

SCIENTIFIC AREA: TEACHING: METHODOLOGY AND TEACHING EXPERIENCES

**TEACHING INNOVATION – A COMPARISON BETWEEN COURSES IN EUROPE
AND IN THE USA**

Manuel Luís Au-Yong Oliveira, manueloliv@gmail.com, Faculty of Economics, University of Porto

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ABSTRACT

What role does the formal teaching of innovation management play? Courses in Europe and the USA are reviewed, especially two courses, MIETE, taught at the University of Porto, in Portugal, and the Stanford University and Michigan University model from the USA. As these flagship courses have resulted in real innovations being introduced into the market formal teaching may well play a decisive role in the larger scenario of real innovation management. A literature review was performed and these two aforementioned cases studied in depth – MIETE via repeated contact with its Director and through the analysis of other publicly available information; while the Stanford University and Michigan University model was analysed by way of a comprehensive publication. A model for innovation and entrepreneurship is put forward whereby personal characteristics, the environment, and career experience and formal teaching will all play a part in the output of innovation and entrepreneurship in society.

Key Words: Teaching, innovation, Europe, USA

1. INTRODUCTION

Today, creativity is sought after, praised, and nurtured. This has not always been the case though. Most human societies are conservative and do whatever possible to maintain their current form. The innovative scientist Galilei Galileo was denounced and imprisoned. Galilei's scientific forefather, Giordano Bruno, perished burned at the stake. Bach, van Gogh and Mendel weren't recognised while living. Freud, Darwin and Keynes were ridiculed. However, in our era, things are different. Innovation is now embraced (Gardner, 2006).

Teixeira (2004, p.1) states that “the importance of promoting innovation has been elevated up to a status of official standard since the Lisbon European Summit in 2000” and that “the strategic goal was put forward for Europe to become the most competitive and dynamic knowledge-based economy in the World over the next ten years” (ibid., p2). Innovation is seen to enhance employment and society through its improvement of economic competitiveness and thus the author was motivated to contribute to the understanding of its mechanisms.

What role does the formal teaching of innovation management play? Are countries and their enterprises more or less innovative due to the teaching practices nationwide? Is it possible to speak of a national culture being more conducive to innovation and if so how can it be developed to improve the competitiveness of nations?

The idea for this article came from a review of the extant literature on research of innovation management teaching which revealed that this area is currently under-developed. Top managers in organizations and industry consistently identify that innovation management and the creation of new products and services is one of their priorities. How then should business and engineering schools go about the teaching of innovation management?

The author hopes that this article may contribute in some way to the pedagogy debate, as new teaching and learning practices about innovation are believed to be needed, for both undergraduate and graduate courses, especially in Europe, where courses which unite technology training and the hands-on creation of new ventures are rare (Ferreira, 2007).

The knowledge that Portugal's innovation capability has improved satisfactorily over the last 40 years and especially from 1995-2001 (Teixeira, 2004) was another motivating factor for this study.

2. INNOVATIVENESS IS AN IMPORTANT PATH TO PERFORMANCE

At the Fórum Empresas 2007, held recently at the Faculty of Engineering of the University of Porto, René Cordeiro defended that we have gone from a Push Economy to a Pull Economy; in the former we had demand exceeding supply, in the latter we have supply exceeding demand. This means, in turn, that periodic product innovation is no longer enough – now we need to continuously innovate, both our products and our processes. Strong and stable companies have given way to fast and agile companies. A creative initiative is necessary, copying the competition means waiting and this will lead to failure. We need to manage innovation. Companies will grow if a culture of change is nurtured – the need to innovate is real.

Innovation is not confined to engineering, manufacturing or research but rather it extends across all parts of a business. Knowledge is possibly the most important input into the production of innovations (Winter, 1984).

Some academics refer that Organizational structure, strategy, as well as innovativeness are linked with performance (Capon *et al.*, 1992) and suggest that a company must innovate to gain a competitive advantage, whether it be to survive or grow (Deshpandé and Farley, 1999).

Based on 4,938 innovations, Edwards and Gordon (1984) classified innovations according to levels of significance: 1) innovations that establish an entirely new category of product, 2) innovations that are the first of their type on the market in an already existing product category, 3) innovations that represent a big improvement in existing technology, and 4) innovations that are a modest improvement designed to update an existing product.

Rui Guimarães recently spoke of (at a COTEC Portugal seminar in Porto, October 2007) how innovation deeply values knowledge. R&D produces knowledge and training diffuses it. However entrepreneurship, the enjoyment of taking calculated risks, to be able to learn from experience, involving the sharing of knowledge and the search for excellence, and the toleration of set-backs and failure, is also a necessary condition for innovation to occur.

3. COURSES IN EUROPE IN THE AREA OF INNOVATION AND ENTREPRENEURSHIP

“Innovation has not always received the scholarly attention it deserves... When innovation studies started to emerge as a separate field of research in the 1960s, it did so mostly outside the existing disciplines and the most prestigious universities... This is now changing.” (Fagerberg, 2005, p.1-2). The prestigious Science Policy Research Unit (SPRU, founded in 1965), at the University of Sussex, is an example of how possibly, at the time, “science studies” or “science policy studies” may have been a more acceptable term than “innovation studies” (*ibid.*). The Saïd Business School, at the University of Oxford and the Judge Business School, at the University of Cambridge, do currently offer innovation courses. The author ventures to state however that in the USA the courses are more “hands-on” (please refer to Tables 1 and 2). Note that Manchester Business School and the University of Nottingham Business School, also in Table 1 below, both ranked in the top ten in the UK this year (Kalta Consulting).

Peter Prud’Homme Van Reine (Ferreira, 2007) recently did an assessment of Masters level courses in entrepreneurship and innovation. According to Van Reine, universities typically offer Masters courses which focus upon research and theory (e.g. at Judge Business School, at the University of Cambridge, see table 1) whilst in polytechnics entrepreneurship programmes tend to focus on more practical issues. The development of a business plan may well be one of these issues (table 2 - Lally School of Management and Technology, Rensselaer Polytechnic Institute). Van Reine goes on to say that to stimulate independent entrepreneurship integrated programmes are needed, at the Masters level. However, the success of these programmes will not depend on their high interest but on their implementation, which is difficult, as unique capabilities are required: an approach which is interdisciplinary is needed, and academic rigour must be coupled with interaction with practitioners; and practical solution-seeking work, for the whole process of new business ventures, as well as entrepreneurship skill development, must be present and make a mark. In Europe universities which possess all of these capabilities are hard to come by, thus the existent focus of university entrepreneurship programmes on “theoretical aspects” (Ferreira, 2007, p.10) (another example can be found in the Netherlands, the Rotterdam School of Management, with its MSc in Entrepreneurship and New Business Venturing, which lacks in practical training).

According to Van Reine's research, the MIETE course at the University of Porto is "an innovative programme in Europe" (ibid.) and will contribute to the creation of a European entrepreneurial innovation culture, as it is specifically oriented to the launching of new technology ventures (thus different than HEC-Entrepreneurs (Paris), for example).

The University of Oslo (four Nobel Prize winners indicates the quality of the research at the University) Master programme in Innovation and Entrepreneurship, along with MIETE at the University of Porto, are examples of formal hands-on training in Europe though admittedly in the USA this sort of course is very much advanced. Note that MIETE had an initial partnership with an American university (NCSU – North Carolina State University) to start with and so its orientation may thus not be a surprise.

Table 1 – European courses in the area of innovation and entrepreneurship

Name of institution	Name of course	Details
Saïd Business School, University of Oxford (http://www.sbs.ox.ac.uk/MBA/programme/programme-overview.htm)	MBA	One year MBA. During the second term students undertake an Entrepreneurship project which involves the production of a complete business plan suitable for presentation to venture capitalists and other practitioners. The Entrepreneurship project offers a great chance to develop new products or business models in a safe environment. International contact with inventors is encouraged.
Judge Business School, University of Cambridge, UK (http://www.jbs.cam.ac.uk)	MPhil in Innovation, Strategy and Organisation	Full-time, nine months' masters programme combining advanced study and research. The programme explores innovation and change through three interconnecting themes: innovation and work practices, innovation and strategic change, and new organisational forms. Research methodology and a substantial dissertation form part of the programme. Oriented directly to those wishing to prepare for a career in academic research.
Manchester Business School, University of Manchester, UK (http://www.mbs.ac.uk)	Management of science, technology and innovation MSc	A taught course which can be taken as a one-year full-time course or part-time over two years. Looks at how knowledge and technology are generated and transferred for the good of society and the economy. The aim is to produce well trained analysts of science, technology and innovation, familiar with economic, social, political and management theories and approaches, and able to apply their knowledge at both an organizational (firm) level and policy level. There is a strong emphasis on research training, development of personal communication skills, team-working and presentation, which gives graduates an excellent basis to pursue careers in policy, management, consultancy, academic research and teaching.
Nottingham Business School, University of Nottingham, UK (http://www.nottingham.ac.uk)	MSc Entrepreneurship	Aims to develop an understanding of the management of innovation from a number of perspectives. Entrepreneurship Project undertaken to develop the experiences gained from previous semesters. Interactive problem-solving process explored. There is a strong focus on technology transfer from universities and research institutes out to industry and

		between industrial partners. Students will get "hands on" experience by researching technology transfer strategies in universities.
University of Oslo, Norway (http://www.uio.no)	MSc Innovation & entrepreneurship	Already during the first semester you will be exposed to entrepreneurship in practice, as you will be given the opportunity to work in a start-up company in Singapore or Boston. In the third semester, you will be immersed in the practical dimensions of entrepreneurship, when you are involved in leading the first phase of a real commercialisation process. This process will be based on research results from the Department of Informatics and the Department of Molecular Bioscience, and the work will involve writing a business plan, and undertaking market surveys and product development.

4. COURSES IN THE USA IN THE AREA OF INNOVATION AND ENTREPRENEURSHIP

JPIM (Journal of product innovation management) (2002) published a special issue on innovation management teaching in which several courses are analysed. Table 2 is a result of our analysis of this and other data. Stanford University, in particular, is very highly ranked Worldwide and this course is developed upon in the text below.

Table 2 – Details of courses in the USA (adapted from O'Connor, 2002; Cardozo *et al.*, 2002; Silvester *et al.*, 2002; and Lovejoy and Srinivasan, 2002)

Name of institution	Name of course	Details
Harvard Business School (http://www.hbs.edu/entrepreneurship/courses.html)	Harvard Business School Technology and Entrepreneurship Curriculum (HBSTEC) – E.g. MBA course Managing innovation and product development (MIPD)	Why are some organizations routinely more innovative than others? What strategies can be pursued to capture value from innovation? What capabilities must be developed in order to ensure that a firm responds effectively to sudden and dramatic technological and/or market changes? These issues will be explored in MIPD. Cases are given about innovating organisations. MIPD provides a set of frameworks and tools to help a general manager more effectively design and manage the strategies, processes, and organizational structures required for innovation.
Stanford University and University of Michigan	Integrated design for marketability and manufacturing (IDMM at Stanford); Integrated product development (IPD at Michigan)	A project is undertaken; student teams have to perform well in each of the marketing, manufacturing, engineering and design dimensions; hands-on manufacture of customer-ready prototypes is performed; a tradeshow occurs at the end; projects are subjected to a market-based performance test.
Carlson School of Management, Institute of Technology (the engineering school), Department of Biomedical Engineering; University of Minnesota	New product design and business development (for 2 nd year MBA's & Masters in Engineering students)	One year long course; heavy focus on learning by doing; heavy reliance on guest speakers; just-in-time topical lectures; industry counterparts involved a great deal; student teams work with company personnel on projects sponsored by individual companies so as to gain hands-on experience in a real product development project; time constraints stimulate learning.
Lally School of Management and Technology, Rensselaer	New product development - required 2 semester course	The goal is to immerse each student in a cross-functional team-oriented experience in

Polytechnic Institute	of all 1 st year MBA's	identifying, developing, and commercializing a new product; students forced to immerse in the market all the way; multidisciplinary approach, each student will have engaged in all activities that comprise the product development process by the end of the course; offers projects leading up to commercialization plan; faculty represent different views of the NPD process - marketing, manufacturing and accounting.
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5. MIETE (FEUP) VERSUS STANFORD UNIVERSITY/ UNIVERSITY OF MICHIGAN

These courses are examples of best teaching practices in Europe and in the USA and are compared in Table 3.

Table 3 – A comparison between two flagship innovation courses in Europe and the USA (adapted from Ferreira, 2007 and Lovejoy and Srinivasan, 2002)

Item analysed/ basis for comparison	Course: MIETE, at the University of Porto – note that the course has been adapted/ restructured following implementation, in practice, in Portugal (Europe)	Course: IDMM at Stanford University/ IPD at the University of Michigan (USA)
Course objective	The real objective is to assemble a sound and solid business plan (with real commercialization problems) ready to be analysed by investors by the end of the course	Objective is the hands-on manufacture of customer-ready prototypes in a simulated economic competition against benchmark products and against other student teams
Faculties responsible for the course	This course is a partnership between two faculties and thus resides in the Faculty of Engineering and the Faculty of Economics, both of the University of Porto	At Stanford the course resides in the Graduate School of Business and the School of Engineering (the Product Design Department resides within the Mechanical Engineering Department); at Michigan the course resides at the Business School, the College of Engineering, and the College of Art and Design
Type of participants/ students	Cross-disciplinary teams of students (no limit to student entries who must however be 2 nd cycle students who have completed 1 st cycle 3 year courses at university)	Cross-disciplinary teams of students (2 nd year MBA's; graduate engineering students; graduate students Art & Design)
Disciplines covered	Cross-disciplinary course - Involves faculty from several academic units (business, engineering and design, and any other technological course of the student's choice (thus providing the flexibility to adjust the technical training to the students' needs))	Cross-disciplinary course - Involves faculty from several academic units (business, engineering and design)
Type of training	Hands-on training - takes its participants through the entire venture creation process	Hands-on training - takes its participants through the entire venture creation process
Tools used during course	Combines real training in the innovation process and technology commercialization	Qualitative consumer research; product domain research; full-profile conjoint analysis; trade show; web channel (Michigan)
Financial support	MIETE has no financial sponsors	Stanford has the financial support

		of the Alliance for Innovative Manufacturing (AIM); Michigan is financially supported by the Tauber Manufacturing Institute (TMI) – both supporting organizations are dedicated to manufacturing education
Content delivery	Just-in-time (JIT) theory given to support the practical hands-on innovation process	Content delivery on a just-in-time basis (JIT) relevant to the project, to enhance student learning
External contacts by students during course	Contact with area specialists and cold-calling are encouraged	Potential customers and retail salespersons interviewed
Emphasis/ Analysis	Emphasis on products and corresponding markets	Alternative product offerings and available technologies analysed
Duration	Two year course dissertation included	Stanford – course runs across 20 weeks; at Michigan the course runs for 14 weeks
Student interaction	Interaction of its students with researchers from different fields at the University of Porto	Interviewees “potential customers” researched at the beginning and at the end of the course (at a trade show)
<i>Learning by doing</i> emphasis	Emphasis on learning by doing even if the technology is not commercialized in the end	Emphasis on learning by doing and from the experience of the final product competition
Faculty required	Course requires faculty with broad interests and experience with real practitioner innovation	Course requires faculty with broad interests
Product choice	Technologies are chosen by students in contact with the University of Porto R&D groups. Students are also allowed to follow their own path, their own ideas, and considering interaction with enterprises	Product category chosen by teachers to save time, be fair, and ensure machinery for prototyping is available; relevance for the customer population also taken into account
Results in practice	Two companies have been started as a result of the course since 2004	Commercial firms have purchased the rights for two of the new products developed by student teams over a period of ten years

6. A CLOSER LOOK AT MIETE: THE PORTUGUESE AND EUROPEAN CASE

Note that differences between MIETE and the Oslo programme include the fact that MIETE clearly utilises the resources at its disposal by promoting relations between its students and researchers from different disciplines at the University of Porto (areas such as medicine, pharmaceutical, sports, biomechanics and engineering are accessible to students) whilst at Oslo the scope students have access to is limited to interaction with only the Department of Informatics and the Department of Molecular Bioscience.

It is worth mentioning that the University of Porto (UP) is ranked 11th amongst the top Iberian-American research institutions in terms of scientific production (a total of 750 such institutions were analysed from 10 Iberian-American countries - Portugal, Spain, Brazil, Argentina, Chile, Columbia, Cuba, Mexico, Peru and Venezuela), and is thus the best in Portugal (please refer to the following web site for further information: <http://www.cienciahoje.pt/index.php?oid=21880&op=all>). The Technical University of Lisbon is the second best university in Portugal, placed 19th in this study, followed by the University of Lisbon, in 26th place. The University of Aveiro came 31st, and the University of Coimbra 33rd.

“Because it is its purpose to create a customer, any business enterprise has two – and only these two – basic functions: marketing and innovation. They are the entrepreneurial functions.” (Drucker, 1954, p.37). MIETE has these two anchors in its course curricula – marketing and innovation – with related subjects being given in the first and second semesters of the course – namely, marketing management, product and services development

management, entrepreneurship (all three given in the first semester); and managing innovation, and business creation and development (both second semester subjects); and thus closely follows the above.

MIETE's real objective "is to assemble a sound and solid business plan ready to be analysed by investors by the end of the course" (Ferreira, 2007, p.8). People of all types are wanted in MIETE - multidisciplinary/ a mix is seen to be very important for the course, people from various areas being mixed together. Each person will bring their particular vision to a problem and their experience also.

Robin Lowe, principal lecturer in marketing at Sheffield Hallam University and Head of the Sheffield Business School Enterprise Centre stated that Masters programmes are changing considerably in the 2000s and problem-focused approaches are more relevant than the traditional low risk MBA. Lowe went on to say that MIETE is especially interesting because it integrates business and technology and creates a new business where appropriate; one needs to reflect on and re-evaluate issues, not simply acquire some theories for handling generic problems, and working on a real case will provide the necessary confidence to trigger decision making that will, in turn, lead to the right consequences for a business over the long term (http://miete-blog.blogspot.com/2006_01_01_archive.html).

7. INTERSECTIONAL INNOVATION

Johansson (2006) states that for intersectional innovation to occur (advances in new directions which create a space of their own) the ability to easily link different concepts from different fields must exist. One must knock down associative barriers (that lead to quick, focused solutions) which habitually separate different areas so that one's ideas can go that much further. Previous experience should not be the sole source of solutions encountered – innovators think of solutions not contemplated before, and can do this due to their low associative barriers. Specialists may be too focused so a process must be followed to make their barriers fall, a process which should include:

- Be exposed to various cultures – e.g. of students, faculty, course content/ programmes (have an open attitude)
- Learn differently (i.e. not in the fashion that is normal for academic institutions as this would be a limiting factor of creativity) – *learn by doing*

The multidisciplinary teams, the various disciplines studied, the diverse faculty and the *learning by doing* philosophy, at MIETE and at Stanford/ Michigan, discussed above, promote what is believed to be a beneficial environment for intersectional ideas to occur.

8. A MODEL FOR INNOVATION AND ENTREPRENEURSHIP

Figure 1, below, summarizes the findings of this study. The level of innovation and entrepreneurship in society is seen to depend upon personal characteristics (energy level, intelligence and tolerance of uncertainty), the environment (accessibility of knowledge leaders), and career experiences (assignments which broaden, and promotion of learning by doing). The latter may be impacted by formal teaching. These concepts are developed further below.

Reference will be made (in 8.1, 8.3 and 8.4) to Hofstede's national cultural framework (1984, 1991, 2001), the most widely used in the scholarly domains such as marketing and management studies (Steenkamp, 2001; Soares *et al.*, 2007).

8.1 PERSONAL CHARACTERISTICS - ENERGY LEVEL

A very high energy level is needed to overcome the difficulties involved in producing innovation. Interviewee, and MIETE Director, João José Pinto Ferreira stated that: "The essential prerequisite for a MIETE student is that he or she be motivated to work, that they want to work hard. To want to work hard is essential... We encourage people to try again and to understand that this [innovation] is a searching process, solutions are not found the first time around..."

This aspect of the model is seen to be related to Long Term Orientation (LTO) (Hofstede, 2001), or perseverance and the orientation towards rewards that may only be received in the not so near future.

8.2 PERSONAL CHARACTERISTICS - INTELLIGENCE

In ever more complex environments the innovation process requires sufficient intelligence to successfully manage and lead in a multidisciplinary setting. According to João José Pinto Ferreira, “Innovation has to have two things: novelty and economic or social value. What we do is confront students with the need to find a product or range of products for the market. There are methodologies that lead to a creative solution to a given problem, and we encourage the use of those methodologies.” Without sufficient basic intelligence it will be difficult to set the right direction and accomplish innovation.

8.3 PERSONAL CHARACTERISTICS - TOLERANCE OF UNCERTAINTY

According to the Harvard Business School course Managing innovation and product development we see that: “A distinctive feature of this course is a focus on the relationship between innovation and uncertainty, and the point of view that uncertainty presents opportunities to firms. Putting uncertainty front and centre leads to a deeper appreciation of the innovation challenge. It is not so much to plan, forecast, or predict better; that is, to make decisions based upon what an organization already knows. Rather it is to prepare for, and adapt to, what an organization does not know, so as to benefit from a variety of future possibilities. The course focuses on how organizations can take advantage of uncertainty, focusing on the design of effective processes and structures at multiple levels of the firm.” (<http://www.hbs.edu/mba/academics/coursecatalog/2130.html>).

High uncertainty avoidance cultures, such as Portugal (Hofstede, 2001), may have a problem with the above. Some cultures tolerate uncertainty better than others. For example, Portugal scored very highly in uncertainty avoidance, indeed the second highest of 53 countries analysed Worldwide (ibid.). Uncertainty avoidance, or uncertainty aversion, “results in the assumption that uncertainty is bad” (Usunier and Lee, 2005, p.59). Our research supports the concept that in such cultures individuals will not respond well in innovation settings where results are uncertain, where uncertainty abounds.

Culture is for the most part ingrained in us since childhood and one can speak of large groups e.g. societies as having specific cultural dimensions. However, individual differences will exist and the author upholds that those who can tolerate the uncertainty of the innovation process will be in the best position to contribute more to the innovation and entrepreneurialship of a given society.

It is interesting to add that in a study of eleven EU countries Steenkamp (1999) also found that national cultural uncertainty avoidance has a negative effect on consumer innovativeness. Portugal scored the lowest for consumer innovativeness out of the eleven countries analysed.

8.4 ENVIRONMENT - ACCESSIBILITY OF KNOWLEDGE LEADERS

Interviewee João José Pinto Ferreira stated that “Our students make contact with CEOs and specialists and it is very easy to talk to these persons in the USA. They are very accessible. They are able to give 5 minutes to a student on the phone with the Atlantic Ocean between them. Just to say that CEOs and specialists in the USA will answer the phone. I was really surprised!”

Being able to work with top specialists in a field can greatly enhance the possibility of success of a given innovation process.

The concept of Power distance (Hofstede, 2001) may well be related to the concept of accessibility of knowledge leaders and it would be interesting to develop this further. The author believes that power may be displayed and exercised more by superiors in countries such as Portugal when compared to countries with lower power distance cultures, such as the USA, the UK or Norway (ibid.; Usunier and Lee, 2005). When asked whether Portugal needs to change in this aspect, interviewee João José Pinto Ferreira said: “We have no alternative.” The question remains as to how long it will take us to change our culture in Portugal. It is worth noting that cultures change albeit at a very slow rate (Sivakumar and Nakata, 2001; Soares *et al.*, 2007). Hofstede supports the argument that his country index scores should be valid “until at least 2100... influences like those of new

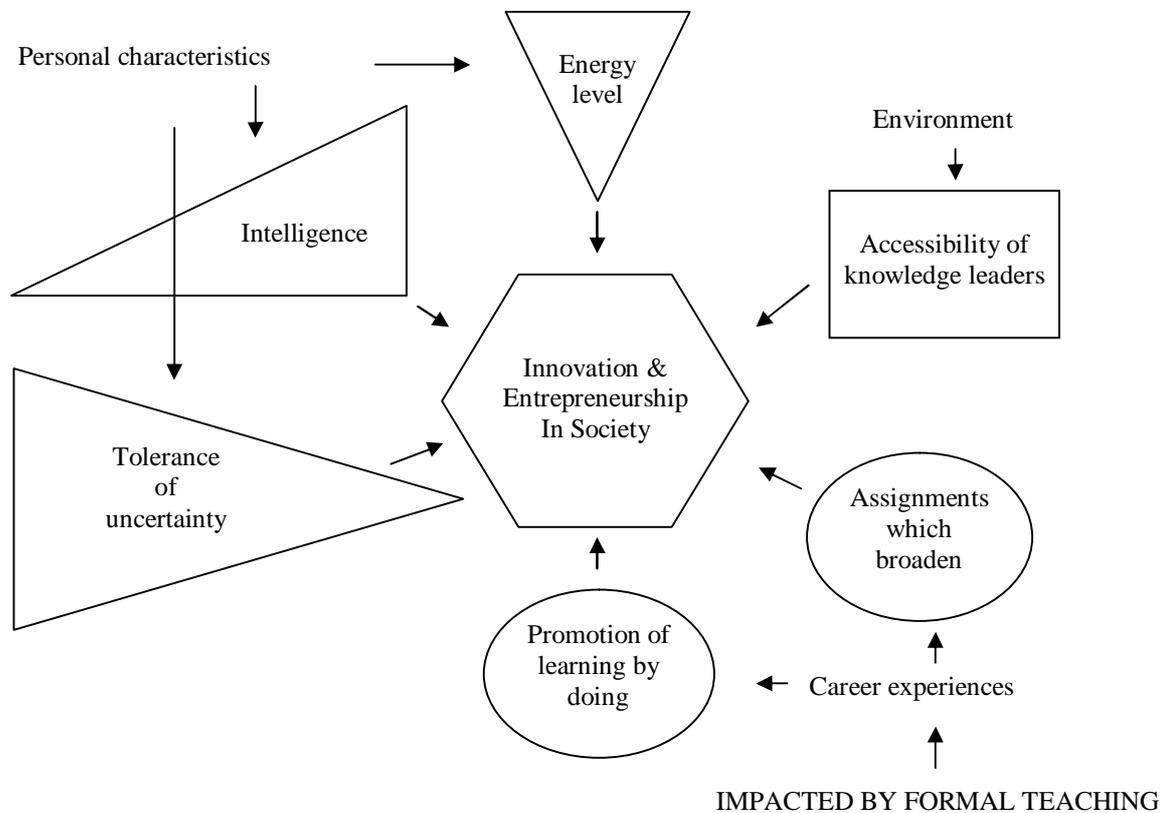
technologies tend to affect all countries without necessarily changing their relative position or ranking” (Hofstede, 2001, p.36).

8.5 CAREER EXPERIENCES/ FORMAL TEACHING - ASSIGNMENTS WHICH BROADEN

Breadth of knowledge is of utmost importance for innovation to occur. Specialists may be too focused so a process must be followed to make their barriers fall (Johansson, 2006). The formal teaching of innovation may make a difference here.

Lovejoy and Srinivasan (2002) remark that business students and faculty are very different from design circle counterparts, the former being naturally more competitive and more secretive (less cooperative). Bringing these two distinct cultures together poses a challenge. Exposure to the IDMM (Stanford) / IPD (Michigan) course is seen as a path which broadens and “administrators, faculty and students all perceive themselves to be better off with the course than without it” (ibid., p.44).

Figure 1 – Entrepreneurship and the role of formal teaching



8.6 CAREER EXPERIENCES/ FORMAL TEACHING - PROMOTION OF LEARNING BY DOING

Entrepreneurship is, according to Peter Drucker, *the systematic practice of innovation*. At MIETE and at Stanford/ Michigan they believe that only by doing do you learn. This may be true in any country. There is an old saying that “what you hear you will forget, what you see you will remember, what you do, you will learn.” MIETE Director stated: “One only becomes a specialist by doing! If I don’t *do*, I won’t be confronted with a series of difficulties which in another fashion I wouldn’t have. An entrepreneur - he or she who systematically innovates - can’t give up because he or she failed. People have to be confronted with the surpassing of difficulties – which is the daily reality.” Niels Bohr (Nobel Prize, Physics, 1922) remarked that “An expert is a person who has made all the mistakes that can be made in a very narrow field.” (quoted in Hernández-Serrano *et al.*, 2002,p.54).

9. CONCLUSION

Gardner states that “the life of the professional is not equivalent to the life of the young student... for pedagogies to be effective, both students and teachers must operate on a level quite different from that typically followed” (Gardner, 2006, p.30).

The way MIETE is taught, at the University of Porto – involving the assembly of a sound and solid business plan (with real commercialization problems) ready to be analysed by investors by the end of the course – has resulted in two innovative companies being set up and so the methodology followed, very “hands-on”, is seen to be favourable to this occurring. The Stanford/ Michigan model, which involves the hands-on manufacture of customer-ready prototypes in a simulated economic competition against benchmark products and against other student teams, has also led to commercial firms having purchased the rights for two of the new products developed by student teams.

Formal teaching then, when used as a means to coach and provide feedback to real problems, may well play a decisive role in the larger scenario of real innovation management.

The model proposed for innovation and entrepreneurship output is in line with research carried out about innovation processes by Peter Prud'homme van Reine (conference about "The key role of entrepreneurship in creating and sustaining cultures of innovation, Faculty of Engineering, University of Porto, 2007), namely that innovation processes are based on uncertainty and create uncertainty. One has to combine danger with opportunity, like the word “crisis” in the Chinese language, which means both. Creativity, the capacity to improvise, will be linked to the degree of uncertainty accepted in a society. Furthermore, van Reine similarly believes that low power distance (or the accessibility of knowledge leaders) will lead to greater levels of innovation; both within a company, where empowerment can play its role, and also in society. A high energy level is needed and thus a long term orientation is crucial as it will oftentimes be a visionary sense and the search for future rewards that will see individuals and companies through the innovation process successfully.

10. RECOMMENDATIONS FOR FUTURE RESEARCH

Future research might develop the following topics:

- Are countries and their enterprises more or less innovative due to the teaching practices nationwide?
- Is it possible to speak of a national culture being more conducive to innovation and if so how can it be developed to improve the competitiveness of nations?

Concerning the latter research topic, the national cultural dimension of uncertainty avoidance (Hofstede, 2001), referred to above, could be studied further and an additional link could be made between levels of innovation in a country and its level of uncertainty avoidance. Is it possible to talk of innovation-adverse cultures? If so, how should the teaching of innovation be undertaken in such conditions? Will the challenge be greater?

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