Introduction of Entrepreneurship Education in Engineering Curricula: Experience and Inspiration for National Technical University of Athens

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Abstract
In order to promote relation of higher education to labor market and shift economic development to a higher level, the Greek government is taking incentives to introduce entrepreneurship education to engineering curricula. While the Greek government has earned a certain experience during the implementation of incorporating entrepreneurship education, they are also faced with challenges. Entrepreneurship is a major driving force of increasing employment, improving economic vigor, and enhancing innovativeness. However, entrepreneurship education is still an emerging effort in Greece, or even the entire Europe. The practices and experience of NTUA in introducing entrepreneurship education to engineering curricula gives us the implications as the essence of entrepreneurship education is still the quality education.

Keywords: Greece, engineering curriculum, entrepreneurship education

1. ENTREPRENEURSHIP EDUCATION IN GREEK HIGHER EDUCATION INSTITUTIONS

In order to reverse the economic depression, the Lisbon 2000 European Council Summit determined to increase the competitiveness of European Union in order to achieve the goal of becoming “the most competitive and dynamic economic entity in the world” by 2010 (Skayannis, 2010). In 2005, EU proposed the “Strategy for development and employment”, which regarded economic growth and employment as the two core components of the new Lisbon strategy. As stated in 2007 Lisbon Strategic Report, “one third of graduates from Greek higher education institutions suffer from unemployment; the rate is over two times that of EU average, which is 14%.” Greece has been the only EU member state where unemployment increases with the improvement of education level. The recent (2008 - 2010) economic crisis in Europe, and situations of public sector debt (13.6%) as well as public deficit (115% of GDP) specifically in Greece, have made employment of Greek higher education institution graduates even more problematic. Faced with the disagreement between graduates cultivated by higher education and realistic expectations from labor market, Greek government has been proactively promoting entrepreneurship education to further enhance the bond between higher education and labor market, which is in alignment with the core spirit of the Lisbon strategy.

The number of new enterprises in Greece has been sliding between 1990 and 2003 (Hellenic Federation of Enterprises 2004). Entrepreneurship activities are well known for their small scale, technical and organizational features as well as slow transition of management process. They are primarily either low-tech oriented, or based on low cost or under protection measures against strong competitive pressure. Additionally, all research and development system indicators of reflect that business sector is reluctant to take advantage of R&D when improving its competitiveness as well as that they are unable to make use of external technology, for innovativeness has been comparatively weak in EU. After the Lisbon Council, entrepreneurship education was introduced into other departments and schools than economic schools, funded by Greece Operational Programme on Education and Initial Vocational Training. 28 higher education institutions have participated in entrepreneurship education since 2002 in Greece (Papayannakis, 2008). The introduction of entrepreneurship education into higher education institution has been a significant approach for the economic development and graduate employment promotion. All participant institutions in entrepreneurship education have reached the agreement that the value of entrepreneurship education lies in the growth of entrepreneurship and the economic development that follows, and that the key of entrepreneurship education is to arm students with entrepreneurship and enthusiastic attitude toward entrepreneurship activities rather than setting up new enterprises.

In the process of developing and promoting entrepreneurship education, the Greece government, during the exploration of relationship between entrepreneurship education and labor market, discovers that 25% of managers in Greece have engineering backgrounds, while recent research shows that engineering curricula fall short in economic and managerial knowledge; engineers seem discontent of their study for the knowledge and skills in the new areas that are contemporarily required. Several scholars advocated that engineering and economic as well as managerial skills should be combined to attend to the establishment and operation of a new
firm. They stressed the requirement of engineers having enterprise, social and inter-personal skills which enable them to prosper in their organizational circumstances at work. Taking Canada for example, there has been a big positive correlation between entrepreneurship education and establishing new firms, as 40% engineering student with entrepreneurship education end up creating their own companies. In order to match the skills of engineers and requirements of emerging knowledge economy, students not only are expected to study entrepreneurship activities, but also should have clear understanding of the interaction between technology and economy. To this end, the Greece government is actively promoting the establishment of entrepreneurship courses within engineering curricula in higher education institutions, so that 1) future engineers are provided with entrepreneurship and management skills, 2) their capabilities of meeting the new needs of knowledge economy are improved, and 3) the issue of disagreement between higher education talent development and labor market requirements is solved.

2. NETWORK TEACHING PLATFORM BASED ON INTERNET

2.1. Network teaching platform

Network education with its flexible and diverse characteristics of school education, countries continue to rapidly become one of mainstream education, social education, community education has become one of the core competition based on the point of national educational development technology. The western developed countries have made all kinds of subsides and support policies to help the network education providers, developers and service providers to improve their quality of education resources, expand the influence of network teaching and network learning, network teaching will be regarded as the traditional school education has concentrated force complement. The Chinese government has opened the network education in more than 350 universities, covering the mainstream education, with online and offline mode for students to provide quality and efficient means of learning. Supporting technology of network education is the network education of all kinds of software and hardware platform, they work together to provide users with fast, high quality, interactive learning environment, in-depth analysis of the system function module can grasp the development characteristics of current network education, the development of clear thinking, to carry out the design and lay the foundation for the development of such systems.

*WEBCT*: it is a network computer system for Bristal Columbia of the University of education and learning system, including the function of online learning, multimedia teaching resources, teaching quality inspection, release the on-line test, performance management, learning curve, with course release etc.

*Vitual-U system*: it developed by the University of Simon Fraser, Canada, is unique in that it is easy to create and manage educational learning groups to facilitate discussion.

*WISH*: system is developed by the University of Pennsylavnia, based on the traditional network teaching platform, it can also realize the electronic whiteboard, video, e-mail, teaching resources management and other functions.

*Moodle*: the domestic translation for magic lamp system, is one of the well-known network learning system, by the Australian teacher Martin Dougiamas development, using PHP server script language, the database uses My SQL, guarantee the robust and stability of bottom support platform. Moodle is based on the SCORM interactive learning network standard, modular system design facilitates the integration with the third party educational resources. At present, China is gradually carrying out the
localization of Moodle, which may improve the current intelligent network education platform, the degree of integration is not enough.

2.2. System Architecture

The full name of the B/S architecture is Browser/Server, the browser / server architecture. Browser refers to the Web browser, a very small number of business logic in front of the realization, but the main business logic in the server side, Browser client, Web server and DB side of the so-called three layer architecture App. B/S architecture does not require special installation, only Web browser can. B/S architecture, the display logic to the Web browser, transaction logic on the Web App, so as to avoid a huge fat client, reducing the pressure on the client. Because the client contains little logic, it has also become a thin client.
3. CASE STUDY OF NATIONAL TECHNICAL UNIVERSITY OF ATHENS

National Technical University of Athens (NTUA), where one third of the Greek engineers come from, has the longest history in Greek technology sector. NTUA launched a program named “Development and implementation of entrepreneurship courses and supporting activities in the National Technical University of Athens” in 2003. Being an educational experiment, the program was intended to improve entrepreneurship education amongst undergraduate student to enhance their innovativeness and broaden their horizon in theoretical and practical issues during the establishment of new enterprises and initial phase of management. Major objectives of the program include (1) to help student gain confidence in creating and operating new firms through developing knowledge, essential skills and abilities of comprehension and judgment, (2) to form an environment where student utilize particular approaches and tools to study the evaluation of ideas, and (3) to materialize thoughts of students with specific framework to support potential entrepreneurs. The program primarily consists of theoretical lecturing, practical education and fundamental support accommodation.

3.1. Lecturing

A shared education pool including theoretical research, case study and specific software tools has been established to assist students in obtaining the first-hand available knowledge and skills in regards to enterprise behavior. These resources were positioned in a “Electronic Classroom” platform (a server that all student can log on). Every student could take advantage of the courses that are particularly designed with necessary entrepreneurship material related to each school through this platform. Instructors were participating in the training lecture as well, parallel to the educational activities of students. NTUA also developed partnership with The Athens University of Economics and Business based on specific topics and benefited from their management experience.

3.2. Practical Education

A famous case from NTUA in Greece or even the entire EU in terms of the practices of entrepreneur education is establishing virtual enterprise. The introduction of virtual enterprise compromises the lack of actual training in technical universities, and can be connected to the nation-wide entrepreneur training framework at the same time. This model has been considered as the “success model” by Greek Ministry of Education and promoted in national vocational training system. NTUA is also actively participating in various activities held by Europe JA-YE, which was established in September 2002 with the aim of spreading entrepreneurship ideology amongst students. Participant member universities need to assist student to create mini-enterprises on campus based on action-oriented educational philosophy. Mini-enterprises are those real firms undertaking production, sales or service provision under a certain protection conditions. Nearly 600,000 students are participating in management of mini-enterprises annually in EU.

3.3. Support system

The support system of entrepreneurship education from NTUA is realized through “entrepreneurship studio” and “entrepreneurship library”. The latter include specific theoretical and empirical research. The technological incubator, which is currently under construction, in Lavrion Technology Park is another parallel action that provides graduates who are willing to convert ideas to practices with important information network and materialized infrastructure.

The overall progress of entrepreneurship education in NTUA is shown in figure 1:
Students showed great interest in the implementation of entrepreneurship education in NTUA, both reflected in participation and course evaluation. They gave extremely high praises to entrepreneurship curricula, teaching materials, quality of teaching tools, the two-way approach and supporting facilities. Additionally, surveys for young engineer graduates strongly confirmed the belief that economic, management and entrepreneurship courses are highly rewarding to engineers. External evaluators (scholars and industrial personnel) believed that the integration of entrepreneurship education in NTUA’s curricula and the blended learning approach as an interesting and positive educational experiment deserved high recognition, and the deed could be disseminated to other sectors. The results of the program also drew interest of exterior organizations. For example, the Technical Chamber of Greece, the official association of engineers in Greece, showed the intention in taking part in the program and funding the enterprise design contest, awarding scholarship for theses and organizing graduate engineer seminars.

Several weaknesses and constraints, however, have also been revealed during the implementation of the program, primarily include:

1. Creating company does not equal to entrepreneurship education. European Foundation for Entrepreneurship Research and the European Foundation for Management Development have collectively stated in 2004 that this has become one constraint of introducing entrepreneurship education to European universities (Wilson, 2005). Most schools in NTUA are mostly concentrated on establishing new firms.

2. There are difficulties in multi-disciplinary curriculum design. Since the traditional education model is still in a dominant position, introducing non-technical subject, especially economic and management, is still a controversy. Taking into consideration of the existing over-loaded engineering curricula, acceptance of curriculum modification proves to be even a harder step to take.

3. The continuity of courses is not guaranteed. It is only secure if entrepreneurship courses are integrated into a coherent engineering curriculum design, while NTUA has only been exploring within a framework of a better continuity.

4. Particular instructors are needed for entrepreneurship education. There has been a lack in professional entrepreneurship education instructors, as there is not a single university with a degree in entrepreneurship education so far. All staff in NTUA participating in entrepreneurship education comes from other disciplines, either engineering or business and management.

4. CONCLUSIONS AND IMPLICATIONS

Entrepreneurship is a major driving force of increasing employment, improving economic vigor, and enhancing innovativeness. However, entrepreneurship education is still an emerging effort in Greece, or even...
the entire Europe. Heated discussion is still underway in terms of requirements and methods of introducing specific entrepreneurship courses to higher education. The practices and experience of NTUA in introducing entrepreneurship education to engineering curricula gives us the following implications:

1. Entrepreneurship education is one form of quality education. As pointed out by Dr. Timmons at Babson School in US, entrepreneurship education in universities does not resemble social employment trainings which deal with the issue of survival; nor is it a “fast track education for entrepreneurs”. The true meaning of entrepreneurship education lies in the “entrepreneurship genes” embodied in future generations, whose fundamental value is to develop revolutionary entrepreneurship(Xiang, 2003). The purpose of developing entrepreneurship education in engineering sector is to form the entrepreneurship spirit and the positive attitude toward entrepreneurship activities for students. Therefore, entrepreneurship education is far more than simply creating a new firm; it reaches to all sectors including economy, politics, military, science and technology, etc, as the essence of entrepreneurship education is quality education. Should entrepreneurship education be interpreted solely as establishing enterprises, its aiming sector will be restricted within the economic sector, which is a narrow and limited understanding of entrepreneurship education and practices. This is against the nature of entrepreneurship education.

2. The importance of developing entrepreneurship education in non-economic areas. Entrepreneurship education in member states in EU including Greece has been constantly expanding to sectors other than economy and business. Taking UK for example, approximately 95% of higher education institutions offer students various forms of entrepreneurship education. According to “Entrepreneurship Survey of Higher Education in England”, despite that business schools continue to account for the majority of entrepreneurship education (61%), development of entrepreneurship education in engineering, art and design, mathematics, natural science and medical area is flourishing, with the proportion of 8%, 8%, 4%, 4% and 1%, respectively. Entrepreneurship education help student identify and evaluate opportunities and provide them with necessary skills and knowledge to take advantage of those opportunities. Entrepreneurship education also offer business knowledge like marketing and management, which is generally difficult for non-economic student to obtain otherwise. EU particularly encourage member states to incorporate entrepreneurship and excellence competitiveness into engineering and technical disciplines, which allow students and scholars to better commercialize innovations and new technologies. Under the picture of China, promoting entrepreneurship education in non-economic area has significant implications on improving labor market and resolving employment difficulties for university graduates.

3. Inter-disciplinary curriculum design is a key component of entrepreneurship education research. With global competition heating up, entrepreneurship spirit has been gradually included in the strategic plan of different countries and international organizations. The current trend of trying to grant each and every university student the access to entrepreneurship education makes inter-disciplinary curriculum design more demanding than ever before. Through the development of over 60 years, inter-disciplinary entrepreneurship curriculum system has been maturely formed in the United States where many universities have developed teaching materials that are closer to students and reality and entrepreneurship case databases to provide vivid entrepreneurship references(Mei, 2009). The “Electronic Classroom” in NTUA, Greece, is also an effective attempt of inter-disciplinary curriculum design. Member states in EU encourage universities to blend entrepreneurship education into different discipline development. “Establish teamwork development and exploit business innovations, so that economic students, business students and students with other different backgrounds can jointly study together”. Entrepreneurship Survey of Higher Education in England, 2007, shows that business and management schools are the main providers of entrepreneurship education with 61% combined, followed by 9% from engineering schools, 8% from art and design discipline, and 5% from science discipline. The disciplinary orientation of educational content has been a common issue for Chinese universities. Inter-disciplinary penetrations are insufficient, along with the attention to the possible business opportunities through integration of theories and practices. The Opinions on vigorously promote innovation and entrepreneurship education and college students entrepreneurship work, issued by Ministry of Education in 2010, has considered the enhancement of innovative entrepreneurship education curriculum framework development as one of the major concerns.

4. Establishment of multiple entrepreneurship experimental platforms and centers. The improvement of incubators and science and technology parks provides university students with funds, locations, facilities and specialized instructions, which promises the eventual transition from innovation to entrepreneurship actions. The “Entrepreneurship Studio” “Entrepreneurship Library” and technology incubator in Lavrion Science and Technology Park are all excellent platform that offers student entrepreneurship and enterprise management all-round skill training, working as the converter of innovative entrepreneurship ideas. NTUA also takes part in activities from European JA-YE and build interactive platform that encompasses all kinds of social organizations and enterprises. So far, the entrepreneurship scheme competitions in China are more politicized than commercialized, as they lack participation of enterprises. The reciprocal situation between firms and universities is not yet formed and need to be completed continuously.
5. More effort are needed in building entrepreneurship instructor team. One of the most important obstacles for NTUA to promote entrepreneurship education is the limitation of entrepreneurship instructors, especially the professional instructors for entrepreneurship education. The number of universities with entrepreneurship master’s degree in Italy increased from two in 2003 to 11 in 2010. Entrepreneurship instructors in the United States usually possess both academic background in entrepreneurship and practical entrepreneurship experience. Semi-professional instructors with no entrepreneurship experience, former administrative instructors, and special entrepreneurship instructors produced by short-term intensive training account for most instructors for entrepreneurship in Chinese universities. Development of specialized entrepreneurship instructor team is a difficult and unfinished task in the long run.

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