

Proceedings of the 4th International Barcelona Conference on Higher Education**Vol. 7. Higher education for sustainable development**GUNI - Global University Network for Innovation – www.guni-rmies.net**Trends in Technological Master programs focused on
Sustainability in Europe****Tadeo Baldiri Salcedo Rahola**

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Abstract

The Bologna process is close to be finished, 2010 is the deadline. Not all the goals are fully accomplished yet, but several changes in all Europe (46 countries involved) have been accomplished and have created a new image for the European Higher Education Space.

The main goal of the Bologna process is to offer a common framework for European Higher Education to allow the mobility of all the academics involved, students, researchers, teachers and graduates.

University education will be structured on three levels: bachelor, master and PhD. Bachelor and master education will allow graduates to acquire professional attributions, while doctoral level education is limited to research purposes. In the case of engineering education the full professional attributes will only be achieved after the master level.

At the same time, a new concept is introduced in higher education: sustainability. This concept affects all levels of higher education, from the own operation of universities to the subjects of all kind of studies. These two processes together have lead to the apparition of masters focused in sustainability.

The first masters focusing on this topic were the ones taking care of

environmental problems, such as Environmental Engineering. But later on resource management and Industrial Ecology masters have started to be focused on sustainability too and in the last years various kinds of specific masters have been created.

Nowadays we have a wide offer of Masters in Sustainability, that are created in accordance with the Bologna process. Internationalization is creating competition between universities at the European level. In the SDPROMO project trends of this new market are identified.

The aim for internationalization starts with the movement of students. The percentage of master programs in English is increasing enormously. It is not only a trend in the countries of Northern Europe. Some universities are doing more than a change of teaching language, they are offering help to look for scholarships or offering some scholarships themselves for foreign students.

Moreover some are trying to attract international students by partnerships with universities of other continents. Nowadays the search for international students doesn't stop at the European borders.

The movement of teachers seems to be a most difficult question. Organizing masters between different universities, allowing the students to spend their study period between more than one country is the way to increase the value of these programs. Initiatives as Erasmus Mundus are stimulating this trend.

Alliances between universities from the same country are occurring too. By these alliances, universities can increase their portfolio of Masters programs, without additional staff requirements.

In the competition to attract a major number of students, masters programs must be different, compared not only to the other ones organized by other national universities, but also in European arena. As a consequence specialized masters in specific sustainability topics start to be something common.

In future this wide offer of specialized masters will coexist with the classical masters; the offer will be higher than the demand if we only take into account the European students. Even if a percentage of students move from classical to more specialized masters, attracting non European students will be essential.

This competition at European level is good to increase the quality of the curricula and the variety of supply. A large problem is the increase of tuition that students have to pay. Moreover, increased costs of living adds to the financial burden for the student.

Looking at the tuition, we can observe, in some of the European countries, a clear difference between the bachelor and master level, but both levels must be accomplished on technical studies to acquire professional attributions. For the student, it is the total tuition that counts.

Only a minor percentage of the master students receive a scholarship to study

abroad. This inequity in education is well known from the American higher education system. Will the Bologna reforms, by introducing new elements of competition lead to a similar higher education system?

The competition between universities will cause a continuous search for more attractive programs and the movement of students worldwide starts to be a reality. These patterns direct us straight away to at least one feature of the American higher education model, with its first and second league universities. The first league is only accessible for the extremely smart and/or rich, the second league for the rest.

A major difference is that in Europe education at university level has been an option for a large part of the population since the 1960s. Its costs are covered for the major part by the government and selection is general only based on merits. American universities are rich and thereby able to make investments in the quality of their education. However, they are inefficient in the utilisation of American talents: i.e. smart but poor students will sometimes not reach the appropriate level of graduation. European universities are more talent-efficient as financial barriers play a minor role in admission. Will they remain so?

The Bologna process and the growing awareness of the necessity of sustainable development are defining the shape of a new range of MSc programs in the European Higher Education Space. Environmental Engineering and Industrial Ecology Masters are the most well know of this kind of new programs. In the last years several other ones have appeared on the market. In the SDpromo¹ project trends of this new SD education market are identified. The Bologna process has enlarged the scope for university competition, which has forced them to specialize their education and internationalize their activities to increase their potential group of students. The effect of this policy is that the offer of master programs focused on sustainable development is becoming larger and the quality of the programs is going up. At the same time the students' cost for being educated are increasing as are his living expenses. Competitiveness between universities at European level is increasing too. The higher education system develops into the direction of the US higher education model. This development brings certain risks that are discussed in this paper.

¹ SDpromo - Promoting European Education in Sustainable Development - is a project within the Erasmus Mundus Action 4 program, developed by KTH (Sweden), UPC (Spain) and TU Delft (Netherlands)

The Bologna process is close to be finished, 2010 is the deadline. Not all the goals are fully accomplished yet, but several changes in all Europe, 46 countries involved, have been accomplished and have created a new image for the European Higher Education Space. The main goal of the Bologna process is to offer a common framework for European Higher Education to allow the mobility of all the academics involved, students, researchers, teachers and graduates.

University education will be structured on three levels: bachelor (BSc), master (MSc) and doctorate (PhD). After the bachelor phase of three years, the student is supposed to be able to choose between different master programs. The master level is set to be 1-2 years long. In the majority of countries, technical studies allow students to achieve some professional attributions. The doctorate level (PhD), 3-4 years, is limited to research purposes. This structure was entirely new to some countries, while it was more or less in line with the structure of academic education in other countries. The structure has been nearly fully accepted by all EU members, but in several countries, the implementation process is still going on (Eurydice, 2007: 15).

In order to make the credits transferable throughout Europe the European Credit Transfer and Accumulation System (ECTS) created for the Erasmus program has been chosen by the Bologna process to be the single one used in all universities. It enables students to change universities within Europe without losing study time. It is fully implemented in all master programs in all countries with the exception of the United Kingdom and Azerbaijan (Eurydice, 2007: 26).

According to the Bologna directives, the length of masters programs must be between 60 and 120 ECTS. (1 ECTS is the equivalent of 28.5 hours of student work). As in the majority of countries, the master level allows students to achieve some professional attributions, two full academic years of study (120 ECTS) is the usual period that is needed to succeed in obtaining an MSc. However, there are exceptions. Especially people who obtained already a first degree and have professional experience might obtain an MSc:

- part time
- by distance learning
- by shorter programs.

Especially in the United Kingdom, there are special post-graduate masters. Distance learning is an option to obtain an MSc for international students. This might reduce their expenses. What really differs in the structure of the analyzed masters is the percentage of hours on site. This mainly depends on the teaching methods and traditions of universities.

At the same time that the Higher Education structure has been adapted to the Bologna process, sustainability as a concept is becoming more and more important. Environmental Engineering has been present among engineering programs for long. In the 1970's, the environmental issue became more important. Many universities started separate departments and educational programs for environmental science. When the Brundtland committee introduced the concept of "Sustainable Development" (WCED, 1987), it was often considered to be a small extension to environmental issues. However, in engineering universities, Sustainable Development implied a change from 'specific cleaning technologies' to 'leaps in efficiency of all technologies', and from environment as a 'barrier for technology' to SD as being a 'major challenge for technological innovation'. The interdisciplinary character of SD fitted well to the engineering traditions, as rather being focused on providing solutions for multifaceted problems, than being focused on scientific traditions. These changes in engineering universities did not come overnight, were not accepted instantaneously, and often took great efforts (Capdevilla et al., 2002, Ferrer-Balas, 2005, Mulder 2004a, 2004b, 2006). However, clearly the concept of SD affected engineering universities much more than the classic universities.

Later on several universities have created master programs on Industrial Ecology. Industrial ecology was popularized in 1989 in a Scientific American article by Robert Frosch and Nicholas E. Gallopoulos. Their vision was

"why would not our industrial system behave like an ecosystem, where the wastes of a species may be resource to another species? Why would not the outputs of an industry be the inputs of another, thus reducing use of raw materials, pollution, and saving on waste treatment?" (Frosch, 1989)

Now these programs, and especially environmental engineering, are present in a considerable number of universities. Sustainable Development has also been used as a main topic in several programs that have a management-, policy- or economic

perspective. Several SD focused master programs are related to specific topics such as energy, water, agriculture, or transport.

As a part of the SDpromo project trends of this new market are identified in a report that will be published in their website (the data used to exemplify this paper come from this report). To obtain an image about the situation of SD related master programmes in Europe they have used two search methodologies. Sending out a questionnaire by surface mail and a reminder by email to all European universities that give engineering degrees. The addresses were obtained from FEANI, the Federation Europeenne de Association National de Ingeniere, in Brussels. Additionally, they used the social network of the SDPROMO project partners to complete the list.

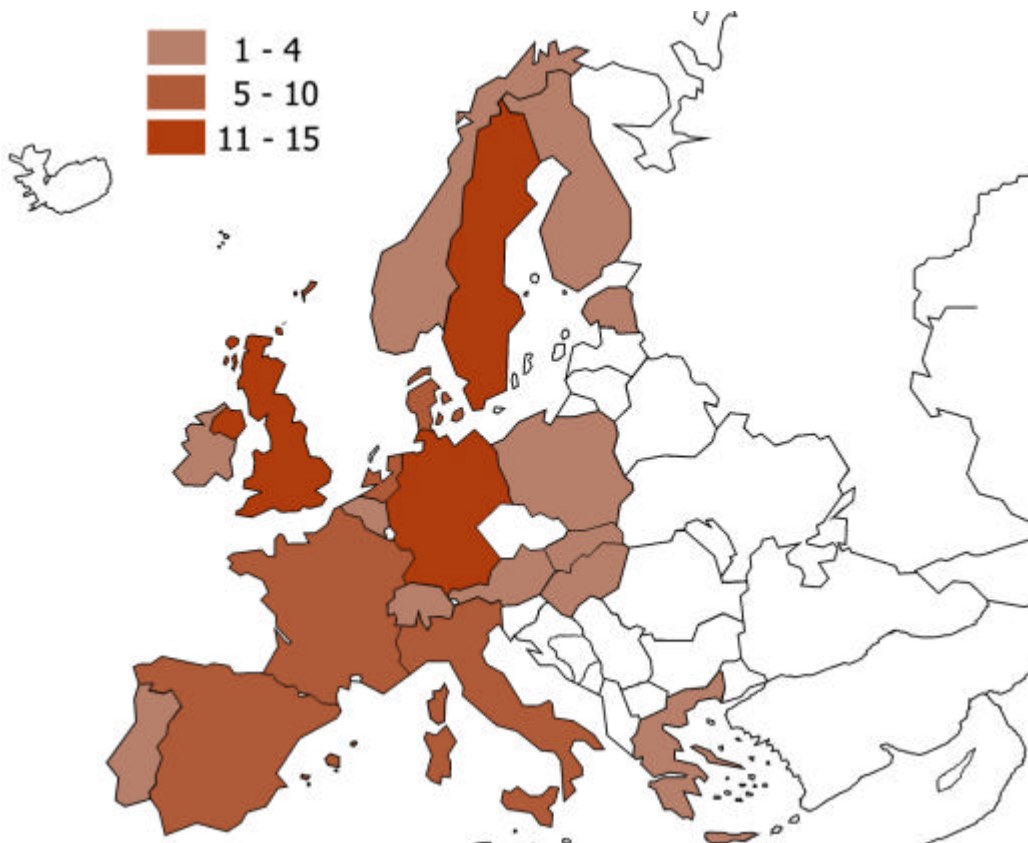


Figure 1. SDpromo report masters by country.

From the 46 countries represented in the European Space for Higher Education, 20 have at least one master program that is analyzed in this report. The report does not

claim to be complete. However, the number of included programs, 75, signifies a considerable representativeness of this overview of master programmes. From this analysis we can conclude that internationalization is enlarging the space where universities compete to attract students. This forces them to specialize their offer which has some risks.

Internationalization

One of the principal aims of the Bologna process is to stimulate the mobility of students, teachers and researchers (Bologna declaration, 1999). The framework to allow this mobility has already been put in place. The competition to attract students is at the European level. The students involved in this challenge are not only the ones coming from European countries. Also international students could easily spend part of their masters program at a second European university.

The first adaptation that universities made was changing their teaching language. In recent years, northern European universities massively turned to English as teaching language. Nowadays, the southern European universities also start to offer masters programs in English. In the SDpromo overview 55% of masters from not English speaking countries are taught in English. Moreover, in some Northern European countries also bachelor programs have turned to English as a teaching language.

Another stimulus for the change of teaching language is the creation of several joint Masters Programs between universities from different countries. Some of these joint masters consider the multilingual character of their program as a cultural richness but most of them chose the practical way to teach only in English.

For universities, joint masters programs between universities, international or national, is a way to increase their offer without additional staff. Moreover, specific partnerships between universities, often with non-European universities are a usual practice; China is becoming the most targeted zone for this kind of partnerships. In these joint masters, students usually study at least in two of the organizing universities during his study period. This usually means living in two different countries for one year, with cultural and financial consequences.

The mobility of teachers is a harder issue to be achieved. The joint masters offer a partial solution to this problem. Teaching students that have studied in different institutions allow teachers to learn about other ways to work. Good partnerships between universities make it easier to collaborate also in research projects.

To motivate students to do part of their study in other European countries, several exchange programs have been created. The most successful of these programs is the well-known Erasmus program. By this program, 1.5 millions Europeans students have had the opportunity to study in another country for a maximum period of one year, during the last 20 years (Erasmus program, 2008). It was an important factor in forcing universities to turn to the ECTS system.

The European master programs offer a good opportunity for students to have an international experience. Two years abroad to improve the knowledge of a foreign language, obtain a better curriculum and experience different cultures. The fact that the master is the second step in higher education allows the universities to select the candidates. It gives the process more flexibility. For SD oriented master programs, this implies that the participating students have various disciplinary backgrounds, which reinforces the interdisciplinarity of the program. In bachelor level education in most European countries student selection is a more strict process (Eurydice, 2007:24).

At the European level, one interesting program that has been operational since 2004 is the Erasmus Mundus program (2008), which promotes Master courses jointly organized by universities from different European countries and offers opportunities for scholarships to European and non-European students. Nowadays 104 Masters are offered in the program, from which 7 are SD related.

Specialization

Due to the competition to attract students from all over the world, universities can try to attract more students by offering specific original programs. For sure, universities will continue offering as their principal product the traditional degrees. With these degrees they will usually only compete on the national level. Nevertheless, they are starting to offer more specific masters, by which they can really offer something unique.

Sustainable development as a main topic of study is not a common degree. This also becomes clear from the large differences between the programs that are

offered. Environmental engineering and industrial ecology are the most common masters. We can foresee that these degrees could perhaps become traditional degrees in future.

The other SD focused master programs are related to specific topics such as energy, water, agriculture, or transport. Very often the programs have a rather interdisciplinary character. Naturally, this is a good thing for an SD oriented program, but it makes categorization a doubtful activity. Nevertheless, we differentiate between programs that are more general and programs that are targeted at SD in a specific technological field or application.

General

- Environmental Engineering
- Industrial Ecology
- Management and Policy

Specific

- Architecture and Urban Planning
- Energy
- Forestry and Agriculture
- Transport
- Water and waste

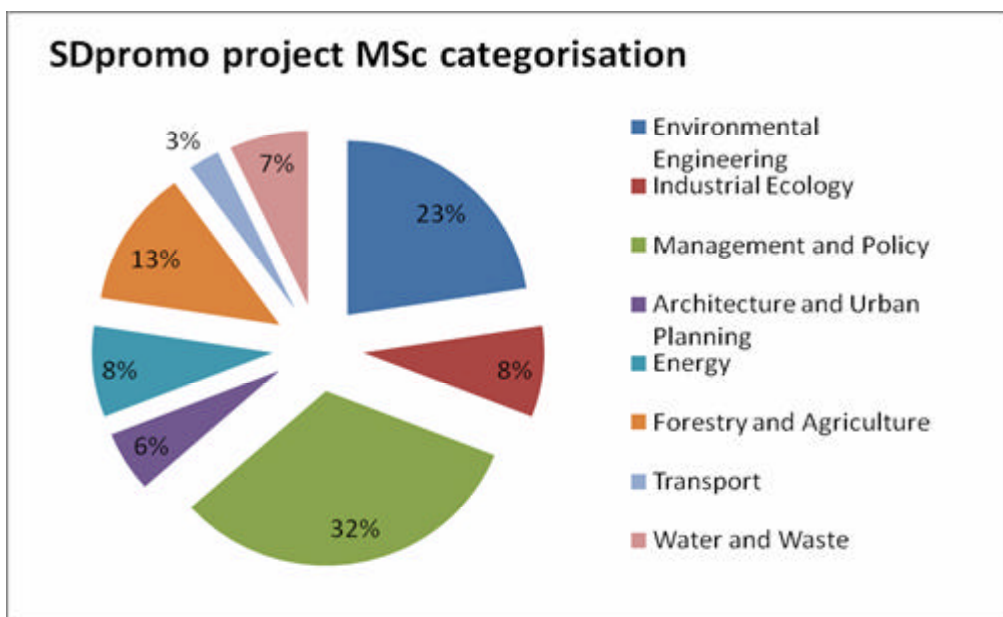


Figure 2. SDpromo report masters by category.

The future of the other degrees might be more insecure. They can be considered as bets of the universities to attract students. However, within a competitive market, products that do not sell well, will disappear. The official accreditation of SD masters programs might sometimes be a problem. Usually it is a long process before a diploma is accepted as an official degree.

Risks

All changes in the higher education system have financial consequences. Universities become suppliers in an education market, and (forced to) charge higher prices for their programs. Enlargement of the offer of master programs and improvements to be more competitive have a price. This has caused rising tuitions in most European countries.

If we look at the tuitions at university level for bachelor programs, we can see that on average the highest tuition for one year study is 1600€ (Eurydice, 2007: 89). Now looking at the master programs analyzed in the SDpromo overview, we found on average cost of 3320€ for EU students, 4960€ for non-EU students per year². However, these costs vary considerable by country. Moreover, costs of living will be higher too, given the demand for travel. The extra cost of study in another country (travel, residence, administrative costs) can easily be underestimated.

The increase of the price of education might create a real problem for non- EU students. If we take into account that it takes a bachelor- and a masters program to become an engineer with all professional attributions, students might be heavily indebted when graduating. Scholarships, like the Erasmus Mundus scholarships, are not abundant. Moreover, they do not always cover all costs.

The other risk for a candidate student is the selection of candidates by the institutions. Universities want the best students and want more students. For students it might not always be clear what is the best university for them. They might be lured into a programme that does not fit their needs.

There might also be a favourable effect of the competition for students: Very often, universities were hardly paying attention to the quality of education. Research

²Average cost of analyzed masters at exemption of the no cost ones (Sweden, Norway and Finland)

was the way to make career, and 'education came with the job'. Now universities are forced to pay proper attention to the quality of their educational programs.

Some of these changes might lead us to features of the US higher education model, with its first and second league universities. With only few exceptions, the first league is only accessible for the extremely smart and/or rich, the second league for the rest. Thus far, tuition in Europe is considerably lower than in the USA.

In Europe education at university level has been an option for a large part of the population since the 1960s. Its costs are covered for the major part by the government and selection is general only based on merits. US universities make investments in the quality of their education as they depend on their educational reputation, and on their alumni. However, the US university system is inefficient in the utilization of talents: i.e. smart but poor students will sometimes not reach the appropriate level of graduation. Thus far, European universities are more talent-efficient as financial barriers play a minor role in admission. However, given the competition between universities, leading to more specialized Masters programs, there is a fair chance that governments might limit their contributions to new masters programs. This will not keep the successful universities from offering more specialised masters programs, which might lead to first tier and second tier universities. Will Europe be able to remain talent efficient under these conditions?

Conclusions

Sustainable Development education will continue to be developed. It will lead to more new educational programs, with new points of views and specializations. These new programs are shaped in accordance to the Bologna process, which is motivating the students to be mobile across Europe. Opportunities are offered to a large number of students to improve their technical and human skills as well as the life experience of an international adventure.

Moreover, at the institution level, the Bologna process has motivated the creation of new alliances and partnerships. The knowledge shared between professionals from various institutions means a stimulus for improving the level of education and for high level research. At the same time, this process of internationalization will cause the creation of a competitive European Master market



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that could lead us to adopt some patterns of the US higher education system. This system has pros and cons. European universities must avoid the pitfalls of that system in order to guarantee a successful academic community for all talents.

Bibliography

- ? Bologna declaration (1999). European Ministers of Education.
http://ec.europa.eu/education/policies/educ/bologna/bologna_en.html
- ? Capdevila I, Bruno J, Jofre L. 2002. Curriculum greening and environmental research co-ordination at the Technical University of Catalonia, Barcelona. Journal of Cleaner Production 10, (1) pp. 25-32
- ? Erasmus Mundus program.
http://ec.europa.eu/education/programmes/mundus/student/index_en.html
(January 30th, 2008)
- ? Erasmus program. European commission website.
http://ec.europa.eu/education/news/erasmus20_en.html (January 30th, 2008)
- ? Eurydice (2007), Focus on the Structure of Higher Education in Europe, National Trends in the Bologna Process 2006/07, Brussels.
<http://www.eurydice.org/portal/page/portal/Eurydice/Products?sortByCol=5>
(January 16th, 2008)
- ? Eurydice (2007), Key data on Higher Education in Europe, 2007 edition, Brussels 2007.
<http://www.eurydice.org/portal/page/portal/Eurydice/Products?sortByCol=5>
(January 16th, 2008)
- ? Frosch, R.A., and N. E. Gallopoulos (1989) "Strategies for Manufacturing", Scientific American 261: 3, pp 144-152
- ? Ferrer-Balas, D., Mulder, K., 2005, Special Issue EESD International Journal of Sustainability in Higher Education



- ? Mulder, K.F., 2004a, Engineering Education in Sustainable Development: Sustainability as a tool to open up the windows of engineering institutions, Business Strategy and the Environment 13 no. 4 pp. 275-285
- ? Mulder, K.F., 2004b, Special issue International Journal of Sustainability in Higher Education, Emerald isbn 1-84544-043-9
- ? Mulder, K.F., 2006, Engineering Curricula in Sustainable Development, An evaluation of changes at Delft UT, European Journal of Engineering Education 31, no. 2, pp. 133-144
- ? SDpromo, Promoting European Education in Sustainable Development, <http://www.sdpromo.info/> (January 30th, 2008)
- ? World Commission on Environment and Development (WCED), 1987, Our Common Future, Oxford University Press, Oxford-New York