

BEST Academics and Companies Forum Report

“Innovations in Engineering Education”

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Author: Educational Committee of BEST

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Abstract

BACo - BEST Academics and Companies - is an event where students, academics and representatives from companies meet and discuss education-related topics. The goal of this event is to bring together the three stakeholders in education and help them exchange opinions, share experiences, offer suggestions and find solutions to common issues.

Optimizing the European engineering education by updating study programs according to the changes on the needs of the market, increasing the awareness among students on mobility and research and getting an input on the internship issues from all the parties involved were topics discussed during this three day event in Zagreb.

Participants were students from different European countries, teachers from SEFI, Thematic Networks and University of Zagreb and also company representatives.

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Day 1: Mobility

Introduction

Nowadays, with the technological advances of transportation and information technology, scholarly and scientific contacts have been multiplied and intensified. Students and information can travel with high velocity and low cost between countries. International students' flow is being marketed, while knowledge, in the form of skilled human resources, science, technology, and research products, has become a vital resource for industrialized countries.

Mobility of students is, of course, a very old phenomenon and certain regions of the world have a long experience with it. Many European countries have known the influx of students from their former colonies. Generally, geopolitical considerations have always been influential in policies regarding student mobility. However, there is also a growing conviction that one of the most effective means to prepare future graduates for the needs of an increasingly international professional life in a global economy is simply to study and live abroad. The educational and social benefits, such as acquiring new and cross-cultural knowledge and competencies, improving foreign language proficiency (especially in English), establishing international personal and professional networks, becoming familiar with other countries and cultures, etc. are being stressed by international educators.

"Mobility and internationalisation" - (Prof. Urbano Domínguez, University of Valladolid, Spain)

Internationalisation in higher education is a process aimed at integrating research and teaching in a supra-national framework by joining efforts and sharing experiences among the institutions implied. It is generally felt that educational, cultural, economic and political aspects of the process can lead both to the expansion of the field of influence of the Centres and the improvement of the quality of the education they provide. Mobility of students and lecturers has also a positive influence on innovating curricula and teaching and learning methods.

Several European Union mobility programmes have been in operation for decades, implying an increasing number of higher education institutions across Europe. During these years a significant yet still reduced proportion of students and teachers have participated in international exchanges. However, to have those programmes operating at the best of their capabilities, many obstacles have to be removed or alleviated.

Old academic structures and outdated curricula act as barriers to students and staff mobility. Financial support both at European and national level is not enough to allow free movement to economically deprived students. Additional difficulties are found

by people belonging to countries recently incorporated to the European Union. These points are just a few samples of some of the problems that require discussion.

Discussion groups' outcomes

Discussion group 1

Students' expectations from mobility are:

- Personal development
- Trying a new educational system
- Prolonging studies in order to have more degrees and more knowledge
- Language learning / practice

Companies' expectations from mobility of students:

- Acquiring soft skills
- Experience in different cultures
- Becoming open minded

Problems of mobility:

- Funding
- Recognition
- Brain drain

Discussion group 2

Most of the participants in this group have had some experience of studying abroad for a period of time. They have a common statement that the issue of Mobility is of high interest to all the educational stakeholders and that it should be improved in order to reach as many students as possible without neglecting the quality of the educational process.

The reasons why mobility is considered important for participants are: cultural exchange, travel experience and independence. The possibility to start living on your own abroad is the premise of self-development: gaining new skills, learning to adapt in a different culture and society, reaching wider career opportunities and enlarging your network of friends.

Bologna Process and Mobility

By 2010, a common tool for evaluating educational programs, ECTS, will be in full operation in the countries that signed the agreement. In order to do that, the communication between universities should improve.

The issue of vertical vs. horizontal mobility was also discussed during this point. Vertical mobility (taking a full degree abroad) is not so well advertised and the process of selection from the home university and the receiving university is difficult.

Horizontal mobility is far more accessible to students, but it also has different views depending on the country you come from. The problem of the imbalance between

accepting and sending students is a reality in the Eastern-European countries. The cause for all this is the economic status of the countries. A solution, discussed for this, would be the joint degrees that would assure both universities have a balanced exchange program.

The problems of mobility

Brain drain

This is another aspect of uneven exchange of students. Countries with less proficient economies are moving towards more developed countries. Brain drain is an effect of mobility on which universities can't do anything and it is all on the politicians and economists' decisions. The conclusion of the participants was that if their knowledge were more valued and recognized in another environment and place, then they would go there.

Funding

Economic factor is an important issue for students regarding mobility, mostly for Eastern-European countries. The student grants and loans systems are different from country to country. While the possibility of receiving a grant from a company is rather limited in Eastern Europe, in Scandinavia the students receive grants and loans from the state. The big question discussed about economics was the balance between sending more students with less money abroad and sending fewer students with all covered expenses. The group agreed that the need to send more students is far more important than the amount of money received. A possible solution would be for students to work preferably inside the university in programs with or without the involvement of companies. This would bring self-confidence, keep them linked to their studies and would partially solve the problem of funding.

Recognition

Recognition depends on lots of facts: teachers and their attitudes, committees, bodies involved in the recognition process. There should be a harmonization of quality of knowledge and studies between the universities. Universities should try different models and see how they work in order to find the optimum model of study possible. The freedom of choice that students have is a constraint in the harmonization process. In conclusion it was agreed that it is up to the educational bodies to establish the procedures of recognition and that once a student leaves the visiting university he or she can be sure that the study abroad will be recognized in the home university.

Language

The language is another possible problem that aroused in the discussions. Several countries tend to impose their language as a study requirement, while others use English as a language of study. In some cases, the lectures taught in English have a lower level than the ones taught in the countries' language. The popularity of the destination of choice is also affected by the language. Even if the language problem exists, it is far less important than the other ones previously discussed.

Discussion group 3

The group focused more on identifying the problems that arise in the mobility process and trying to find solutions for them.

Mobility is important because it provides life-experience and cultural knowledge that enhances the soft skills that companies are so happy for their employees to have. For a company cultural diversity is important and mobility is well seen from the companies' point of view.

Both types of mobility are important: vertical and horizontal. While vertical mobility asks for a long term commitment, horizontal mobility makes students more open minded and flexible. Other types of mobility were discussed like : professional-company mobility , the process of sending employees to other countries for a period in order to acquire knowledge and then come back to the their home country to share the knowledge gained, or short term mobility – courses organized by BEST or other organizations, trainings and camps organized by companies for students.

The problems that the participant faced when they attempted to go to study abroad are the following:

Recognition

Bureaucracy and recognition: in most countries the formalities for applying for a semester abroad are changing very often and the recognition of the period is not guaranteed all the time. It depends on the teachers, the university's prestige and the scale of grades used. A solution for the grading problem would be a unique European system of grades, imposed on all Universities Europe-wide, like the ECTS for credits. The prestige of universities interferes here; there is a difference between the same grades between two universities of different caliber. One of the problems that may arise with grades is the possibility of cheating on exams and that's why companies tend to ask for more soft skills and learning abilities from their future employees. Students who are coming home after a period of exchange could be interviewed by their university, so that the home university employees get feedback and learn more on how they might update the educational process. The feedback could be offered also for the hosting university while on the program.

Funding

Another issue of student mobility is the economic factor. It would be interesting to see companies supporting students for their stages abroad. The fact is that major companies have educational budgets, but those are for employees only. They train their employees in order for them to develop themselves more quickly.

Language

One of the reasons to go abroad for a year is to learn the language of that country. Even if the courses are taught in English, basic courses of local language should be delivered to students. Secondary education schools should also provide students with knowledge of foreign languages: their focus should be on English, French and German. Another issue discussed regarding Mobility was brain drain. It is mainly about the economics and especially that the state should take care of those students who come back after a period of study in another country, with a higher standard of living by helping them to stay and to demonstrate their abilities in their native country. Also the companies and the state should pay much attention to the communication that they can have with these students: they should be able to motivate them and to listen to their opinions. However this process of brain drain is less likely to be controlled and it will continue further.

Day 2: Curricula

Introduction

The Technical Universities have been always striving to offer their students effective education for the sake of the engineering students, the Universities themselves and most importantly the whole society that expects to benefit from the work of these future professionals. The efforts of the Technical Universities are usually expressed through the curricula, the equipment and a variety of teaching and research activities.

The engineering students have been always questioning their offered curricula, while the Higher Education Institutions (HEIs) have been always trying to keep them up-to-date, according to the needs of the society. At the same time, the companies have been requesting certain skills or knowledge from their employees for the sake of business and development.

“Innovative curricula in engineering education on the background of the Bologna Process” (Prof. Günter Heitmann, TU Berlin, Germany)

Engineering education needs continuous improvement, even more than many other subject areas. This is due to the fast changing demands caused by the new developments in science and technology, the societal and economic requirements regarding sustainable and environmentally appropriate growth, the changes of the organisation of work and the labour market, the expectations from the students, the new teaching and learning technologies and approaches. Demands are also raised by political aims and conditions, such as the financial support of higher education and research and the European integration. A current challenge is the aim to arrive at a common European Higher Education Area by 2010 and implement a three cycle consecutive system of higher education in all subject areas. The need to develop curricula which after three years of study at the undergraduate level provide qualifications, which ensure employability and prepare for continuous professional and scientific development of the graduates, threatens the traditional 5 to 6 year programs at some continental European Universities and requires creative solutions of curricula and new teaching/learning arrangements.

What kind of solutions could that be? And how can curricula of high standard and quality be implemented which are mutually recognized in Europe and even globally and which facilitate mobility of students and graduates?

The introduction to this topic will present the current challenges and the various activities in the frame of the Bologna Process including the attempt of the EU supported project EUR-ACE to determine quality standards and procedures for the development and accreditation of engineering programs. It will also show examples of good practice from various European universities.

Discussions should focus on the question how the various stakeholders, including the students, can find and agree on innovative curricula and cooperate successfully in implementing and running such programs.

Discussion groups' outcomes

Discussion group 1

Q: Why are curricula needed and why people follow it?

A: The curricula are there to create a tool that defines the learning objectives. If the students can choose to follow only the subjects they want, then they will never be engineers with the necessary wide knowledge, as the specialization comes later. "À la carte" studies are not as complete as the knowledge you get with integrated curricula. Curricula are the reflection of a discipline.

Q: How free should be the curricula?

A: There is some kind of core curricula and then students can have a choice of subjects in order to adapt to the market. The core subjects are the ones that make the engineers in all countries; the elective ones make the specialists.

Q: Is it positive that the market influences the curricula?

A: Companies act as an indicator that something is missing or wrong in the curricula. They say what they require from an engineer and the universities define the curricula on their own. The university should follow the trends of the market, but not be enslaved by them. What are needed to give the students are ideals. If the ideals are lost, the universities are lost, and we would be creating products specialized for the market demand.

Q: How compliant are the current curricula to the concept of long life learning?

A: Engineering students should have the capacity and eagerness to learn. If they want to progress in the world they need to keep learning. Universities give the students the competence to keep learning all the life. It is adapted if you have some margin to work and learn by yourself. In the US they have mandatory training for engineers; otherwise the engineer status is lost.

Q: How specialized should the students be at the end of their studies?

A: The first cycle should be broad and the second more specialized. The second cycle should create an engineer who knows why, while the first cycle just only how to do things. Both theory and practice should be present in both cycles. Theory is more important for the second cycle as it is more oriented like a step towards for PhD.

Q: Should be the curricula harmonized in Europe?

A: Harmonization has to mean recognition of degrees. There are different levels of harmonization, one can have the same courses but the level can vary a lot. As we live in a globalize world, students need to be able to be competent everywhere. Being an engineer means one has to know the same, but the way of teaching should be specified by each university.

Q: How do you see curricula changes in time?

A: It is a process that takes a lot of time and when universities do not respond, the society responds. Universities are responding very well to the Bologna process.

Discussion group 2

Some flexibility is needed in the core curricula. When students arrive from high school they are not sure about what they want to study, but in the last years they should have more freedom. In Europe what is to be achieved in the curricula are the outcomes, as students have to prepare for their career. Common core qualities are needed, not common curricula.

Universities also have to prepare students for workforce in the global environment. Technology changes a lot, but soft skills don't. It's not needed for students to be very specialized, but they have to learn how to learn, how to adapt to changes, have communications and managerial skills. This could be achieved with extra curricula activities during the period of study.

It's not necessary that all the curricula are harmonized; anyway they are in part because of the global market. But not all the production is global, so the local needs should also be taken into consideration. The quality of the assessment should be tested by the market and also the universities.

The curricula should change when needed, depending on the industrial progress. It is important to have a quality assurance and a quality system, to be able to identify the problems before trying to update the curricula. Students have also to be aware of the changes, the effects and the consequences. They don't need technological skills; they need to learn how to learn so their knowledge will be adopted on the current technologies trends.

Discussion group 3

It is needed to have curricula which will be a guideline for the students' education, but they have to also be flexible. Students should learn the basics in the first years because often in the beginning they don't know what they want, and then it will be easier to choose further specialization. Specific courses throughout the study period should be elective. The faculties should first give students a wide education and knowledge, to give them the possibility to study abroad and also to work abroad, in the end of their study.

After the first cycle of studies, students should be encouraged to continue studying, but also to be able to go to the work market. The second cycle should give a better enhancement of mobility, yet should avoid over qualifications for certain jobs and prepare students for work experience. In the curricula there should be compulsory project management and communication skills courses. Students should work on projects during their studies and learn from their mistakes, always with the constant help from their teachers.

Companies should also influence the curricula by giving feedbacks to universities and saying what is missing in the students' education. The communication between stakeholders should be permanent. Professors should adapt the course content according to the needs of the market. The companies can also influence through internships or guidelines. E-learning courses could be a tool for further personal development.

Day 3: Internship and research

Introduction

An internship is any short-term, supervised work experience usually related to a student's major field, for which the student earns academic credit. The work can be full- or part-time, on- or off-campus, paid or unpaid.

An internship is a unique aspect of education that integrates study with planned and supervised career-related work experience. Students are involved as non-paid “authentic employees” receiving academic credit for work experiences. The purpose of the program is to develop and strengthen the student’s education and career preparation. An internship will expose the student to the interpersonal relationships a job requires, both with co-workers and supervisors that are essential in obtaining a successful, satisfying career. Internships enable employers to assist the universities in preparing students to work in today’s business environment.

As a definition: research is an active, diligent and systematic process of inquiry in order to discover, interpret or revise facts, events, behaviors, or theories, or to make practical applications with the help of such facts, laws or theories. Research can be split into two main parts: basic research and applied research.

Basic research (also called *fundamental* or *pure* research) has as its primary objective the advancement of knowledge and the theoretical understanding of the relations among variables. It is *exploratory* and often driven by the researcher’s curiosity, interest or hunch. It is conducted without a practical end in mind although it can have unexpected results that point to practical applications. The terms “basic” or “fundamental” research indicates that, through theory generation, basic research provides the foundation for further, often applied research.

Applied research is done to solve specific, practical questions; its primary aim is not to gain knowledge for its own sake. It can be *exploratory* but often it is *descriptive*. It is almost always done on the basis of basic research. Often the research is carried out by academic or industrial institutions. More often an academic institution such as a university will have a specific applied research programme funded by an industrial partner.

“Internship and Research” (Prof. Alfredo Soeiro, SEFI President, University of Porto, Portugal)

Europe has been at the forefront of industrial development and technological innovation since the industrial revolution, but in the XX century, it felt surpassed by the USA and Japan, particularly in the aftermath of World War II. In the last couple of decades, it regained momentum and all European countries have made substantial efforts for investing in the development of industrial competitiveness through engineering research and education. Industrial internships for engineering students

play an essential role in the quality improvement of the engineering education. It gives an opportunity for companies to follow the learning paths of future engineers and provide students with a prospective view of their profession. The internships in companies, during the course work and right after the completion of studies, are an excellent tool for engineering schools to develop their relationship with industry and society, in general. Research in engineering provides the enhancement of curricula and of the capacity for graduates to promote innovation and competitiveness in the companies accepting the recent graduates. There are experiences of close cooperation between universities and companies concerning themes and financing of research. Some of the European sponsored programs have contributed to the development of these links between the universities and the industry. There are some cases of involvement of industry's views in the university curriculum development, after the implementation of these strategic partnerships between academia and industry. A clear example is the continuing professional development programs for engineers developed in cooperation between industry and university. These aspects of internships in companies and cooperation between industry and universities are essential for a better qualification and competitiveness of the engineering community in Europe.

Discussion groups' outcomes

Discussion group 1

The aim of an internship is to help students acquire a clear view of their field of studies. It prepares them for the real life experience and gives them further motivation for the continuation of their studies. However, it's difficult to organize it in a centralized manner.

The place of internship in curricula is discussable. It's also a question of infrastructure to have a mandatory internship. It can be optional, because there are difficulties in organizing internships in a large scale and also difficulties in convincing companies to offer internships. Here, there is also another problem, which is the weak quality assurance. For an internship, the expectations of both sides must be defined; a common interest must be found by students and companies.

On the one hand, students also have to be motivated into engaging in an internship with a financial motivation like salaries, with the personal development, a further education and also ECTS Credits can be given for the internship. Establishment of personal contacts can lead to easier employment after internship and this can also be a motivation for students. On the other hand, companies have also been motivated to accept internship students. They have to realize their possible gain from offering an internship, such as reduction of the cost and the promotion of a prestigious company image (social sensitivity).

A conclusion of the internship discussion was that an internship should be mandatory after ensuring every student can get one. It should be centrally organized by the university for most of the students and it should be accredited either by ECTS credits or grades.

The research is the university's connection to the market and this means to further development and horizon expansion. Today, research is mostly funded by state and there are also some EU-funded research programs. There is also company-funded research, as an alternative way of funding. The basic research should be funded by the state. A university's existence and tradition can't rely on companies. However, the cooperation for further research with companies can help to create some communication channels to the market and it can enhance the university's funding. But this shouldn't take too much of the university's "vital energy".

The undergraduate research is a kind of motivation for students, which allows involvement of students in state-of-the-art projects. This could be an alternative to the internship. Besides, the student unions can help the involvement of students in research.

Discussion group 2

Q: Why do we need internships?

A: Internships give experience rather than knowledge... for knowledge the students have the university. With an internship students are getting life experience with the application of knowledge and in some cases credits. They are improving their CV, and for their future, they can get better opportunities and are learning how to adapt to new situations.

Q: When do students need internship?

A: The need to the internship can be between the first and the second cycle. But also, in every level it can be interesting to do an internship in order to have the skills that are mentioned previously. Sometimes, it is better to have two internships. During the first cycle, this can be a non-professional internship and during the second cycle, this can be more specialized one in the specific field.

Q: How can students get access to internships?

A: In some countries, it's obvious that if a university doesn't ensure quality of studies, it can be difficult to convince a company to hire students. In most countries, students have to search for internships by themselves. This means that they have to check university boards, web pages and personal networks.

Q: What can the criteria be for selection?

A: The criteria for selection can be previous experiences and knowledge. Students can apply for internships as for a normal job, and teachers who know more the students are not involved. Companies can apply the same standards as for the people they are hiring.

Q: How can these internships be recognized?

A: If an internship is considered as a requirement to graduates, it should be recognized and rearrangements in the students' timetables should be made for these internships. The number of working hours and also the time needed for the evaluation of the report have also to be taken into consideration. Recognition can't be only about the results achieved, but it's also about the process of learning and working that students have done.

Q: How can research be defined?

A: The innovations in engineering define research; however students need to be careful in order to not separate companies and research. Besides, in the contrary of what most people think, the research is not always required to end with a publication.

Q: How can we make the researchers' fundraising?

A: In some cases, companies are paying universities for doing research related to market demands and the university provides them the knowledge. The university does research and the results will be used by the company to exploit them economically. Nowadays, most of the money available for research is controlled by companies and the state. In Research case, the universities provide knowledge and people, companies and the state provide money. In many countries, there are economic benefits from the state to the companies that invest in research.

Discussion group 3

The internships are a quite important issue on engineering education. There are many advantages of the internships like having contacts with the labor market. With an internship, the student is inside of a company, so that he or she can observe the company's structure. Besides, the student is gaining the practical use of theory.

On the other hand, there are some problems, such as not having enough companies that offer internships or internship students are not taken seriously by stakeholders. There is also the fact that internships are not advertised enough as they deserve. The discussion group is proposing here a solution for these problems, which is creating a new kind of strict cooperation between student organisations and these companies.

As a more common idea, an internship should be mandatory and it must be connected to studies. Today, it's obvious that during some internship, students are just making coffee and washing dishes. Having a mandatory internship can increase the quality of internships and also the engineering education. However, the duration of these internships has to be chosen clearly to have a relation with the curricula.

Nevertheless, the selection criteria for internships have to be clear in order not to have problems in the future. These criteria can be the average of the students' grades and also the field of studies. In multinational companies, language knowledge can be also a big criterion. Companies can check also the technical background of students in order to give them some projects. The years of studies are also another criterion in order to guess the technical background of the students. Last but not least, a good motivation of a student can be the most important criterion. Internship is like a job interview that lasts for a long period so students and companies can have a nice impression on the other side.

There can be an evaluation at the end of the internship by the students and the companies. Even if it is hard to evaluate internships, this can help to recognition of internships. All stakeholders have to give some feedback about internships and students in order to increase the quality of internships. However, there can be fake

reports from students. The solution for this problem is having a better communication between the two sides.

For the research, there isn't enough interest from students and teachers as well. The reason for this is maybe because of the small budgets or the poor research quality. Unfortunately, research is not available in every university. The solution that discussion groups proposed for research problems is to have a university network for research.