based Learning (PBL)
Project-based course
Flipped class
Collaborative learning
Learning by case method
Learning by teaching
Online learning
Blended learning

During the project period, each of the 8 partner universities have experiemented with some of the above innovation-oriented pedgogical methods, in one or several selected courses. Feedbacks have been collected from both students and teaching staff. While most students are positive to the new, un-conventional learning methods, there is still a lot of work left to change the mindset of students and especially teachers, and to better organize the learning process.

Partner universities have also experimenetd on self assessment of innovation competenecs by students. The assessment is using the FINCODA Innovation Barometer, developped by a group of European universities lead by Turku University of Applied Sciences (TUAS). The barometer consists of 34 indicators addressing different types of innovation competenecs listed above. Students can regularly evaluate themselves using these 34 indicators. Chapter 2 will list these 34 indicators and give more descriptions about innovation pedagogy and innovation competence assessment at partner universities.

3.5 Establishment of innovation centers at 8 partner universities

In addition to provide training on innovation, entrepreneurship and innovation competence development, the INNOCENS project has worked for 3 years to build the innovation capacity at partner

universities by establishing innovation centers. These centers are built based on the experiences of IDEASUPV of Polytechncial University of Valencia (UPV) and the Innovation Office of the Royal Institute of Technology (KTH) in Sweden.

Each innovation center establishe by the INNOCENS project is a separate unit within the partner university, with 1-3 dedicated staff (full time or partner time employees), office rooms and necessary equipment. While partner universities provided the furniture and other facilities, the INNOCENS project has provided IT and other office equipment to a total value of about 159 000 EUR. In 2019, all partner universities have opened their innovation centers.

The fundamental task of innovation centers is to provide pre-incubator services to students and teachers in their innovation work. Whenever a student or a teacher has a rough new idea, he or she can come to business coachers (mentors) at the center to get help to evaluate and validate the idea, to find partners or external advisors or investors or other funding sources so that the idea can become a viable business (e.g. a startup).

8 innovation centers at partner universities

	Partner university	Name of the center	Head of the center	Opening ceremony
1	NPUA	NPUA Innovation Incubator	Amalya Mkhitaryan	2018-06-08
2	NUACA	Center for Innovation and Entrepreneurship	Hermine Samvelyan	2018-05-11
3	GTU	Innovation Center	Boris Gitolendia	2018-05-23
4	BSU_GE	Innovation Center	Tamaz Chkhartishvili	2018-05-29
5	BSU_BY	BSU Innovation Center	Dzianis Marmysh	2019-04-29
6	BrSTU	Innovation Center	Valeriy Kasyanik	2019-07-22
7	AUPET	AUPET Innovation Center	Madina Aliyarova	2018-06-06
8	TarSU	Center for Innovation and Entrepreneurship	Natalya Chernyavskaya	2018-03-02

Since the establishment, the innovation centers have conducted a series of initial activities:

- Marketing and promotion so that all students/teachers at the university know the center and its services
- Organize regular seminars, training courses, workshops, summer schools to promote innovation and entrepreneurship among students and teachers
- Build a local innovation ecosystem by networking with external entrepreneurs, companies, relevant government agencies, local technology parks, incubators, etc
- Organize innovation competitions

3.6 Organizing innovation competitions

Organizing innovation competition is a way to attract young students to participate in innovation activities. It is also a practice of active learning: learn innovation by doing it. However, it is emphasized that winning competition is not the ultimate goal of innovation. The real competition is on the market, not in a pitch presentation in front of a jury.

During the period of February-September, 2019, the INNOCENS project organized an INNOCENS innovation competition among students of the 8 partner universities. By participating in the innovation competitions, a large number of students at partner universities actively learn how to evaluate a business idea, build a team, write a business plan and present the idea before a jury and receive feedbacks from the jury.

The criteria for the INNOCENS innovation competition is:

Novolty of the idea
Commercial values
Social impact
Quality of the business plan
Pitch performance

The innovation competition was announced at the end of January 2019. At the end of April 2019, 188 business ideas from 8 partner universities have been submitted to the competition.

Number of business ideas submitted to the INNOCENS innovation competition

	Partner university	Number
1	National Polytechnical University of Armenia (NPUA)	44
2	National University of Architecture and Construction of Armenia (NUACA)	31
3	Georgian Technical University (GTU)	1
4	Batumi state University (BSU_GE), Georgia	23
5	Belarusian State University (BSU_AY)	16
6	Brest State Technical University (NrSTU), Belarus	14
7	Almaty University of Power Engineering & Telecommunication (AUPET), Kazakhstan	15
8	Taraz State University (TarSU), Kazkahstan	26
	Total	188

Main features of the competition are summarized below:

(1) A team of three students submit a business idea before April 30, 201.
(2) At least one team member must be a student at one of the 8 partner universities:
(3) Each partner university organized a pitch competition to choose a local winner before the end of May 2019. If more than 10 business ideas from the same partner university have been received, the university concerned made a pre-selection of 10 candidates for the local pitch competition.
(4) The 8 winning teams submited a full business plan before August 13, 2019
(5) The 8 local winning teams participated in the final competition in Valencia, Spain, on September 13, 2019.

The team from National Polytechnical University of Armenia (NPUA) won the final competition, with a design of a mini robot which can automatically detect problems in underground pipelines. The winner team presented their business idea at INNOCENS final conference in Nur-Sultan, Kazakhstan, in October 2019.

4 Summary of results

Started in October 2016, the INNOCENS project has been successfully completed in October 2019, thanks to excellent cooperation and hard work of staff members and students from 19 partner organizations in 7 countries.

All activities planned in the original project proposal have been implemented. The achieved results can be summarized below.

- At the beginning of the project, we have conducted questionnaire surveys among enterprises, students and universities. The surveys have shown: most enterprises did not think universities in the partner countries provide students with sufficient innovation and entrepreneurial skills. Students in general are willing to learn more on entrepreneurship. For both enterprises and students, the main difficulties in entrepreneurship are: team building, lack of funding, regulations, risk aversion.

- We have organized a series of innovation events and innovation competitions which significantly increased the students' and staff members' awareness on the importance of innovation for a country's socioecnomical development.

- Through study visits, training courses, workshops, seminars, partner country staff have greatly improved their knowledge and skills in innovation and entrepreneurship.

- By introducing two general courses (*Innovation systems*, *Entrepreneurship for engineers*), all students in the 8 partner universities, independent of their study subjects, now have opportunity to learn basic knowledge and skills in innovation and entrepreneurship.

- 8 innovation centers have been established with university-recognised organizational structure, dedicated staff, new IT equipment and office space. All centers have become operational in providing support to students and teachers in their business idea development.

- We have organized studnet innovation competitions at 8 partner universities which have attracted 188 new business ideas. Students have had opportunity to learn business idea development by doing it in practice.