Original Article

Best practices for developing university bioentrepreneurship education programmes

Received (in revised form): 15th September 2008

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ABSTRACT **The objective of this paper is to present a comprehensive overview on the bioentrepreneurship education programme organised within the framework of the project 'Technological Entrepreneurship at the Free University of Brussels (Vrije Universiteit Brussel, VUB)'. The main motivations for implementing this high-technology entrepreneurship education programme are the threats posed by the low entrepreneurial activity in Belgium and by the European innovation paradox. The biotechnology programme was implemented**

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to stimulate and teach bioentrepreneurship among master students in business and bio-engineering at the university. The theoretical background of the paper focuses on entrepreneurship education in an academic environment and relating success factors to discover possible solutions. Following this, the paper presents a case study on the bioentrepreneurship programme implemented at the VUB. The main objective of the project is to develop and implement a set of integrated, interdisciplinary courses, organised by different faculties and attended by students in business and in bio-engineering. By presenting this solution and showing that it is possible to implement an interdisciplinary educational programme on bioentrepreneurship in a university environment, the authors suggest increasing the number of such programmes across European universities.

Journal of Commercial Biotechnology (2009) **15,** 136–150. doi:10.1057/jcb.2008.44;
published online 18 November 2008

Keywords: bioentrepreneurship; entrepreneurship education; high-technology entrepreneurship; higher education

INTRODUCTION

Europe's future economic outlook is undermined by the alleged innovation paradox. At the European Innovation day in Brussels (2006), the Finnish Prime Minister, Mr Vanhanen, summarised the problem as followed: 'Europe is not innovation poor, but we have a real European paradox – we invest substantially in education and R&D spending is increasing but, for some reason, the investment does not translate into successful companies, new products and good jobs'.[1] In the long run, this lack of technology transfer may result in an unfavourable economic situation for Europe. After all, stagnation means decline.

The last decades, the concept of creative destruction, which was coined by Joseph Schumpeter in his book *Capital, Socialism and Democracy* in 1942,[2] was and is used by many governments to launch multiple programmes to stimulate innovation and entrepreneurship in a country or region, especially with a focus on high technology. This is proved by the numerous self-declared biotechnology clusters emerging in Europe, usually supported by regional governments. Although the situation is slightly improving, the innovation paradox remains one of Europe's biggest challenges for the future as is recognised by the member states in the Lisbon treaty.

The objective of the paper is to present a comprehensive overview on the bioentrepreneurship education programme organised within the framework of the project 'Technological Entrepreneurship at the Free University of Brussels (Vrije Universiteit Brussel, VUB)'. The project addresses some of the problems described by Mr Vanhanen, and hopefully contributes to solving the paradox by promoting high-technology entrepreneurship among university students. As an introduction, the background of the project is sketched, along with some interesting research on entrepreneurship. Following this, the paper discusses the educational theory frameworks constructing the programme. The bioentrepreneurship curriculum is then presented as a case study and can be used as a basic structure or source of inspiration for other bioentrepreneurship education initiatives. Before drawing final conclusions, we evaluate the implemented project against best practices in the field.

THE BELGIAN SITUATION

The Belgian biotechnology industry

Belgium, being a small and open economy in the heart of Europe, is also a victim of the European innovation paradox. In the field of biotechnology research, Belgium has always

been a world-class player. This is illustrated by the work of researchers like Marc Van Montagu and Jeff Schell who invented the first technology to introduce recombinant genes in plants. The first genetically modified plant in the world (a petunia) grew in Ghent and shortly after this breakthrough, one of the world's first green biotechnology companies, Plant Genetic Systems (now Bayer CropScience), was founded in 1982. Simultaneously; Walter Fiers, Desiré Collen and many other Belgian researchers became renowned for their advancements in the field of biotechnology.[3]

Together with the foundation of companies like Innogenetics and Thromb-X, these breakthroughs illustrate the biotechnology excellence present in Belgium at that time. Despite these early successes, the formation of new successful biotechnology companies in Belgium dropped to virtually zero until the end of the 1990s.[4,5]

From that moment on, the story of the Belgian biotechnology industry is roughly parallel to the development of biotechnology industry in the rest of continental Europe. Even with enormous government support for basic research, Europe was unable to catch up with the thriving US biotechnology industry. It is only now, a couple of years after the burst of the genomics bubble that things are getting better for Europe. Measured in terms of revenue, attracted capital or employment, Europe cannot compete with its US counterpart. Europe, however, has a higher rate (50 per cent) of new company foundation than the US. Taking into account the higher share of large companies (in terms of employment and revenues) in the US, we can state that the US biotechnology industry is more mature than the European biotechnology industry.[6,7]

Flanders, the northern part of Belgium, has a strong growing biotechnology industry, driven by the presence of world-class scientific research and the commitment of the Flemish government towards the biotechnology industry.[4] It is due to initiatives like the foundation of the Flanders Institute of Biotechnology (VIB) that the region kept its top position in the world of scientific research and is increasingly able to translate this position into new biotechnology companies. Nowadays, Flanders counts over 45 dedicated biotechnology companies, of which most are small or medium-sized companies.[8] The growth of the biotechnology industry in our region increases the demand for scientists, managers and entrepreneurs with an interest in biotechnology.

Entrepreneurship level in Belgium

It is observed that, as per capita income increases in high-income countries, the prevalence rate of early-stage entrepreneurship also increases as more opportunities may arise. Yet, significant differences in early-stage entrepreneurship prevalence are observed within the group of high-income countries. 'Among high-income countries, Iceland (12.5 per cent), Hong Kong (10.0 per cent) and the United States (9.6 per cent) show the highest levels of early-stage entrepreneurial activity. Lowest rates were found in Austria (2.4 per cent), Puerto Rico (3.1 per cent) and Belgium (3.2 per cent)'.[9] These variations are influenced by differences in cultural, demographic and institutional factors.[9]

Considering the overall entrepreneurial activity in high-income countries (see Table 1), comparison with other countries in the sample shows that Belgium is the least entrepreneurial high-income country.[9] This suggests that the cultural, demographic and institutional influences supporting entrepreneurship are practically absent in Belgium.

This observation, together with the growing demand for entrepreneurs by the biotechnology industry, implies that there is trouble ahead. To keep the Flemish biotechnology industry growing and to solve the innovation paradox, there is a strong need to stimulate (high-technology) entrepreneurship, especially in higher education.

Table 1: Overall entrepreneurial activity in high-income countries

High-income country	*Overall entrepreneurial activity (%)*
Austria	8.4
Belgium	4.6
Denmark	11.1
Finland	14.0
France	4.8
Greece	18.7
Hong Kong	15.0
Iceland	19.8
Ireland	16.8
Israel	7.4
Italy	10.4
Japan	12.6
Netherlands	11.3
Norway	12.0
Portugal	15.4
Puerto Rico	5.2
Slovenia	9.3
Spain	13.4
Sweden	8.8
Switzerland	12.7
United Arab Emirates	11.8
United Kingdom	10.5
United States	14.1

Adopted from the GEM 2007 report (p. 16).[9]

SOLVING THE INNOVATION PARADOX: A FOCUS ON ENTREPRENEURS

To sustain the growth of the biotechnology industry in the Flanders region, it is necessary that we solve the innovation paradox. There are numerous possibilities to try and address the paradox, like the popular top-down approach where governments provide incentives for young, innovative companies.

The authors believe that it is vital for governments to recognise the importance of the 'entrepreneur' when looking for a solution to the paradox. A government can merely set and support the right conditions for a highly innovative industry to grow, but it can seldom translate a technology platform into a successful company. To achieve this, an individual who is willing and able to create real value out of potential value, an entrepreneur, is needed.

In a high-technology context, particularly in the biotechnology context, these issues are even more complicated. One individual cannot set up and run an innovative biotechnology company. The topic of having the right entrepreneurial team in place to grow a successful young and innovative company will be discussed later on in section 'But we want successful, growth-oriented companies…'.

With the project 'Technological Entrepreneurship at the VUB', we try to focus on this future high-technology entrepreneurs by providing them with an educational programme fitted for the specific demands of a technology, such as biotechnology. In the next paragraphs, we try to outline some basic findings on entrepreneurs and entrepreneurship education to determine what we can achieve in higher education.

SUPPORTING ENTREPRENEURSHIP: WHERE TO START?

As shown in Figure 1, the authors[9] of the Global Entrepreneurship Monitor (GEM) constructed a 'value chain of entrepreneurship' based on existing literature, defining the path of the individual entrepreneur engaging in the foundation of a new venture.

This framework provides some interesting insights from an educational point of view. It is clear that in the context of education, the target groups of (master) students in business and science will most likely position themselves at the left side of this value chain (potential entrepreneurs).

The conceptual model identifies several important drivers for 'national entrepreneurial capacity'. Eventually, the drive towards (or away from) entrepreneurship comes from the potential entrepreneur's perception towards own skills and the environment. The more confident the potential entrepreneur is about these factors, the more likely the step towards nascent entrepreneurship becomes. According to the GEM report, these factors can be possibly determined by educational programmes and the presence of successful

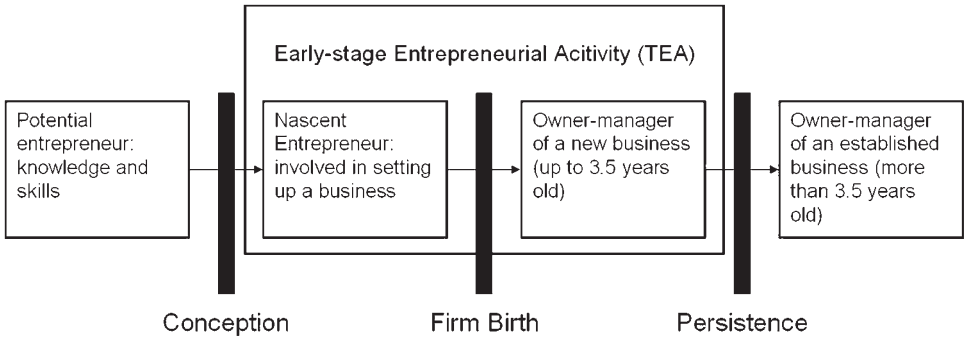

Figure 1: The GEM conceptual model, adopted from the GEM 2007 executive report (p. 4).

entrepreneurs within the potential entrepreneur's environment. Of course, it is equally important for entrepreneurs to be able to spot opportunities arising in the market. This is an aspect that can be trained during education. Also very important are the demographic determinants of entrepreneurship. The cultural and institutional support for entrepreneurs differs across countries and has an impact on the prevalence of entrepreneurial activity. When stimulating bioentrepreneurship during higher education, it is the aim of the academic staff to identify and motivate the potential entrepreneurs in the classroom; to make them more confident about their skills and experience regarding entrepreneurship and to get the potential entrepreneurs in touch with successful entrepreneurs. All this should lead to an improved perception of own ability to start up a company and should facilitate the step towards early-stage entrepreneurial activity.

BUT WE WANT SUCCESSFUL, GROWTH-ORIENTED COMPANIES…

When looking at the economic situation of a country or region and in particular to the formation rate of new companies, it is important to put the findings into perspective. First of all, people can start a new company out of necessity, to survive. This form of entrepreneurship is not very prevalent in high-income countries, where a strong social support system is usually in place. In high-income countries, a company is typically founded because an opportunity arises. On the one hand, entrepreneurs engage in the foundation of companies which are not oriented on growth. On the other, growth-oriented, new technology-based firms (NTBFs) that form the basis of the future economic growth are founded. '… NTBFs are thought to embody the technologies of the future which will provide secure employment opportunities for several generations'.[10]

The authors Iris Vanaelst and Bart Clarysse analyse the relationship between the entrepreneurial teams and the performance of young innovative companies. They revealed some of the factors determining the future success of young innovative companies.[11–13] In a selection of innovative high-technology new ventures, Vanaelst and Clarysse compared the entrepreneurial teams of 20 most successful and 20 least successful young innovative Flemish companies. In this case, success was measured by the growth of the companies in both revenue and employment.

Vanaelst and Clarysse[14] define four types of start-up teams: family teams, solo-entrepreneurs, composed teams and organic teams. These different types are presented in Figure 2. The horizontal axis shows the strength of the instrumental relationship between the start-up team members, that is, whether the team members possess the complementary

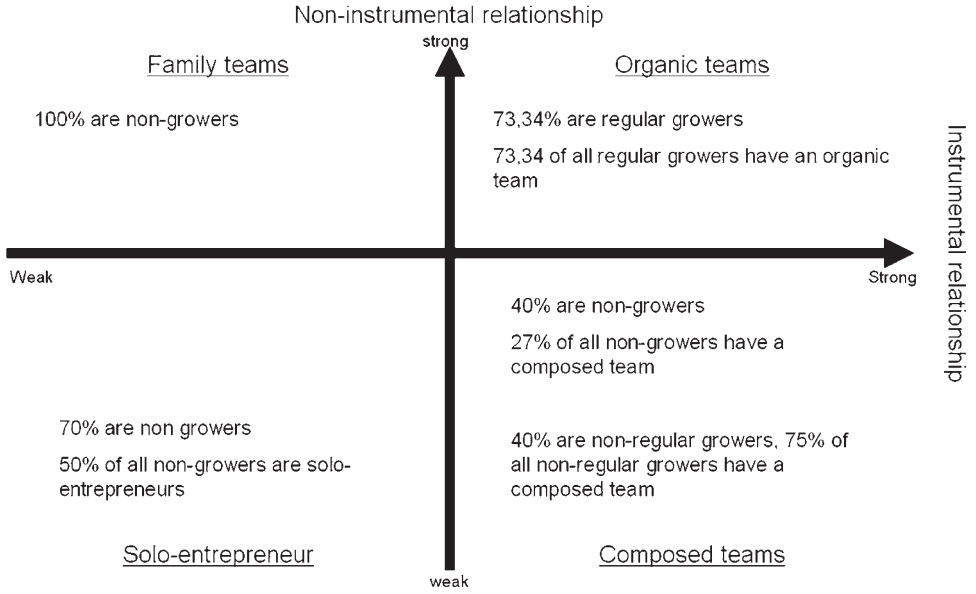

Figure 2: Entrepreneurial teams and growth, adopted from Vanaelst and Clarysse (p. 130).[14]

experience or skills necessary to realise an opportunity. The vertical axis shows the strength of the non-instrumental relationships between the team members, that is, the affective bond between the entrepreneurs.

When matching the growth of companies with the type of relationships prevailing between the entrepreneurial team members before founding the new venture, some very interesting observations, especially towards composed and organic teams, were made. Start-up teams composed of team members with complementary functional experience are usually more successful than unbalanced teams because of their confronting opinion on the company's strategy. This often leads to a personal conflict within teams composed solely on the instrumental basis. The presence of personal conflicts in a company has a negative effect on the growth path of that company. Organic teams, composed with team members who are already acquainted and respect each other and who have complementary skills, often succeed in not letting the confronting opinion on the management of the company result into a personal conflict. The lower rate of personal conflicts leads to a more sustainable growth of the company.[15] Another study on success factors of entrepreneurial teams was conducted by Lechler.[16] The author concludes that the social interaction of team members influences the new venture success. In this study, social interaction is composed of the following factors: communication, cohesion, work norms, mutual support, coordination and the balance of member contributions. The concern on communication is also shared by the authors Vyakarnam *et al.*[15] in their paper based on a literature review and a qualitative study about the relation between entrepreneurial teams and venture growth and success. The authors highlight that effective teams should have a clear and shared understanding on the goals and the vision of the new venture to be successful. Additionally, rapid growing firms should have clear leadership from the top team. The authors state that criteria for integrating new team members should be based on the individual's experience in the industry and in growth-oriented companies, the ability to fit

in the organisational culture and personal credibility. Furthermore, the candidate's network, technical competences and trustworthiness are important. Another research from Ardichvili *et al.*[17] analysed whether personality traits have an impact on the success of entrepreneurial ventures. The authors conclude that generally, no significant determinants occurred. Two traits, optimism and creativity, however, show to be related to successful opportunity recognition. The brief literature review showed that organic teams in relation to the social interaction of the team members have an impact on the success and growth of a new venture.

When trying to explain the growth path of young innovative companies, Heirman and Clarysse[5] show that experience in R&D (a proxy for the strength of the company's technology base) had no significant impact on the growth of a company. The difference in growth paths of the sample companies could be explained by the difference in the amount of commercial expertise present in the start-up teams. The presence of this kind of experience had a significant positive effect on the growth of the company. Furthermore, it is not sufficient to only have commercial experience within the newly formed companies, it is also significant to have expertise within the sector or technology.[5]

TEACHING ENTREPRENEURSHIP AT UNIVERSITY

Kloftsen[18] names three basic activities that 'should be found at a university' to stimulate entrepreneurship. At first, these are the activities that create and maintain a university-wide 'enterprising culture'. Secondly, there have to be special courses in entrepreneurship 'where students can learn more about entrepreneurship as a subject itself'. Thirdly, there should be special 'training programmes' for individuals who would like to start their own business.

When conceptualising courses in entrepreneurship education, the main focus is on adequate entrepreneurial qualification of students interested in starting a new venture. This qualification is, according to Sabisch and Meissner,[19] an important factor when solving constraints related to new ventures. The students are often not familiar with necessary business know-how. Additionally, Braukmann[20] argues that entrepreneurship education should be integrated in the curriculum of a student. A comprehensive preparation of students is essential if they decide to set up a business of their own.

There are different approaches to implement entrepreneurship education programmes in a university. Myrah and Currie[21] state a 'lack of standardisation' within these programmes. Missing standardisation, these programmes do have in common that they aim at a successful education of students who are interested in setting up a new venture or being self-employed. An example for such a programme is the three-stage programme by Ripsas.[22] On the basis of this programme, Beer[23] developed an advanced programme. Another example is the model of Jones and English.[24] The challenging aspect of developing such university programmes is the complex character of entrepreneurship education. This is due to the fact that there are interfaces between classic business administration science and with other sciences such as sociology or psychology.[25]

To meet all different aspects of a broad entrepreneurship education, most university entrepreneurship education programmes are based upon a three-stage concept described by Heidack.[26] This concept shows the consecutive order of entrepreneurship courses. The first stage of 'knowledge-based learning' consists of courses with the purpose to teach basics in entrepreneurship. The courses of the second stage ('Indirect practice') have the objective to apply the gained knowledge from the first stage to case studies. In the third stage, knowledge is applied and experiences are gained from a real entrepreneurial business case. According to Heidack, such an order of entrepreneurship education courses generates a

higher knowledge and qualification level from stage to stage.

Furthermore, Honig[27] mentions the high impact of self-generated experiences or tacit knowledge on the success of entrepreneurs. Braukmann and Schneider[28] add to this point: 'Learning by doing and reflecting the lessons learned has to be conceptually interconnected'. These authors support educational concepts that allow the participating students to learn from own mistakes. Consequently, students are better prepared for challenging business situations and practical experiences can also be considered as a success factor for an entrepreneurship programme. Further research on success factors for entrepreneurship education programmes is carried out by Kloftsen.[18]

With the increasing importance of research in entrepreneurship education the content, teaching methodology and results are becoming a central issue.[28–32] Therefore, Alberti *et al*.[29] identify six key determinants (goals, assessment, audiences, contents, educators and pedagogies) for designing entrepreneurship education programmes. They develop a comprehensive model which describes the dependencies between the key issues.

SO, EDUCATION IN BIOENTREPRENEURSHIP…

When combining all the findings and theoretical frameworks, we tried to identify the conditions to which education in 'technological entrepreneurship' should comply. This is not the complete list of conditions; it is an enumeration of the most important improvements or accents that we wish to incorporate in the project 'Technological Entrepreneurship at the VUB'.

Focus the education on a specific technology

Generic courses on entrepreneurship or business economics are helpful, and even necessary, to provide the potential entrepreneurs with the needful basic skills and insights. However, these generic courses have only a limited impact and often fail to capture the specific dynamics of a particular industry or sector, such as biotechnology. Therefore, potential bioentrepreneurs should receive education adapted to their needs and attend courses with a biotechnology industry focus.

Interdisciplinary student groups

The importance of entrepreneurial teams consisting of team members with complementary skills cannot be stressed enough. In such teams, communication plays a vital role. To achieve this cross-fertilisation, both business and science students should take courses together and work on business or technology projects in mixed teams. The observation that 'organic teams' are more likely to be successful calls for the need of creating affective bonds between potential entrepreneurs, in this case, students in business engineering (an educational programme between applied economics and engineering) and students in bio-engineering.

Strong emphasis on practice

Teaching entrepreneurship requires the academic staff to leave the classic 'ex-cathedra' teaching method to stimulate the students to participate actively in the classroom and on business projects. Furthermore, it is necessary to make sure that the students experience that their work is appreciated and valuable for third parties such as university research departments.

Demystify entrepreneurship

As described in the previous paragraphs, it is substantial to convince the potential entrepreneurs that founding your own business is not science fiction; it is a reality which can prove to be very satisfying. To achieve this in a classroom, our aim is to have guest lectures of successful entrepreneurs throughout the curriculum of our master students (not limited to one course).

THE PROPOSED SOLUTION

The opportunity

In 2006, the Flemish government launched a call for educational projects to bridge the gap between education and industry. At that moment, the Department of Business Economics and Strategy at the VUB already had experience in the education and research in entrepreneurship but felt that, to achieve a connection between university education and high-technology entrepreneurship, a broader project was needed. Consequently, Professor Dr Rosette S'Jegers and Marc Goldchstein successfully initiated and elaborated the project 'Technological Entrepreneurship at the VUB'.

The project started 1st January, 2007 at the VUB, funded by the Flemish government (50 per cent) and by a number of private partners (50 per cent). Some of the private partners, for example, venture capitalists, contribute to the courses.

The fruitful soil

Projects like this are not viable in a vacuum; they grow in an existing 'ecosystem'; as can be learned from the story of Silicon Valley[33] and the biotechnology industry.[34] The formation of 'Business Engineer Solvay' has very strong 'technological roots' for more than 100 years. This formation was developed by the Université Libre de Bruxelles (ULB) and the VUB under impulse of Ernest Solvay and has been copied by many other universities.

The backbone of the project is the strategic collaboration between the research departments of Business Economics and Strategy (BEDR), Micro-Electronics (ETRO), Industrial Microbiology and Food Biotechnology (IMDO), Photonics (TONA) and Chemical Engineering (CHIS), proving the cross-faculty nature of this project. The Technology Transfer Interface Cell of the VUB is responsible for the valorisation of technologies developed at the university and thus is a logical and active partner within the project. The characteristics of the VUB have an important impact on the success of the project. At the campus in the southeast of Brussels, all faculties (except for the medicine faculty) are gathered on 2.5 km^2. This broad range of high-class research departments literally shares walls. Informal contacts are numerous and cooperation across faculty walls can be operational, and not just on paper.

Project outline

The overall goal of the project is to improve the cultural support for high-technology entrepreneurship among our master students at the VUB. By using technology-focused training with a strong emphasis on practice and entrepreneurship education, we aim to improve the perception of our students regarding their own skills and abilities to start up a business.

Bringing different target groups of students together and letting them work in mixed groups on economic, technology-based, projects, we try to accomplish cross-fertilisation and improved communication between the learning audiences.

It is important to emphasise that this is not just a secondary or optional course. The project is a strategic development axis for all faculties involved and the basic courses are mandatory for the target groups. After completing these courses, the students can opt to focus their studies on 'technological entrepreneurship'.

Curriculum design

At the VUB, all master students in business engineering have to choose at least one 'technological programme'. When completing their master studies, these students would have received an introduction in a certain technology and its business economics. There are four programmes (technologies) among which the master students of business engineering can choose from:

- Biotechnology
- Photonics

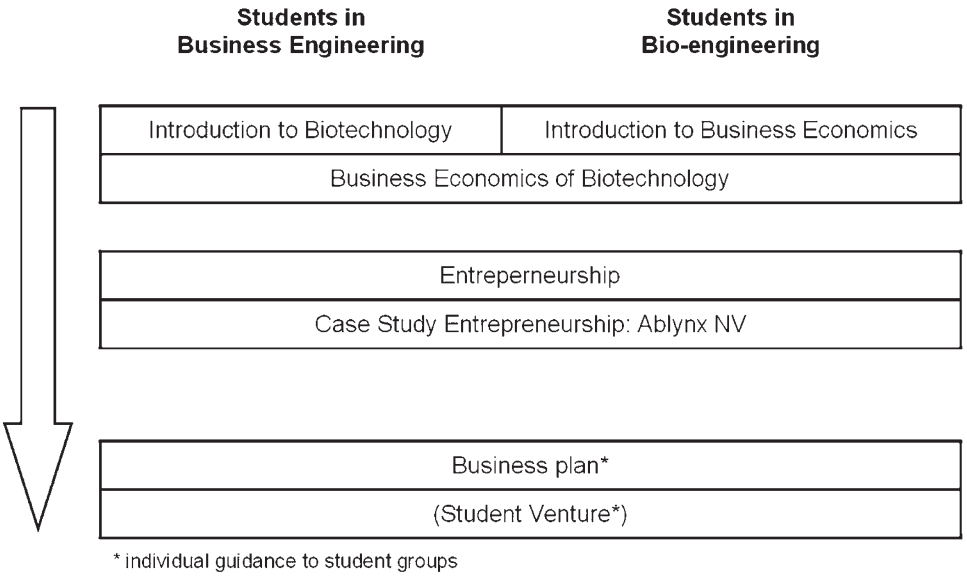

Figure 3: Curriculum design, bioentrepreneurship programme for master students in business engineering and bio-engineering.

- Micro-electronics
- Nanotechnology, chemistry and materials

For students in engineering or in sciences, there is no option. The engineering students have to take a number of mandatory courses among which the course on business economics of their technology field. Optionally, they can opt to follow the course on entrepreneurship or participate in business plan projects and get deeply involved in valorisation projects together with their peer students from the faculty of economics.

In this paper, we will only discuss the programme on bioentrepreneurship.

The bioentrepreneurship curriculum

In a first stage, both groups of students receive an introduction to 'the other domain': an introduction to biotechnology for the students in business engineering, and an introduction to business economics for the students in bio-engineering (Figure 3). The most important goal of this course is to supply the students with the mindset of the other target group and to facilitate fluent communication between the two groups. The courses were designed by applying the six key issues of the Alberti *et al.* framework.[29]

Subsequently, both the future business and the bio-engineers are put together and they receive a course on the 'Business Economics of Biotechnology'. The development of this course is one of the main deliverables of the project. The course content and guest speakers are completely adapted to the biotechnology industry and builds on basic business economics. This course is perfectly accessible for the students in bio-engineering since they followed the course on business economics earlier in their curriculum. Topics of this course are high-level overviews, such as the history of biotechnology, an industry profile and clustering dynamics as well as business-level topics like business development, intellectual property strategy and the financials of biotechnology companies. The project team was able to attract several key people from the Belgian biotechnology industry to contribute to the course. This theoretical part puts a strong focus on young, innovative biotechnology companies, bioentrepreneurship and current events of the biotechnology industry. Students in business

engineering have to write a paper on a selected topic, for example, on the drivers of biopharma deals, or work on a biotechnology business project. Where possible, students in bio-engineering are added to the teams to achieve the multidisciplinary exchange we aim for. For example, last year we had a team consisting of two students in business engineering and one student in bio-engineering. Their task was to explore the possible valorisation path for a newly discovered strain of lactococcus bacteria with probiotic properties.

The course 'Business Economics of Biotechnology' contributes to reaching several of the overall goals of the project. By bringing together the different target audiences and letting them work together on biotechnology topics, communication between the two groups improves. This is an important step towards creating multidisciplinary potential entrepreneurs. Furthermore, the formation of affective bonds, important in organic teams, is stimulated.

Every first semester a generic course on entrepreneurship is organised. This course is taught by Marc Goldchstein, who has more than 16 years of experience in young technology-based companies. The students who take the course, which is mandatory for business engineers and optional for bio-engineers, get a mixture of classic ex-cathedrae lectures and interactive class discussions on papers and case studies relating to high-technology entrepreneurship. This course includes an extensive case study on a young, innovative biotechnology firm, Ablynx NV. Founded by VIB and GIMV in 2001, the company commercialises the Nanobody® technology platform which was discovered and developed at our university. The company already signed several major deals with pharmaceutical companies and raised more than €70m of venture capital before going to the Brussels stock exchange in November 2007, raising another €75m.

For this case study, more than 8 h of classroom time were dedicated on 'the story of Ablynx'. It is not the academic staff who teaches this case study, but they are the individuals involved in the company that contribute to the course. Speakers in this course are Professor Dr Serge Muyldermans, one of the inventors of the technology platform; Dr Sonja Haesen, director of the TTI; Dr Gaston Matthyssens, author of the initial Ablynx business plan; Dr Mark Vaeck, the first CEO of Ablynx; and Frank Bulens, director of the company and investment manager of GIMV, a venture capitalist.

This course is very important in the project as it teaches basic knowledge on the dynamics of entrepreneurship (industrial lifecycles, dominant design, venture capital, etc) and provides the students with some best practices and guest lectures from successful entrepreneurs to make 'entrepreneurship' more tangible. There is also a strong focus on the application of theoretical framework on technology cases during the entrepreneurship seminars.

Optionally, students can work on their own business plan in (preferably multidisciplinary) teams. Every year, we organise a 'project fair' for interested students. At this fair, researchers from the partner department, like the biotechnology department, can present their technology and the valorisation issues they wish to solve. After a brief presentation, students can meet with the researchers to obtain extra information on the project. When the teams are formed, the researcher ideally becomes the driving force of the student team, introducing them in the technology and demanding concrete answer from them. These projects range from writing a complete business plans to solving topical questions and address the need for self-generated experience or tacit knowledge as outlined by Honig.[27] For example, last year two student teams worked on a cost calculation model for a biotechnology application. This practical orientation within the programme is also considered as a success factor for entrepreneurship education. Under certain

conditions, the students can transform a business plan into a real company by starting up a student venture. The holding company NV Entrepreneurial Talent Corporation, a joint venture of our university with a private partner, provides up to €6,000 of starting capital to entrepreneurial students.

The course on entrepreneurship and the business projects contribute to building the right entrepreneurial qualifications among the interested students.[20] The programme offers master students the possibility to shape their studies in the direction of bioentrepreneurship. This need for integration of entrepreneurship education throughout the student's curriculum is identified by Braukmann.[20] The different faculties wish to create a supportive culture for bioentrepreneurs and their teams. By aiming on maximum cross-fertilisation of both target audiences when working on a biotechnology topic, the formation of organic teams is stimulated. Furthermore, we try to provide the students throughout the curriculum with factual information on entrepreneurship and the biotechnology industry so that they will be better prepared to recognise and exploit an opportunity in the future.

It is clear that the bioentrepreneurship programme is designed following the three-stage concept described by Heidack.[26] The programme evolves from knowledge-based learning over indirect practice to real-time experience. All courses in the third stage are not mandatory for the students; they have to choose for the hands on experience. This facilitates the integration of such courses in the curricula of students from other faculties.

Furthermore, we try to incorporate the three basic activities that should be present at a university when stimulating entrepreneurship among students outlined by Kloftsen.[18]

All the entrepreneurship courses and training programmes presented are already organised for different target audiences. Creating and sustaining an entrepreneurial culture at the university is challenging and it will take several years to achieve this.

We realise that it is very unlikely that the student teams set a successful biotechnology company right after they graduate. But hopefully, within a couple of years, after they gained more experience in the biotechnology industry, they will turn to each other to found a new biotechnology company, and become successful organic entrepreneurial teams.

EVALUATION OF OUR PROPOSED SOLUTION AGAINST BEST PRACTICES

In March 2008, the European Commission published a report on entrepreneurship education in higher education.[35] In this report, specialists in the field of entrepreneurship education formulate a number of possible measures to stimulate and improve entrepreneurship education in higher education in Europe based on best practices in the field. Next to some more macro-level measures like stimulating the mobility of teachers between industry and education or providing more means for entrepreneurship programmes at universities, they also formulate course-level improvements. In the following paragraphs, we will highlight some of these findings and relate them to our project.

According to the report, teaching entrepreneurship should be integrated in more curricula, and not only in the curricula of business or economic studies. The report states that 'innovative and viable business ideas are more likely to arise from technical, scientific and creative studies [than in Business Schools, red.]'.[35] With our project, we integrate multiple courses, theoretical as well as practical, in the curricula of business and science students.

The real challenge, as defined by the European Commission, is to integrate inter-disciplinary programmes accessible to all students, creating interdisciplinary student teams for the development and exploitation of business projects. To achieve this, universities should adopt their organisational structure to

facilitate the implementation of such programmes across faculties. The characteristics of the VUB facilitate the implementation of interdisciplinary programmes. Students and academic staff are concentrated on a fairly small campus, allowing swift communication between all stakeholders of the project. This allows us to create mixed learning audiences and student teams.

The content of programmes and courses has to be adapted to different target groups. 'The best way to encourage entrepreneurship among students is by giving examples from the relevant technical area'.[35] We do not only have case studies on biotechnology companies in our courses on entrepreneurship or business economics. We provide the students with a full course on the biotechnology industry and offer them biotechnology business projects to work on.

Regarding teaching methods, the report states that it is crucial to use experience-based teaching methods to develop entrepreneurial skills and abilities. This means that the learning approaches should be more interactive than in traditional education. We tend to use a mix of classic lectures and interactive courses on entrepreneurship and business economics of biotechnology. When students opt to participate in business projects, the learning approach is completely interactive.

Furthermore, it is important to engage real entrepreneurs in teaching, not only by guest lectures, but throughout the full curriculum. The project leader worked in young innovative companies for over 16 years, often as a member of the founding team. He is responsible for the entrepreneurship education at the VUB and contributes significantly to all courses. We have guest lectures of successful entrepreneurs in all our courses.

According to the report, it seems to be valuable to involve entrepreneurial alumni in entrepreneurship programmes. We try to involve as many entrepreneurial alumni as possible in the project. In the Ablynx case study, four of the five speakers are university staff members (two) or entrepreneurial alumni of the biotechnology department of the VUB (two).

The quantitative evaluation of the project, however, should be subject to further research.

FURTHER DEVELOPMENT OF THE PROJECT

Starting October 2008, the courses 'Business Economics of Biotechnology' and 'Business Economics of Photonics' will be integrated in the curriculum of the joint master programme 'Business and Technology' from the VUB and the ULB.

In January 2009, the first 'Intensive course: Business and Biotechnology' is organised. The project team will use the developed course material to organise a crash course on bioentrepreneurship open to external participants. As the project is maturing, it is also growing. Several students that followed the programme are now part of the academic staff, often within the partner research departments as business or valorisation experts.

Furthermore, the VUB bioentrepreneurship programme collaborates with 'Dresden Exists', an entrepreneurship initiative in Dresden, Germany. Dresden Exists focuses, among other fields, on bioentrepreneurship and educates and supports academic researchers in the biotechnology field regarding technology transfer and venture creation. Both projects collaborate, for example, on a biotechnology business plan workshop for students and researchers in Dresden. The projects in Brussels and Dresden exchange knowledge on concept development, teaching and grading.

CONCLUSION

The bioentrepreneurship education programme that we implemented at our university complies with the important theoretical findings on entrepreneurial teams and high-technology entrepreneurship education. The project is more than the exchange of courses between different

faculties; it is an integrated cross-faculty project, with multiple stakeholders. As a result of this, the courses are well integrated in the curriculum of business students as well as in the curriculum of students in bio-engineering.

The programme set-up is a three-level approach. First, the target audiences are provided with a theoretical introduction to biotechnology, business economics and entrepreneurship. These topics are then applied in the interactive, biotechnology-focused seminars that accompany the entrepreneurship course and in the course 'Business Economics of Biotechnology'. This last course aims at providing the two groups of students with factual data on the biotechnology industry as well as with insights in the biotechnology business mindset. Interested students and potential entrepreneurs from both target audiences can opt to participate in real-life biotechnology business projects to obtain hands-on experience. This kind of multidisciplinary teamwork is stimulated throughout the courses to shape organic teams, which showed to be determining for the future success of young innovative companies.

By combining all these courses in the curricula of students from different faculties, the project is an interesting case study for everyone interested in supporting and implementing such a modular programme in higher education institutions. The quantitative evaluation of the project, however, should be subject to further research.

ACKNOWLEDGEMENTS

Thanks to Eva Crispeels, Iris Vanaelst and Sebastian Kaiser for their valuable contributions to this paper.

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