

Patterns for Strategy Management of Technology Entrepreneurship and Innovation MSc Program

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Abstract

The paper introduces three patterns for use by university managers and lecturers for creating of Master of Science (MSc) program in engineering and science faculties, developing entrepreneurial skills:

- TECHNOLOGY ENTREPRENEURSHIP AND INNOVATION (TEI) CURRICULA – provide a valuable and computational set of courses to guarantee the competence of graduate students in the turbulent environment;
- TEI MSc PROGRAM – create the road map for successful implementation of the technology entrepreneurship graduate education;
- TEACHERS TEAM – when the human capital is scarce, focus the stress on attracting and retains the best professionals in the fields.

The authors experimented with the MSc graduate Technology Entrepreneurship curriculum design and implementation of the program in the university master level teaching, and used a mix of methods and observation techniques to assess its feasibility and applicability for developing the winning strategy.

Keywords: *Patterns, Technology Entrepreneurship Curricula, Education Strategy*

1 Introduction

Providing citizens and employees with a new set of competences turned out to be in the middle of all changes in public life and economy. Therefore, Information and Communication Technology (ICT) subjects were introduced in school curricula, a lot of initiatives were implemented for educating trainers, establishing computer labs in schools and connecting them to the global networks. While the e-skills necessary for all European citizens are generally solved by educational systems, a lot of challenges remain for building the competences required by industry. In the last few years the issue of e-skills was put on the agenda at different fora all around Europe – ICT Skills Monitoring Group, Career Space industry-led initiative, European e-Skills Forum, e-Skills and e-Learning expert groups at EC, ICT Task Force, etc. The general conclusion coming out of these is that present employees need more than just technical skills and knowledge. The need to equip employees with interdisciplinary skills, combining e-skills with entrepreneurial competences, innovativeness and creative thinking, turned out to be among the highest challenges for businesses, educational institutions and policy makers nowadays [5].

The Entrepreneurship and innovation education process is a management process, not an individual characteristic [3]. As a process it can be described, modeled, analyzed, understood and taught. The core elements of the entrepreneurship process are the evolution and identification of a business opportunity and the recruiting and aggregation of the necessary resources (technology rights, people, money) to pursue the opportunity [16].

Some universities tend to be rather conservative institutions, not eager to change. Therefore, developing a MSc program is not something that happens fast and often. The introduction of major changes within a university faculty, as elsewhere in the world, starts by changing the organizational culture and adopting a new way of thinking and philosophy that will guide staff toward new faculty goals [12, 15, 18].

As a result of analysis and observation of the practice in creating an entrepreneurship program, the paper describes TEI Education Program as a set of patterns [11]. This MSc education follows closely the new technologies change and their impact on industrial practice. In order to remain competitive, scientific and engineering faculties should apply innovation in all its types and practices – organizational, technological, process, etc. They need to closely monitor labor market needs and establish close cooperation with the main users of their services in education and research [13].

The paper introduces three patterns for use by university managers and lecturers for creating of Master of Science program in engineering and science faculties.

Audience

Many innovative universities are trying to reengineer their curricula in response to the dynamic global environment and the socio-economic changes. Only some faculty managers have the luxury of stopping or delaying the educational processes at the universities in order to redesign them. In present dynamic world, no time remains for such stop-overs, and the costs would be dreadful.

These patterns systematize the long-term education management experience and observation of the authors and combine it with recent strategic management approaches. These patterns can be useful for scientific and technology faculties' managers for design, development and implementation of entrepreneurship education in engineering MSc program.

2 The Patterns

The benefits of graduate education practice are communicated through the concept known as a pattern. The concept of patterns was widely described in many industries, papers and books [2, 4, 7, 9, 10, 12, 19]. There are many patterns that deal with specific issues in the strategic management loop of the education and training process - creation and execution of a program for technology entrepreneurship and innovation education programs. This paper presents the following patterns (Fig. 1):

- TEI MSc PROGRAM;
- TEI CURRICULA;
- TEACHERS TEAM.

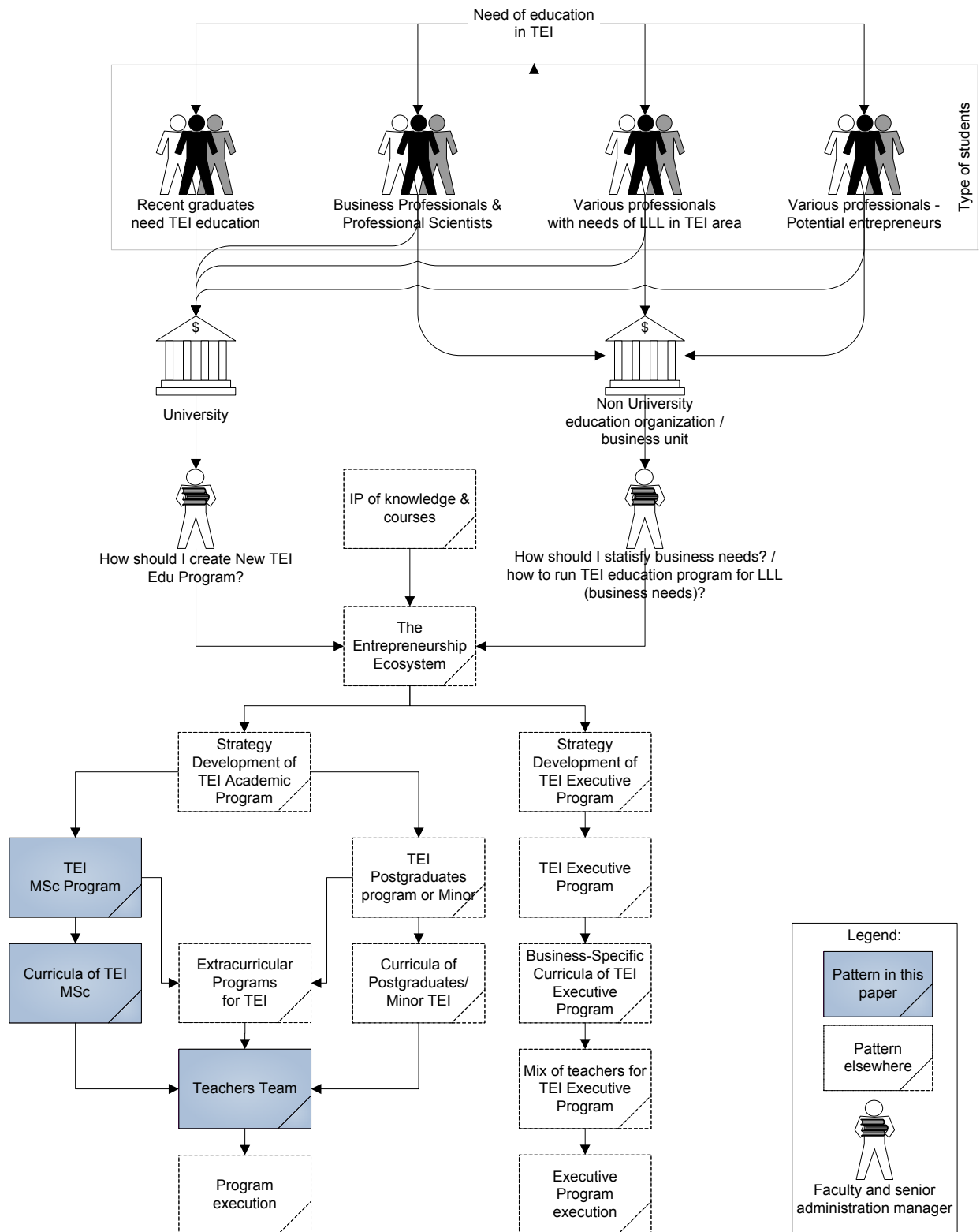


Fig. 1 Development of TEI education program pattern sequence

2.1 TECHNOLOGY ENTREPRENEURSHIP AND INNOVATION MSc PROGRAM:

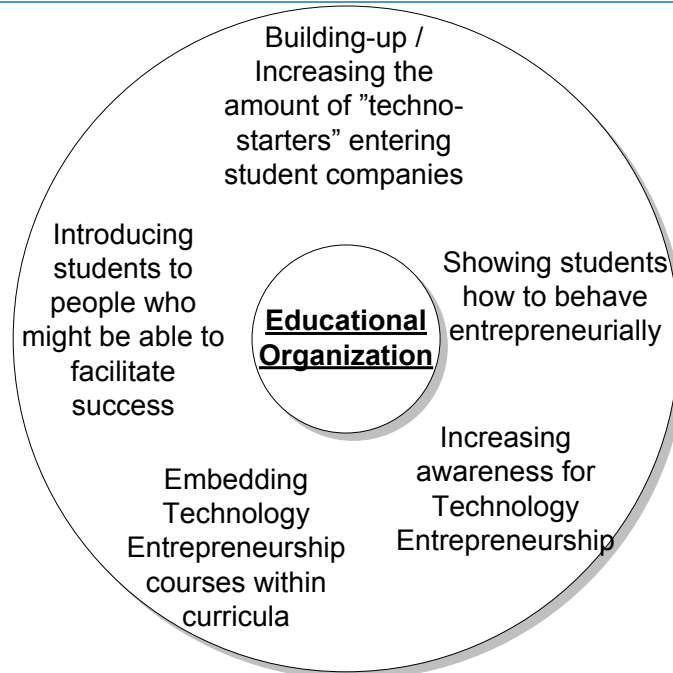


Fig. 2 TEI education program

2.1.1 Context

Students are the main target of any educational program. They could be recent graduates, business professionals and professional scientists, professionals with needs of life-long learning (LLL), or various professionals - potential entrepreneurs. They all might need TEI education (Fig.1).

New technologies and organizational innovations affect the transmission and generation of knowledge. It is generally accepted that the collaboration between businesses and universities can accelerate the rate of innovation and the economic growth in key markets around the world and to facilitate overcoming the following difficulties [6]:

- weak links between science and businesses
- not sufficient measures to develop innovation infrastructure, support services, technological brokerage, intermediary services, etc.
- not involvement of university students in scientific and technological activities
- low innovative culture and weak innovative culture of businesses
- low level of investment in new products and processes
- slow implementation of measures and not systematic and transparent evaluation, etc.

At the same time, it is widely discussed that future employees need not only technology skills, but they need also a set of interdisciplinary skills which traditional education programmes do not provide. There is an obvious need for educational programmes focusing on various scientific disciplines and across traditional university faculties [5].

A key reason for describing a TEI MSc pattern is that strategy management, learning design experience and curricula of the MSc program education can actually be reused. Reinventing the wheel for every new MSc program makes only the faculty increasingly unmanageable and slows down the programme delivery.

2.1.2 Problem

What actions should a decision maker undertake in the process of developing a new TEI MSc program in its own university / department?

2.1.3 Business value.

The TEI MSc PROGRAM pattern allows academic managers to improve the process of education and to grow the efficiency and efficacy of the education.

2.1.4 Forces

There are many forces in the area. Below are summarized the most important ones.

Force 1: Meeting labour market and student needs: On the one hand, universities provide strong education for students with a specific major, e.g. technical/engineering, scientific, etc. and as a result, students are well skilled in technology. But on the other hand, the students need to commercialize their knowledge. Besides, companies are seeking employees not just with technology skills, but most demanded are employees with interdisciplinary skills and knowledge.

Force 2: Bridging the gaps of the university environment and the Entrepreneurship Ecosystem. Universities need to establish stronger links with businesses, but also to focus on research and teaching. Unfortunately, their services not always are adequate to business needs. This leads to the fact that very often university environment is not aligned with entrepreneurship ecosystem. Besides, universities experience serious problems closely related to the general socio-economic and research environment [13]:

- Migration to industry of highly skilled professionals
- Insufficient research funding
- Lack of sufficiently stimulating research environment
- Lack of stable and multiple bridges between research, development, education and training
- Lack of traditions in university-industry-government cooperation.

Force 3: Conservative and separated university environment: Universities are very conservative institutions, not eager to change. Every faculty has a strong knowledge and experience in a specialized field(s). In order to teach management and entrepreneurial skills to professionals in a technical field, there is a need of strengthening faculty's capacity, and integrate researchers and experts in different fields than its core research and teaching areas. The faculty should undertake several activities in order to determine its future strategy in research, technology development and innovation (RTDI) [13].

2.1.5 Solution

Match the MSc programme to local educational ecosystem and deliver benefits to the stakeholders – students, business, government and community.

A project for development of TEI MSc program should be launched and conducted by a faculty team leaders focused on the design and implementation of a new academic educational program.

Some efforts are needed to change the stakeholders' mindset and the model of thinking about MSc degree education. There is a need before launching the program to:

- Increase the awareness for TEI ;
- Increase the number of technology entrepreneurship courses for researchers of the Faculty, and for all stakeholders.

Faculty should gain and enhance its knowledge in the area of TEI and participate in research projects in various areas closely linked to the new program core subjects. University/departments should establish stronger links with businesses and government. Students should have a chance for learning by doing on-the-spot.. Here the strong academia-industry collaboration could facilitate the MSc program as a whole.

Specific objectives for the TEI educational program can be summarised as follows:

- Provision of a mix of competences needed for future entrepreneurs, including technology, business and personal/organisational competences
- Providing students with practical experience and self-confidence in a risky and dynamic environment
- Showing students how to behave entrepreneurially
- Introducing students to people who might be able to facilitate success

After launching a MSc programme on TEI, it is essential to consider some follow-up activities:

- Embedding TEI Education courses within curricula of all university faculties;
- Building-up / Increasing the amount of "techno-starters" entering student companies;

2.1.6 Consequences

Studying entrepreneurship could be an important positive force on students' career development. Whether students are studying entrepreneurship with the definite intent of turning into an entrepreneur or to be a business executive or a more informed stakeholder in general, they will all need entrepreneurial skills, once entering business settings.

Many students will come across of working closely with entrepreneurs in new and small enterprises. These enterprises will have to manage innovation for long-term growth and compete with other similar enterprises.

2.1.7 Variations

Depending of the Entrepreneurship ecosystem, specific strategy can be developed and implemented for building TEI education program. The process of particular adoption of patterns in Fig. 1 can lead to variations in adoption of TEI MSc PROGRAM.

The program can propose a teaching curriculum, classroom and external exercises on site, for teaching the entrepreneurship to engineers and scientists, creating innovative business people with cross-disciplinary skills, technical expertise, and the ability to grasp market opportunities.

2.1.8 Examples

The awareness on the importance of entrepreneurship and management skills was build within several years work at European RTD projects among researchers of the Faculty of Mathematics and Informatics (FMI). The awareness on the business needs for interdisciplinary competences of their future employees resulted in launching in the autumn of 2007 by FMI a new MSc program on TEI. The program turned out to be very successful as the students in school year 2008/2009 increased more than twice.

The Bulgarian format of TEI graduate program has been created due to the transfer of knowledge and support provided by the Intel and UC Berkeley initiative. Due to that initiative a new way of thinking and working was introduced. The teaching methods changed and became more interactive, applying the Intel-UC Berkeley education patterns. New different courses about TE were introduced, in line with the UC Berkeley curriculum.

Only a year after its launching, the program became the most demanded MSc program at Sofia University. Tangible signs of success of this program are already observed as some of the graduates of this program started their own businesses as a result of it [16].

2.1.9 Related work & Sources

Galabova L., Ruskov P., "Analysis of the Status and Opportunities for further Development of Bulgarian Entrepreneurial Education in Universities, Proceedings of the International Conference for Entrepreneurship, Innovation and Regional Development ICEIRD 2008, Skopje&Ohrid, Macedonia 8-12 may 2008, pp. 237-245 [20].

2.2 TECHNOLOGY ENTREPRENEURSHIP AND INNOVATION CURRICULA

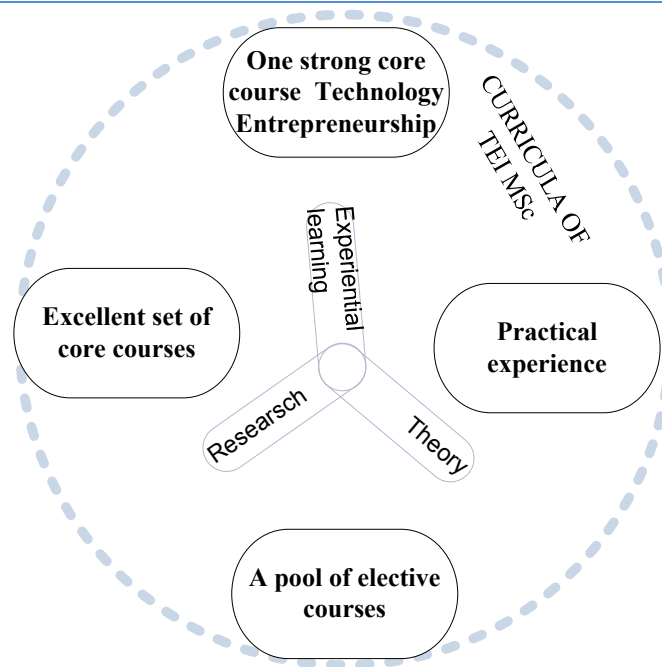


Fig. 3 Curricula of TEI MSc program

2.2.1 Context

One of the biggest challenges facing every economy is how to develop more skilled and productive workforce. Entrepreneurship Education is a key part of the solution to several pressing policy challenges, including university dropout rates, workforce readiness, and country's economic competitiveness. Countries assumed entrepreneurship as a means of growing their markets, and creating jobs in order to be more competitive and with stable economy.

As a whole, engineers and scientists do not know enough about entrepreneurship and innovation in order to successfully translate an idea into business. At the same time, current practice needs a mix of technology and interdisciplinary skills. Therefore, the curricula in TEI shall provide to professionals with scientific and engineering background knowledge in economics and innovation. Its goal is to teach potential entrepreneurs how to commercialize their knowledge, and turn it into new technologies and innovations.

2.2.2 Problem

What type of competences need to gain scientific and engineering graduated students and how to ensure them with the TEI curricula?

2.2.3 Business value.

The pattern helps university managers and lecturers to enrich the quality of courses content. The pattern also allows flexibility of the curricula courses. It addresses the time to market of the program and decreases cost of development.

2.2.4 Forces

Force 1: Motivated Leadership: There are many basic curricula which universities have created in different scientific fields. TEI is an interdisciplinary program and the faculty leaders need best practices in order to be able to create it faster according to the local circumstances. The personal motivation and dedication of the leaders is essential for developing the curriculum and overcoming all possible barriers as well as encourage others to grasp the ideas of the new curriculum.

Force2: Determining proper mix of courses. The curriculum should find the appropriate balance between the different courses in order to ensure the required technology, business and personal/organizational competences of the students. At the same time, the courses need to be developed with a focus on harmony between theory and practice.

Force 3: Ensuring potential teachers. By designing the curriculum it is of utmost importance to consider potential teachers and bridge the gaps between different faculties. Finding motivated talented teachers is an important factor for the success of the new MSc program and the curriculum should be designed taking the best available expertise.

Force 4: Involving stakeholders in the education process: It is well-known that contemporary society and economy need fast implementation of innovation and commercialization of research results and new knowledge, but traditional curricula do not provide the necessary interdisciplinary competences and risk taking abilities. In order to face this problem it is important that the curriculum involves at an early stage stakeholders as guest lecturers in order to share their experience, provide guidance to students as well as opportunities for internship.

Force 5: Ensuring a critical mass of potential applicants: Students in technical subjects need new state-of-the-arts competences in the area of TEI, but such curricula exist only in a small number of universities. There is a need by designing a new curriculum to consider how to reach potential students and encourage them to choose it.

Force 6: Challenges with IP of knowledge and courses. Universities own the intellectual property rights (IPR) of their knowledge. There is worldwide ranking of the universities and their products. At the same time, there are many issues related to using and teaching entrepreneurial knowledge, inviting guest speakers - professors from other universities and real leaders - entrepreneurs, and reusing their knowledge.

2.2.5 Solution

Investigate the curricula best practices of world leading universities (AS_IS), benchmark the leaders in implementing the desired solution (TO_BE) .

Each new initiative needs strong leadership in order to succeed. This is especially important for a new educational curriculum in order to overcome resistance and administrative barriers and motivate followers.

By designing the curriculum should be considered the following:

- Developing one strong first core course with two parts – Technology Entrepreneurship and Technology Entrepreneurship in IT. An excellent set of four to five core courses focused on provision of technology, business and organizational competences. A pool of elective courses adding specific competences for meeting individual needs of the students;
- Theory, research, and experiential learning should merge into one another within the education process and extra curriculum courses by ensuring a proper mix of theory, interactive and practical content;
- Different and complementary teaching materials should be delivered for the courses;
- The teachers team should be formed following the TEACHERS TEAM pattern.
- Engaging the stakeholders as lecturers – leading managers with practical experience in entrepreneurship .
- The new MSc program and the core courses in its curriculum should be widely advertised, as well as the expected results in competence building and the new approach for more practical orientation and stakeholders’ involvement in the educational process.

Finally, the ENTREPRENEURSHIP ECOSISTEM should be considered and along with its INTELLECTUAL PROPERTIES (IP) OF KNOWLEDGE AND COURSES , the decision-maker (faculty and senior administration manager) should carefully design the curriculum of the MSc program on TEI.

2.2.6 Consequences

Faculty leaders have knowledge and best practices for rapid design of new curricula in TEI. Applying the pattern will allow universities to be more competitive.

Graduated students in TEI will fill in the gaps in the fast changing market economy and will speed up new innovative technology products or processes commercialization.

Entrepreneurs educated on this curriculum will have more knowledge and practical experience in decision making and risk taking. This leads to faster and competitive implementation of innovative technologies, products or processes.

The time limitations, due to the large competition at higher students education, require fast reengineering of curricula and creating of new curricula in TEI. But applying the pattern will shorten the time and decrease the efforts needed for development of TEI curricula.

2.2.7 Variations

Depending of the needs of stakeholders, the background of the student, and the type of the university (engineering, scientific, economic, etc.), this pattern can be adapted with various specific compulsory or elective courses included in the curricula.

2.2.8 Examples

Example 1.

As an effort of many of the full-time and adjunct faculty members within the Lester Center for Entrepreneurship at UC Berkeley, the Entrepreneur Curriculum was developed.

The Entrepreneur Curriculum is projected to be a full academic year of courses. It can be offered at the last year of an undergraduate program or in a master’s program. It is best implemented where there are local entrepreneurs who can mentor students or be guest speakers and provide insight into the real experiences. This curriculum is intended to target

high technology start-up companies and will appeal to entrepreneurs in both, the engineering and business disciplines.

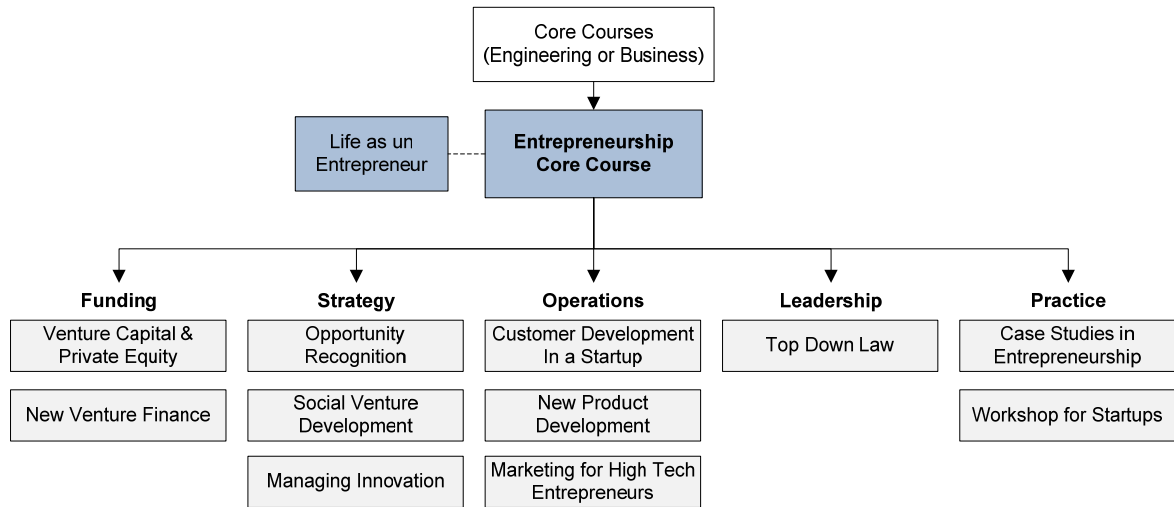


Fig. 4 Entrepreneurship Curriculum at Lester Center for Entrepreneurship and Innovation, Haas School of Business, UC Berkeley

Example 2– Adapted curricula for Technology Entrepreneurship and Innovation at Faculty of Mathematics and Informatics, Sofia, Bulgaria

Following many discussions in Sofia concerning preparation of curriculum and structure of the Master of Science program “Innovation and Technology Entrepreneurship”, the main topics were selected [19]. As in the curriculum of the Berkley University entrepreneurship program, it is identified:

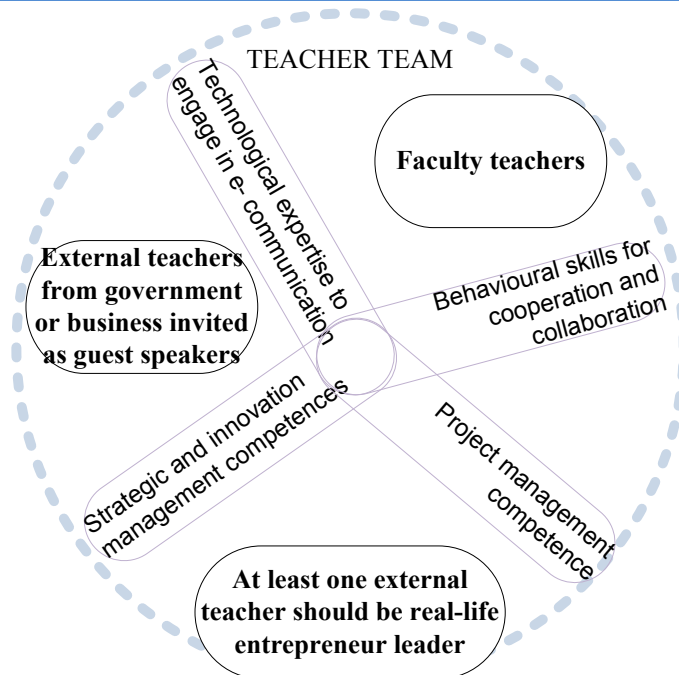
- One core course with two parts – Technology Entrepreneurship and Technology Entrepreneurship in IT (10 academic credits, 120 hours lectures and practical seminars), based on the curricula from Intel of which ~30% derived from the original UC Berkeley “core” curricula, and 70% were created based on the needs of Western and Central Eastern Europe.
- Four basic courses – Innovation Management (7,5 academic credits, 60 hours lectures and practical seminars), Financial management and venture capital (7,5 academic credits, 60 hours lectures and practical seminars), Strategic management (5 academic credits, 60hours lectures and practical seminars) and Marketing management (5 academic credits, 60 hours lectures and practical seminars).
- A pool of elective courses each by – 5 academic credits, 60 hours lectures and practical seminars: Commercial legislation in Bulgaria and Internet and law; Organizational Behavior; e-Business, e-Governance; Knowledge Management, Customer Relationship Management; Project management; Project financing of innovation, Entrepreneurship (Student Company - practical simulation of venture creation - localized for Bulgaria), etc.

2.2.9 Related work & Sources

The curriculum process is described in book:

Engel J. , Charron D. (2006), Technology Entrepreneurship Education, Theory to Practice, Lester Center, UC Berkeley 2006.

2.3 TEACHERS TEAM:



Synergy mix of faculty and external teachers

Fig.5 The teachers team

2.3.1 Context

Teachers are not just important contributors to the education process, but they have become for their universities the most valuable capital. Capable professors are not just hard to find, but faculties are waging a war for talents. Teaching experts do not just bring their background and experience to their classes, but contribute their human capital. A key reason for describing a TEACHERS TEAM pattern is that curricula design experience and execution of the MSc program can actually be effective and efficient only when it is completed with the most talented professors. Nowadays, the greatest risk faced by teachers, especially those in Technology Entrepreneurship area for which the latest technical knowledge is their most critical human capital, is not the loss of a job, but rather the devaluation of the assets and the hard satisfaction of the smartest students' demands.

It should be taken into account how to motivate and keep employees, and the following human capital value chain provides an insight into this issue: [1]:

“1. In addition to being fairly compensated, people place high value on:

- Being in an environment where they can grow and learn and advance
- The managerial skills/abilities of their immediate supervisor
- Being treated fairly, appreciated and acknowledged
- Doing work that makes a contribution

2. These determinants of employee satisfaction drive employee retention

3. The retention rate among key employees drives customer satisfaction

4. Customer satisfaction drives customer retention

5. Customer retention drives profitability and other measures of financial performance including total stockholder return.”

2.3.2 Problem

What kind of teachers should faculty managers recruit, source and select to form teacher's team for technology entrepreneurship education?

2.3.3 Business value

TEACHERS TEAM pattern allows academic managers as an owner and investor of human capital to effectively manage the professors and the positions, and measure this asset where it will generate the highest return of investments. The pattern also increases the teachers' satisfaction because a more transparent process is easier to share and communicate.

2.3.4 Forces

These are common problems typical for academic human capital. The most important driving forces include:

Force 1: A "critical mass" of talented teachers: There is a big gap between existing teachers and a need to find the right faculty, to attract top teaching and research talent. On the one hand, there are some candidates for faculty positions, but on the other, universities experience serious problems closely related to capable teachers [13]:

- Lack of sufficiently stimulating research environment;
- Migration to industry of highly skilled professionals and of experts;
- Increase diversity of hiring
- Lack of youth applicants

Force 2: Team strategic management: Need of dynamic strategy planning and implementation and real measurement in order to take competitive decisions and to lead changes. The academy is tradition-keeping organization and the academic culture is very conservative. But the dynamic globalization and the market economy open the academic processes and change the capabilities of the professors. The brain drain requires creating and updating a strategy for learning and growing in the universities environment.

Force 3: Teachers mind set change management: Fundamental shifts in the way teachers think — and speak — about working life management. The Internet, professional and social networks are strong tools for dissemination of information and practices. At the same time, ICT introduce big changes in the teaching environment – new methodologies, new tools and practices which face teaching staff with enormous challenges to change and adapt rapidly.

Force 4: Synergy mix of faculty and external teachers: Every faculty has strong knowledge and experience in a specialized field(s). But in order to teach management and entrepreneurial skills to professionals in a technical field, there is a need of strengthening faculty's capacity. The teachers abilities associated with e-literacy, innovation, and entrepreneurship are expected to be crucial for strategic success, but are considered insufficient in today's professors.

2.3.5 Solution

Model and develop a dynamic strategy loop cycle about human capital development and execute it as quick as possible. Do real measurement to take competitive decisions and to lead changes.

University should have a synergy mix of faculty and external teachers. External teachers might be invited as guest speakers, part time lecturers etc. At least one external teacher should be real-life entrepreneur leader.

Faculty team members in the new TEI program must have:

- Technological expertise to engage in e-communication;
- Project management competence that extend to handling joint ventures programs and strategic partnerships;
- Strategic and innovation management competences and wide knowledge to understand present technology environment and business demands;
- Behavioural skills that permit successful cross-functional, inter-company, and multi-regional cooperation and collaboration.

2.3.6 Consequences

Studying entrepreneurship could be an important positive force on students' career development. Whether students are studying entrepreneurship with the definite intent of turning into an entrepreneur, or of growing to be a business executive or a more informed stakeholder in general, once students enter into the business, they will all need entrepreneurial skills.

Many students will come across of working closely with entrepreneurs in new and small enterprises. These enterprises will have to manage innovation for long-term growth and compete with other similar enterprises.

2.3.7 Variations

Depending on the ecosystem, this pattern can be adapted with various specific positions, full or part time. Different forms of cooperation between university, business and governance can be implemented.

2.3.8 Example

MSc program TEI in Information Technology at FMI is very successful as the students applying for the second year after launching increased more than twice and new candidates for teaching position appears. The position for PhD education becomes more attractive and applicants grow.

Due to the synergy of the teaching team a new way of thinking and working was established. The TEI team leaders succeed to attract the best teachers from leading Bulgarian universities and well-known experts from business and governance. The teaching methods changed and became more interactive. Teachers wrote many papers and share positive experience between Bulgarian and European Technology Entrepreneurship educators.

2.3.9 Related work & Sources

PATTERN FOR GRADUATE STUDENT COMPANY LIFE CYCLE (Petko Ruskov, Milena Stoycheva, Yanka Todorova 2009) [17].

Conclusion

The pattern thinking and approach are well suited to encourage university managers to expand their perspectives, and also to communicate and to develop the strategic skills and behavior required. Patterns idea is an entirely new approach for TEI education and supporting a 21st century human capital competences. The patterns way of managing the lifecycle and the presented techniques for identifying opportunities and creating action plans in order to ensure education efforts, is proofed to be successful. TEI MSc PROGRAM; TEI CURRICULA; AND TEACHERS TEAM patterns answer many questions concerning graduates' education.

The value of the patterns described in this paper is in integrating knowledge, experience, best practices and tools within one new strategy live-cycle for master program technology entrepreneurship. The described patterns show how to reuse design and implementation of the TEI MSc program.

In the future authors intend to continue the description of more patterns of MSc education in Technology Entrepreneurship and Innovation.

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