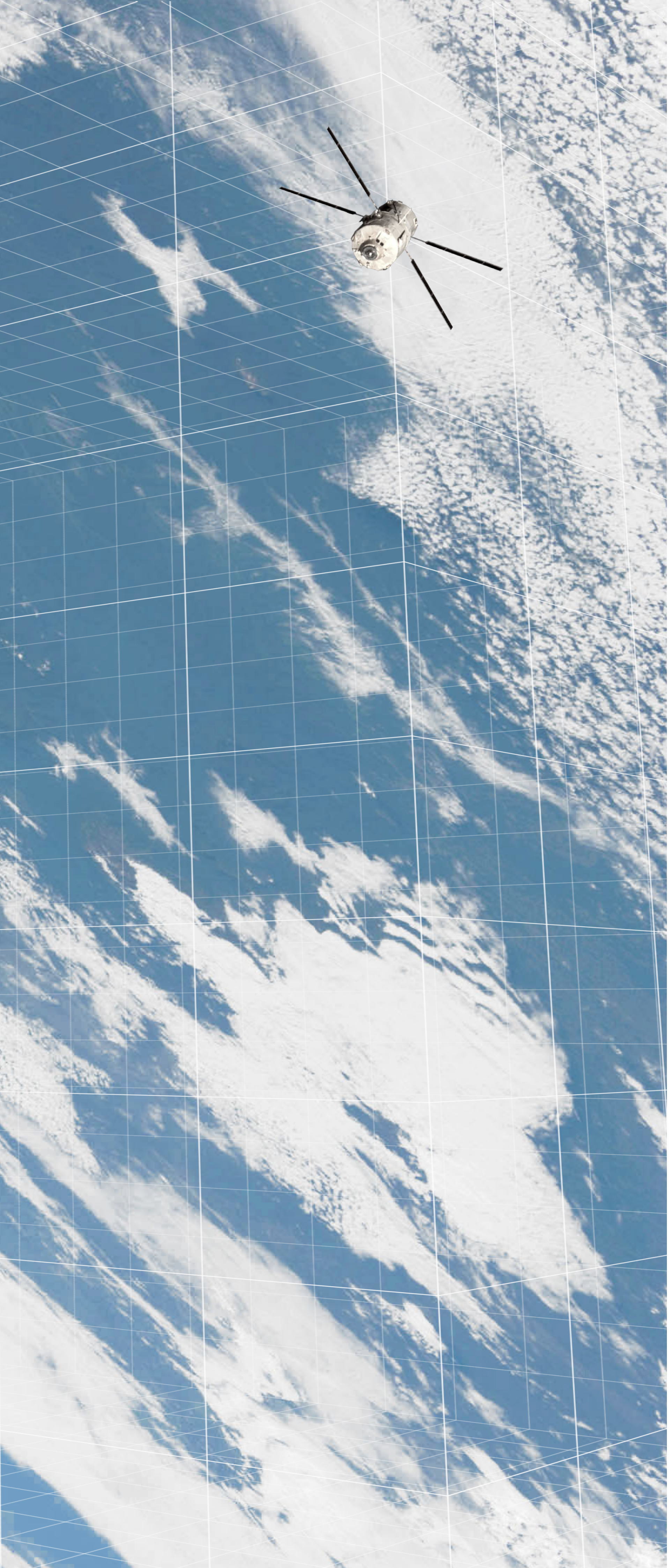

ATTRACT

Enhancing the Attractiveness of Studies in Science and Technology

Education and Culture DG
Lifelong Learning Programme

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"The ideal engineer is a composite ... He is not a scientist, he is not a mathematician, he is not a sociologist or a writer; but he may use the knowledge and techniques of any or all of these disciplines in solving engineering problems." —N. W. Dougherty (1955)

Executive Summary



Background and Objectives

ATTRACT, funded in 2009 under the EU flagship programme "Lifelong Learning", is a follow up initiative of a Swedish national project ("Ung Ingenjör/Young Engineer coordinated by KTH) which had the main objective of investigating the attractiveness of engineering studies for young student.

The project partnership is represented by a sub-group of universities members within the CLUSTER Network (www.cluster.org), a consortium of 13 elite European Universities in Science and Engineering with associate members from around the world.

ATTRACT has brought together key actors in engineering education from eight European Countries with the idea that a better understanding of why young people are becoming less attracted to engineering education would enable a range of measures to be undertaken to ultimately increase the attractiveness.

ATTRACT has aimed at investigating recruitment, admissions and retention from different points of view by involving secondary schools and employers. Participating universities supplied background data from their national database and project findings have been used as a basis for future interactions with policy makers and other authorities within these participating countries.

Methodology

ATTRACT has brought together over a time-span of 34 months universities, secondary schools, employers, policy makers, professional association and media leaders. All of these actors from the involved countries and beyond have been invited to the open meetings and have been involved in the surveys carried out within the different work packages through interviews and questionnaire based studies. In particular, the different stakeholders have participated in three occasions during the project lifetime:

- Mid-term open meeting (Dublin, April 2011)
- Meeting with stakeholders and discussion or recommendations (Leuven, April 2012)
- Final conference and discussion of dissemination, exploitation and follow-up activities (Stockholm, October 2012)

A general framework was developed in the first phase of the project in order to compare the educational systems and circumstances within each of the partner countries under a series of relevant headings, and to help introduce the context of engineering education in different countries. The information provided has offered a general overview of the education system in each partner country, as well as further detail into areas relevant to the ATTRACT project, such as Science, Technology, Engineering and Mathematics (STEM) education at primary and secondary level. The comparison framework presented is classified within the following categories:

- General information about partner universities
- Pre-university education in each partner country
- Career Guidance provision for school students
- University admissions practices
- Financial situation for third-level students

The project activities have been carried out within the following four development work packages (WP):

- The Attractiveness of Being an Engineer (coord. KTH)
- Barriers (coord. TCD)
- Attraction (coord. IST)
- Retention (coord. Aalto)

Results

Perception

In general Engineering is still perceived as a difficult subject since studies in different countries have shown that aside from Health, all other areas are considered to be easier than engineering by upper secondary education pupils. Although important, the difficulty issue is not detrimental. The fact is that engineering has a positive image and other encouraging aspects that are identified by, not only secondary school students, but by a range of social groups.

High income, exciting job, high status and highly respected are normally positive thoughts from what people think in regards to engineers and engineering. Recent graduate engineers play a key role in presenting an attractive and realistic image of the engineering profession for younger generations. The perception of difficult and academically challenging engineering studies has been the main reason for its decreased interest.

Globally, the impact of engineers on the labour market extends far beyond traditional roles. Each country has its own characteristics and particular social, economic and political contexts, and therefore has differing focuses when analysing the labour market. The statistics from respective countries have to be compared within their contextual circumstances.

One important action point in attracting students to the engineering areas is to show them that it does payoff to be an engineer. Not only in terms of economy capital but also when it comes to social or cultural capital. There also remains a shortage of engineers in several fields so the labour market looks good for most countries. Figures also show low unemployment rates.

In Germany, Ireland and in Portugal engineering is often mentioned in a positive way in relation to the labour market since it has for long been put in relation to a good employment outlook and a high salary. In these countries engineers are also described in a positive way as experts are co-responsible for bringing forward the economy. In Sweden on the other hand, engineers are often considered, by non-engineers, as cold, insensitive technocrats, deeply specialized with highly repetitive work and with little or no social contact.

The perception of engineers in media is different within different parts of Europe. Based on our results the overall picture of engineering in the media is positive.

Attraction

It is important to understand that when attracting students to engineering studies, the desirable goal is to attract not only students, but the most highly-motivated and well-qualified applicants.

Globally, each country develops a wide range of national activities aiming not only to raise the public awareness in Science, Technology and Engineering, but also to garner a students' interest in taking up studies in this area. Similarly, tertiary education institutions also have a widespread variety of actions to recruit students to Science and Technology Engineering programs.

It is important to notice that several institutions carry out several actions aimed at balancing the gender representation in Science and Technology Engineering programs, particularly designed for girls.

In general, the opinion of female students tends to be in accordance with male students' views in secondary school. However, the trends show female students to be less likely to undertake an engineering program, especially in Finland. Moreover, female secondary students are more pessimistic about the contribution of engineers to the country's development. It should also be noted that, in Finland, female secondary students seem to consider that engineers' duties do not involve a high level of difficulty in contrast to their male counterpart. In addition, they seem to be more pessimistic about engineers' pay level. On the other hand, in Ireland, girls are less likely to believe that engineers have easy access to the labour market.

It is important to notice that the perceptions of engineering considerably differ between secondary students and university entrants. The percentage of university entrants who enter an engineering program, having chosen it after 10th grade is much higher than the percentage of secondary students who wish to undertake an engineering program, having decided it after 10th grade.

Therefore, in light of the results, the following actions should be recommended:

- To promote Science, Technology, Engineering, and Mathematics (STEM) courses among the youth;
- To support teachers training and development in Science and Technology;
- To enhance the women's participation and role;
- To promote engineers as role models;
- To increase general public awareness about the importance of Science and Technology.

Formal Barriers

Data analysis in Ireland and Portugal shows a clear link between achievement in mathematics, physics and chemistry at high school, and subsequent achievement in university engineering. This reinforces the practice operating in many ATTRACT partner countries of requiring these subjects for entry to engineering programs. Where they are not (or not all) required, recommendations have been made to ensure students have the required prior achievement in these areas, through the weighting of results in the most relevant subjects.

The particulars of the high school systems vary from country to country, but in all students have some degree of choice over what they study. This can force them to choose quite specialised pathways early on or remain in more broad ones, but even so it is possible in most cases for some students to focus significantly on STEM subjects while others undertake only minimal study of them. An approach whereby all students receive a core level of education in a broad range of subjects, or at least delay the specialisation point until later in their high school career, would ensure that a greater number of students would be eligible to pursue engineering should they wish to instead of being effectively excluded by not possessing the required subjects.

While the issue of how best to widen access to tertiary education is the subject of much debate across Europe, it should be of particular concern to engineering departments. In many ATTRACT partner countries engineering undergraduates are drawn from a particularly narrow sector of the available population. Male students significantly outnumber females in the uptake of engineering places, and students from lower socio-economic backgrounds are disproportionately under-represented among engineering students, even by comparison with other disciplines. Merely on the basis of equality this imbalance should not be allowed to continue, but targeting students from these groups also presents an opportunity that should not be ignored for attracting greater numbers of potential students to our engineering programs.

Retention

Student retention has already for long been among the most widely researched areas in higher education. The generalizability of research in this field, however, is problematic due to cultural and structural differences between countries, universities and even programs where research is done.

It has been noted that engineering students tend to drop out of university more often and they take a longer time to graduate than their peers in non-engineering programs.

Student retention is an increasing concern in many institutions of higher education. High dropout rates are undesirable for several reasons. For example, retention not only has an impact on the individual and his/her family but also produces a ripple effect on the postsecondary institutions, the work force and the economy. Indeed, retention is one of the most common ways students, parents and stakeholders evaluate the effectiveness of institutions of higher education

In a constructive environment and quality culture the expectations of all involved should be high, but realistic. It is also very important that these expectations are clearly communicated to all parties and especially for the first-year students as early as possible.

Feedback is essential for all parties to know how they live up to expectations. The different activities building our educational practice are constantly evolving. This development can be greatly enhanced through relevant information and feedback. This helps the institutions to make foresights, with help of early warning systems – at institutional, program and individual level.

Support in different forms can greatly help participants reach their respective goals. The support can help clarifying expectations and providing feedback, but can also have many other forms as described in many of the case studies provided by ATTRACT. This support can be formal and organised, as well as quite informal. Human support must include both academic and well-being support.

The involvement of the participants is vital for a productive educational culture. The culture must grow and it is important that participants see its value. It is important that the reasons behind different activities as well as their results are clearly presented to all involved

There are difficulties in measuring retention in a reliable manner and in identifying the "active ingredients" which, in each activity, are responsible for positive changes in retention data and also the economic benefit. This calls for use of advanced and visual tools such as the "retention footprint" that provide patterns of the phenomenon over a period of time to give information on trends. Joining data from quantitative studies with data from more qualitative studies (e.g. interviews to participants, focus groups, content analysis of support materials) is essential in order to reach a more comprehensive view of change processes over time.

Recommendations

The general recommendations on the attractiveness of engineering studies that emerged from the meetings with the stakeholders have been linked in the final chapter to the critical stages of engineering education and can be summarized as follows:

Youth Impressions and Stem Preparation

- Examination of the factors which influence the decision-making process in relation to subject choice at high school and beyond
- Mechanism which allows for the later 'streaming' of students into designated tracks or branches of education
- Higher level of core STEM content for all students, regardless of area of specialisation
- Encourage more girls to pursue STEM subjects
- Increase participation in engineering among students from lower socio-economic groups
- Use of aptitude tests at university entry for information purposes, to evaluate students' strengths and potential areas of difficulty

University Selection and Orientation

A successful transition would require that universities ensure that entrant students:

- Have a comprehensive face to face academic advising session
- Gain more knowledge of student support services
- Reduce anxiety about the transition to university life
- Understand the necessity of taking ownership and academic responsibility in their educational process.

First and Second Year Experience

- Maintain or increase student self-reports of having made meaningful connections with peers.
- Maintain or increase student involvement in university activities.
- Maintain or increase student self-reports of meaningful interactions with faculty and/or administrators.
- Maintain or increase student understanding of and compliance with the university's expectations of them.
- Increase the number and percentage of third year students who report satisfaction with their chosen major and perform successfully in that major.
- Increase the number and percentage of students who demonstrate progress toward the development of a preliminary life/career plan.
- Identify and report on activities/memberships that seem to correlate to academic performance changes as compared to appropriate comparison groups.
- Maintain or increase the percentage of first year students who are retained to their second year.
- Increase the percentage of second year students who are retained to their third year.

Transition to a Lasting Career

While employment for engineers has been rising, more than ever before, employers look to hire engineering graduates with internship experience in their field. It is the task of the university to make sure students are prepared to enter the workforce and transfer from a program to employment as smoothly as possible. Part of this task involves appropriate advising for the student and providing them with opportunities to gain career-related experience in a variety of settings, while at the same time increasing the cooperation with private sector employers.

Institutionalizing the Recommendations

Strategies for institutionalization vary depending on the context. In some instances, implementing a recommendation is best done once at a time as part of a coordinated overall vision. Other times it is most effective to present the entire package all at once. The creation of a change-ready environment at the university is essential in order to have an atmosphere conducive to change.

Exploitation of Results

At the end of the project's formal lifetime (covered by the LLP funding), the partners will extensively disseminate the results of the study and undertake actions addressed to the national and local decision makers in order to implement the recommendations.

The CLUSTER consortium will also evaluate the work done and follow up with similar activities in the next future. All the 13 consortium members will be invited to implement the developed measures and keep informing the project consortium about similar initiatives each of them is developing at local level. Concerning the tools and good practices developed, partner universities have already expressed their intention of making regular use of them, in particular the field trial methodologies.

During the project lifetime several interactions have taken place between the consortium and SEFI, more in particular the newly created Working Group named "Attractiveness of Engineering Education". Synergies have been identified and it has been decided that ATTRACT will continue operating under this umbrella in the future in order to ensure sustainability to the carried out activities.

Contents

Project Objectives

The contribution to quality in Lifelong Learning can be considered as the project main general objective. ATTRACT brings together key actors in engineering education in seven European Countries with the idea that a better understanding of why young people are less attracted by engineering education will enable a range of measures to be undertaken to ultimately increase the attractiveness. ATTRACT aims at bringing together universities, secondary schools, employers, policy makers, professional associations and media as well as opinion leaders. All these actors from the involved Countries and beyond are constantly consulted, invited to the open meetings and are actively involved in the surveys carried out within the different work packages through interviews and questionnaires based studies.

ATTRACT has facilitated the dialogue and exchange of ideas between the participating universities and related stakeholders with the goal of promoting the quality of educational programs in Science and Technology. Another important task for ATTRACT is to compare some key aspects of the educational system in the participating countries in order to increase the transparency and comparability of the surveys carried out.

ATTRACT aims at investigating recruitment, admission and retention from different points of view by involving secondary schools and employers. Participating universities will supply background data from the national point of view and project findings will be used as a basis for future interactions with policy makers and other authorities in the different countries.

Young pupils eagerly consume new technology but are apparently uninterested in its development and production Whatever the cause, educational providers, graduate employers and government agencies need to communicate what an engineer is and his/her social contribution. The project aims at comparing national perceptions of the engineer profession and engineering courses in order to identify differences and similarities in attitudes between partner countries. ATTRACT draws upon expertise in universities' marketing departments as well as relevant external agencies such as national governmental bodies, companies and trade associations.

ATTRACT focuses on the recruitment dynamics but also on retention related issues and policies adopted in order to reduce the drop-out of students in the first year of their higher education studies.

In a broader perspective, the project tackles also transversal issues of relevance to Higher Education like the low ratio of female students in Science and Engineering education. The fact that female students once admitted often perform better than their male colleagues proves that efforts to increase the balance of genders in this type of studies will also increase the overall quality. In order to do so, it is necessary to explicitly focus both on the contents of the curricula and on the image of the engineering profession which is traditionally identified as a typically male one.

The expected benefits for the target groups will be extensive and of different nature for the different actors. A better understanding of what the Engineering Profession represents for secondary school pupils and their parents is one of the objectives of the project which will provide this group with clear and transparent tools for them to make the right choice for what concerns higher education studies. The Higher Education Institutions will be provided with survey outcomes that will help them in better shaping their marketing, communication and recruitment strategies as well as their retention policies. Employers will be better aware of what is the public perception of the Engineering Profession and what are the difficulties of the Universities in recruiting and retaining the future manpower. In this way, employers will be able to advise and intervene both on the communication issues and on the curricula contents when a mismatch between needs and expectations will be detected. Media will also be provided with clear analysis to better describe the dynamics related to Science and Engineering studies and Engineering profession.

Finally, policy makers will be able to use the outcomes of the surveys in order to fine-tune their educational policies covering the project core issues so to effectively enhance the attractiveness of studies in Science and Engineering, prevent the drop out, remove the formal barriers, and support the recruitment of students in the field with a particular attention to the gender issue.

About the Partnership

The project partnership is represented by a sub-group of universities members of the CLUSTER Network (www.cluster.org). CLUSTER (Consortium Linking Universities of Science and Technology for Education and Research) is a network of 12 elite European Universities in Science and Engineering with associate members from around the world. In 2012, CLUSTER celebrated its twentieth anniversary, a long path on which the role of Engineering Education has been examined and best practices and policies for running our institutions to breed talent have been defined. CLUSTER represents a Multi-location European University of Science and Technology with about 3.000 professors, 11.000 academic staff and 14.000 PhD students, with a total of more than 140,000 students.

In order to keep the consortium small enough to ensure a good level of efficiency, not all the CLUSTER partners have been involved but a fair geographical distribution has been provided with representatives from Scandinavia, Central Europe and the Mediterranean Region. Two CLUSTER universities have decided to join the project activities although not formally included in the partnership and this extends the focus of the project on 9 Countries.

Nevertheless, all the CLUSTER partner universities (including the associated partners from China, Russia, Israel, Brazil, USA and Canada) are constantly informed and consulted at CLUSTER internal meetings about the project progress and planned activities and they are invited to the open sessions.

Since the project is an extension of a previous similar initiative run at Swedish level, two more universities from the Country have been involved in order to benefit from their previous experience.

The cooperation within the project represented anyhow something new and not simply a consolidation of existing relations. This is due to the fact that most of the individuals involved in the action have never been involved in general CLUSTER activities and the 2 Swedish non-CLUSTER partners have never cooperated with the network. Moreover, each partner has involved national stakeholders in the activities and more will be involved when the projects will enter its crucial phase. Most of these new transnational relationships between universities, employers, student associations, professional associations, regional governments, etc. would have never occurred outside of ATTRACT and this alone represents already a very valuable result as creation of a much larger network that might be exploited in the future for a follow up project focused on one of the specific issues raised during the debate.

Acknowledgements

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Education and Culture DG

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Structure of the report

This project proudly represents many steps forward in the successful collaboration throughout a very complex educational landscape. The partners involved in the project represent a wide range of nationalities throughout Europe. Our common goals have enabled the ATTRACT Project to successfully map these complex factors and provide you with an in-depth analysis of best practice. The project activities have been structured in 4 main sections each of them led by a different partner university with continuous input from all participating universities. Each part is aimed at covering one of the aspects that altogether represent the main focus of the project as a whole.

Framework for Institutional Comparison in Partner Countries

The purpose of this section is to provide a framework for comparing the educational systems and circumstances in each of the partner countries under a series of relevant headings, and to help introduce the context of engineering education in different countries.

The information provided will offer a general overview of the education system in each partner country, as well as further detail into areas relevant to the ATTRACT project, such as STEM education at primary and secondary level. While much of the following information is publically available, the data is scattered across a variety of documents in a range of inconsistent formats.

The purpose of this document is to collate data from an extensive range of sources, and by presenting a distilled picture of the similarities and differences between the various national systems, to provide a context in which to view the work contained within each of the other work packages.

The data presented is classified within the following categories:

- General information about partner universities
- Pre-university education in each partner country
- Career Guidance provision for school students
- University admissions practices
- Financial situation for third-level students

Perception

How do we define an Engineer? What aspects of the profession makes becoming an engineer attractive? How does the perception of the Engineering profession differ within the participating countries and among different actors (students, companies, professional associations, parents, media, etc.)

Recruitment

In the Lisbon Strategy, the EU has identified goals such as the increase of the number of graduates in maths, science and technology and the reduction of the gender imbalance in these subjects. The challenge is to attract more young students to studies in science and technology and The ATTRACT project will form the platform where this discussion can be undertaken with an international perspective among partnered universities.

Female students remain highly underrepresented in science and technology while at the same time continuing on to higher education at a higher rate than their male equals. Attracting this increasing number of female students has remained a challenge for several decades. ATTRACT will refuel this initiative and bring in an international perspective. Engineering programs also need to undertake broad recruitment strategies and secure necessary measures in order to support these students.

The aim of this section is to exchange ideas and experiences from previous work and actions in this area. The first part will be devoted to an inventory in order to better describe the present situation at participating universities. The second part will be focused on the development of new ideas, directly focusing on how to bridge the gap between the secondary school and the university- aiming for new (cost efficient) models for cooperation.

Barriers

What are the elements that make the engineering profession and studies in the field not as attractive as it used to be and as it still could/should be? The requirements for admission to engineering programs are often high. This means that a potential student must have passed a certain set of courses during their secondary education. Pre-university education is organized differently in each European country. The educational system in many countries implies that the children and parents must make important decisions regarding their educational life. This may clearly result in exclusion from higher education in general and from higher education in science and engineering in particular. This case is more evident for young students stemming from families with weak or no tradition at all in university studies.

The methods that are used for selecting potential students may also be limiting. Most countries have centralized systems where influence from the actual university is limited. Alternative routes may include interviews with applicants or even allowing standardized tests compliment a student's academic performance rather than strictly rate their potential.

The aim of the section is to characterize the admission systems in the participating countries and based on the findings; determine a method of "Best Practice" for addressing both exclusion and admission. For partners in countries where there is need for system improvement, the findings will support suggestions for alterations to the appropriate national authority.

Retention

A significant proportion of engineering and technology students fail to graduate. Student retention is an increasing concern in many institutions of higher education. High non-completion rates are undesirable for several reasons. Retention not only has an impact on individual students and their families, but also produces a ripple effect on the postsecondary institutions, the workforce and the economy. The main objective is to increase completion rates without lowering standards.

This part elaborates the complex phenomenon of student retention in different countries and partner universities and is looking for good practices to increase student retention and completion rates through field trials. Building upon theories such as those by Tinto and Bean, it can be argued that educational persistence is a product of complex set of interactions among personal, institutional and external factors where a successful match between the student and the institution is of particular importance. We were able to take a closer look at some of these elements in the rather rich system. A comparative student retention framework was developed and economic benefits of targeted retention initiatives investigated.

The trials chosen and conducted provided different approaches to information and actions. The first trial aimed to test and evaluate a method of visualizing and monitoring student retention in a footprint. The purpose of the second trial was to benchmark practices in gathering information from large groups of students on their perceptions of studies, orientation, study choices and academic integration.

The third trial focused on the issue of interaction between students and staff with special emphasis on the interaction supporting academic integration of students and student progression, and the early identification of students at risk via case studies.

Recommendations

The scope of this final chapter is to provide recommendations from the point of view of the different stakeholders on the topics covered by the project and for each of 5 stages identified as the critical steps in Engineering Education.

The set of recommendation has been developed both internally by the work package coordinators and experts from the partner universities and externally by collecting comments from stakeholders that attended the open sessions and who contributed to the online surveys.

The final goal of the project was in fact to investigate the four main topics (perceptions, recruitment, barriers and retention) through surveys, collection of data, comparative studies and field trials in order to identify the critical issues and address concrete recommendations and good practice to the actors that are in the position of implementing these measures and correct therefore the trends and cover the gaps when and where needed.

Glossary

Our glossary gives an overview of some of the specific terms related to higher education. The glossary is not intended to be exhaustive, but to define a common set of concepts, valid for retention studies conducted within the scope of the project. Some educational terms have also been added. Whenever possible, the definitions were retrieved from the ECTS Users' Guide, the OECD Glossary on Education Terms or the Life Long Learning Program Glossary.

Appendix

We have included much more supporting work that has been produced during the lifetime of the project. This will enhance the understanding of the concepts presented within the chapters.

Comparison Framework

As the universities represented within the ATTRACT project differ widely in terms of size, programmes offered, and other factors, Table 1, below, provides background information about the participating universities in order to frame any comparisons which are made.

In the below table, engineering students are understood to be students on programmes which are accredited by the professional body of engineers in the given country. This allows for regional variations (e.g. the inclusion of architecture in Finland but not elsewhere), while still conforming to the conventions governing the profession within each country. It also covers differences in duration of programmes, since in several countries professional-level engineering programmes take five years, while at present in Ireland they typically take four.

Table 1: Overview of partner universities

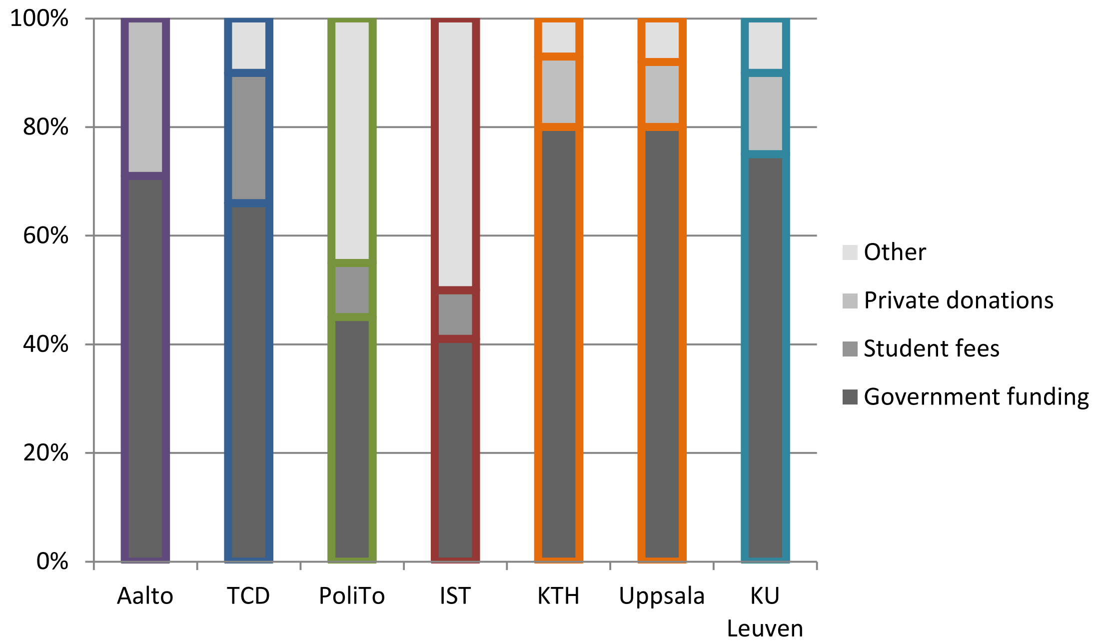
	KU Leuven	Aalto University	Trinity College	PoliTo	IST	KTH	Uppsala
Country	Belgium	Finland	Ireland	Italy	Portugal	Sweden	Sweden
University Type	General	Multi-disciplinary	General	Technical	Technical	Technical	Multi-disciplinary
National Ranking	#1	n/a	#1	#2	#2	#4	#3
Core Funding Sources	Government: 75% Private sources/contract research: 15% Other: 10%	Government: 71% Private donations: 29%	Government: 66% Student fees: 24% Other: 10%	Government: 45% Student fees: 10% Research income: 2% Other: 43%	Government: 41% Student fees: 9% Other (own income): 50%	Government: 80% Private sources: 13% Other: 7%	Government: 80% Private sources: 12% Other: 8%
# of students studying to degree/accredited professional level	36,820	17,020	11,290	26,523	9,445	14,000	20,000
% studying engineering	9% (4,124 students)	25% (4,289 students)	6% (700 students)	74% (19,752 students)	94% (8,832 students)	100% (14,000 students)	12% (2,300 students)
# of postgraduate or doctoral students	4,454	2,496	3,335	1,050	1,135	1,500	2,000
% studying engineering	21% (964 students)	26% (657 students)	14% (460 students)	n/a	69% (779 students)	100% (1,500 students)	5% (100 students)

Table 1 notes:

i. All university rankings are according to the Times Higher Education University Rankings 2011, unless otherwise specified.

ii. The national ranking used refers to the Technical University of Lisbon, of which is IST is a member, as published in the World Report SIR, 2010

Figure 1: The proportion of each university's funding which comes from government, private donations, fees paid by students or other.



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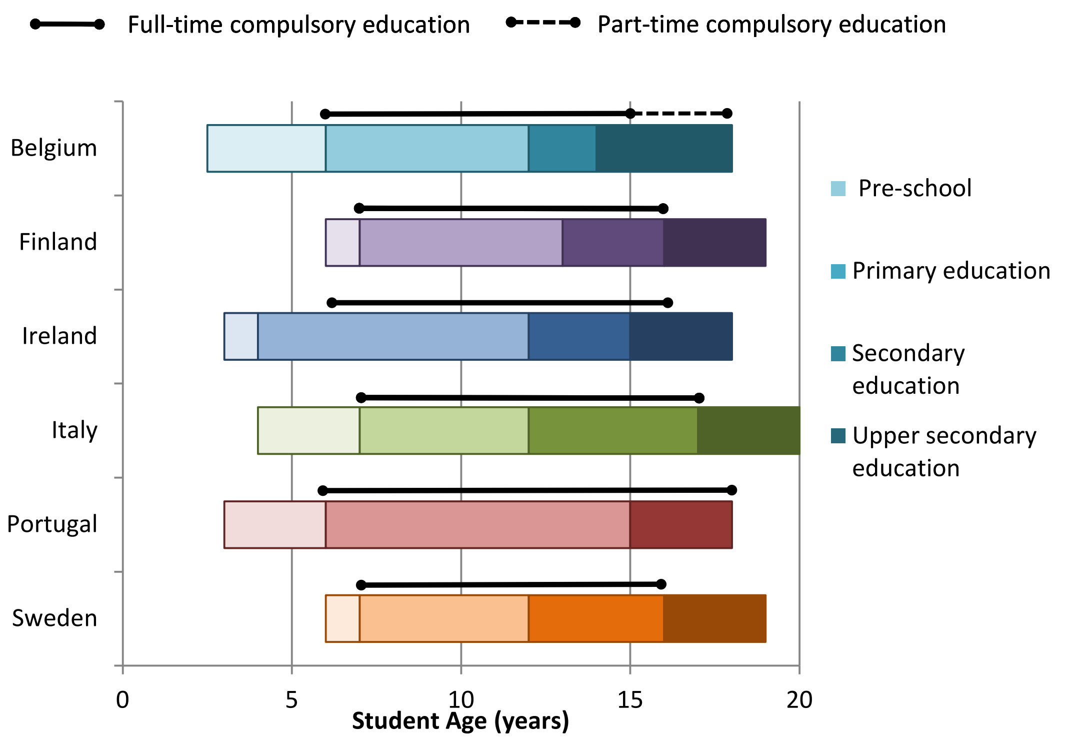
Portugal: IST website, http://www.ist.utl.pt/en/about-IST/facts-figures/ [Accessed 11th May 2011]

Sweden: KTH Royal Institute of Technology Management Report 2010. Uppsala: http://www.sweden.se/eng/Home/Education/Research/Facts/Higher-education-and-research-in-Sweden/

Pre-university education

Information on the pre-university education is provided under a number of headings. The focus of this section is on the primary and secondary education systems in partner countries as they may be said to relate to subsequent uptake of engineering programmes at third-level. As such, in addition to providing general information about the structure of the school system in each country, the area of m concern is the level of exposure to STEM subjects that a student gains from each educational system. Particularly, we have focused on those STEM subjects that are most directly relevant to engineering education, i.e. maths, chemistry, physics, and ICT.

Figure 1: Organisational structure of education systems in partner countries.



References for Figure 2

Belgium: Eurydice National Education System Overview: Belgium (Flemish Community) (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_BN_EN.pdf

Finland: Eurydice National Education System Overview: Finland (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_FI_EN.pdf

Ireland: Eurydice National Education System Overview: Ireland (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_IE_EN.pdf

Italy: Eurydice National Education System Overview: Italy (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_IT_EN.pdf

Portugal: Eurydice National Education System Overview: Portugal (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_PT_EN.pdf

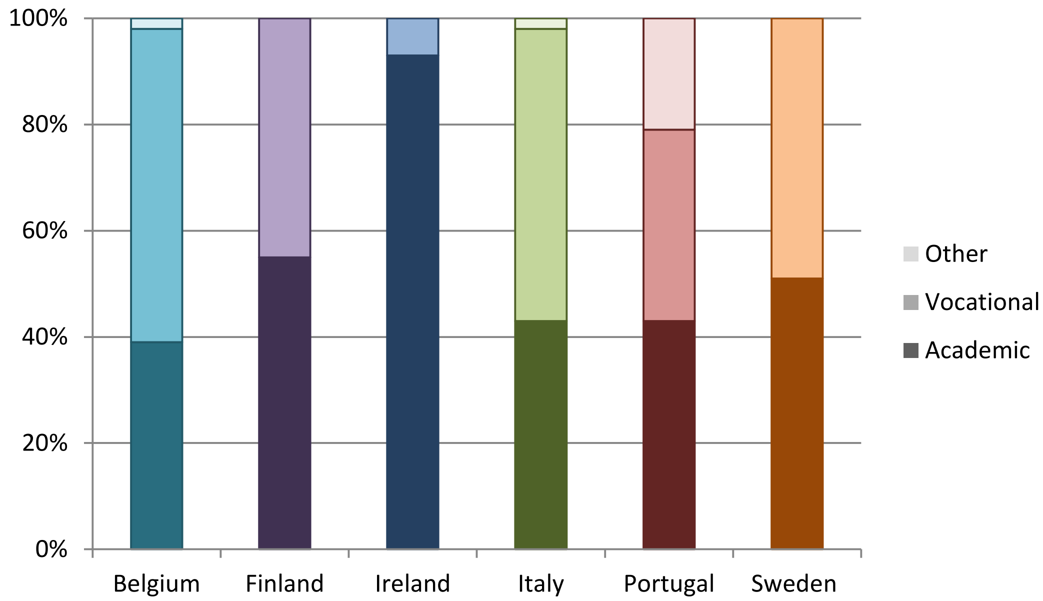
Sweden: Eurydice National Education System Overview: Sweden (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_SE_EN.pdf

High School/Secondary Level Education

Types of secondary school

Many European countries operate different categories of school in the secondary and/or upper-secondary school systems. In the majority of the countries represented in the ATTRACT project, students choose between a general/academic strand of upper-secondary education, or a vocational one. This choice usually has implications for the subjects the students would then study. In many cases, learners choose at a relatively early age (typically 15) which pathway they will follow, and the choice they make can limit the fields of study open to them later on. The specific effects of this practice on engineering education are significant, therefore, since the result is a reduction in the number of students who will have studied the scientific/technological subjects often required for entry to engineering programmes [See WP6 Report for full discussion]. Figure 3 shows the proportion of students following each of the main curriculum types in the partner countries.

Figure 2: % of second-level students by type of school/curriculum



Note: 'Other' may include Adult Education

References for Figure 3

Belgium: ATTRACT WP6 Survey of Partner Countries: Belgium

Finland: Eurydice National Education System Overview: Finland (2011). http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_FI_EN.pdf

Ireland: State Examinations Commission (2010). http://www.examinations.ie/

Italy: Eurydice Eurypedia Database. http://eacea.ec.europa.eu/education/eurydice/eurypedia_en.php

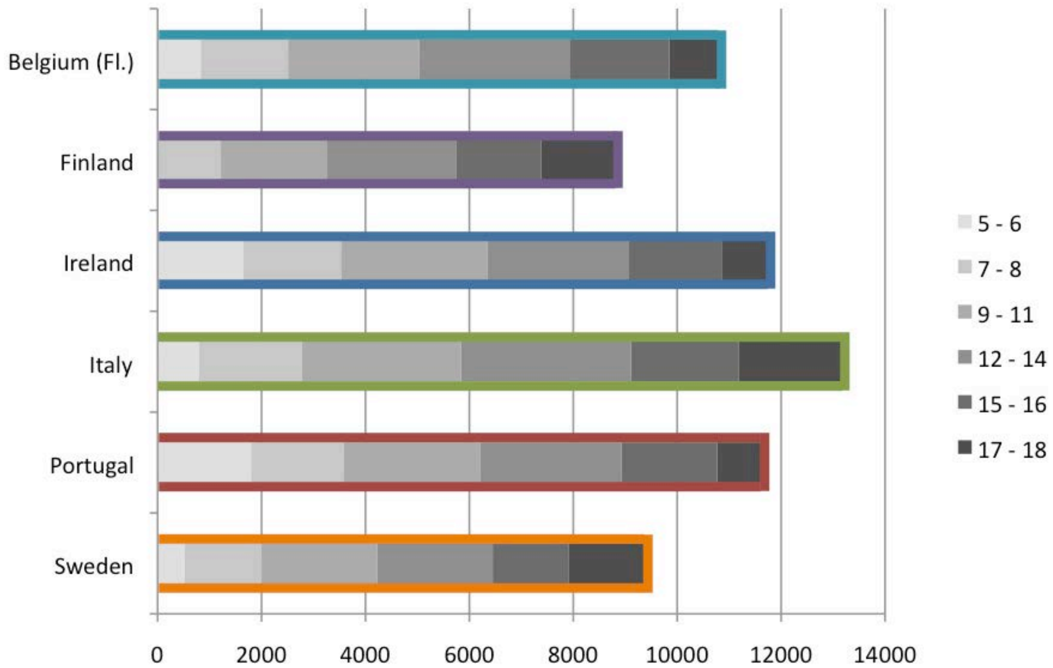
Portugal: Eurydice Eurypedia Database. http://eacea.ec.europa.eu/education/eurydice/eurypedia_en.php

Sweden: Eurydice Eurypedia Database. http://eacea.ec.europa.eu/education/eurydice/eurypedia_en.php

Hours spent in school each year

The below graph depicts the number of hours pupils spend in school each year at each stage of the school system, across the partner countries. The figures in some cases are approximate, as data was often inconsistent across sources. However, the hours shown represent at least the minimum compulsory hours per year, and where possible show the typical number of hours for a student taking the most common strand of schooling.

Figure 3: Average hours spent in school each year



Sources: Eurydice, Recommended Annual Taught Time in Compulsory Full Time Education in Europe, 2010/11; OECD, Education at a Glance 2010; ATTRACT WP6 Survey of Partner Countries, 2010

Students’ exposure to STEM subjects over time

The following figures depict the amount of time students spend studying engineering-relevant subjects throughout their pre-university education.

Each cumulative graph displays lines indicating the average number of hours for which students are exposed to a particular subject, as weighted by the percentage of students electing to study the subject. The graphs also include bars indicating the range of hours from the minimum (state-required) number of hours the student must spend as far as the maximum number of hours (should they choose to also study elective subjects in the field).

Figure 4: Students exposure to Maths over time

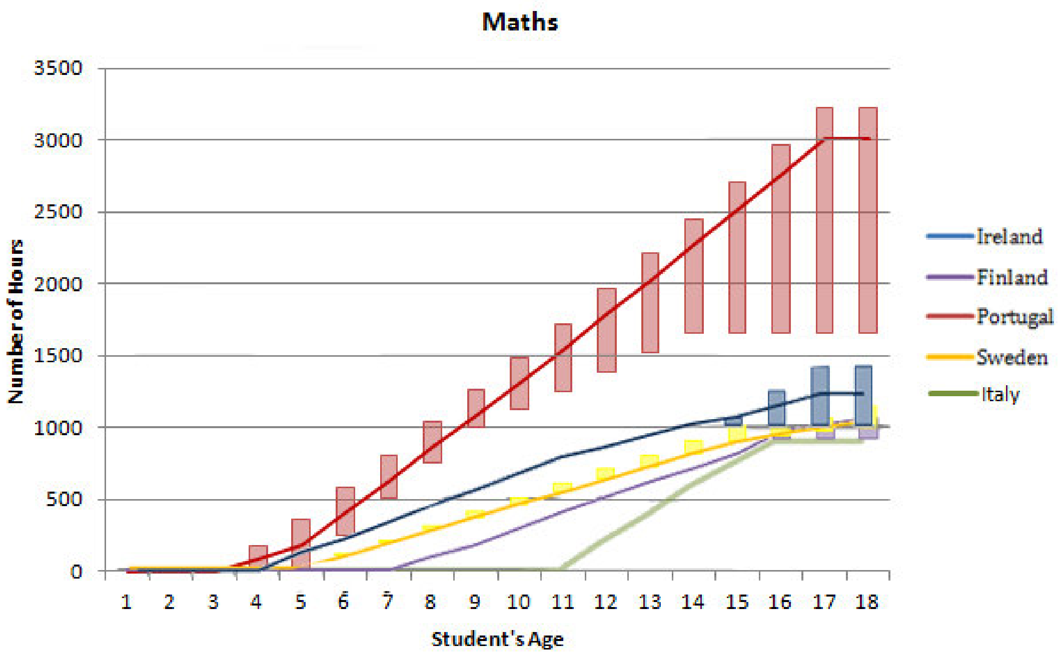
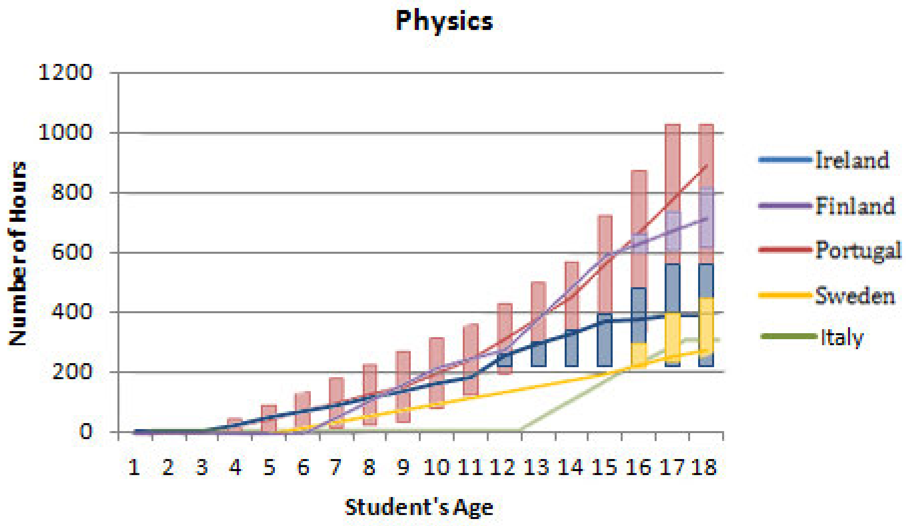


Figure 5: Students exposure to Physics over time



Please note the change in scale along the y-axis

Figure 6: Students exposure to Chemistry over time

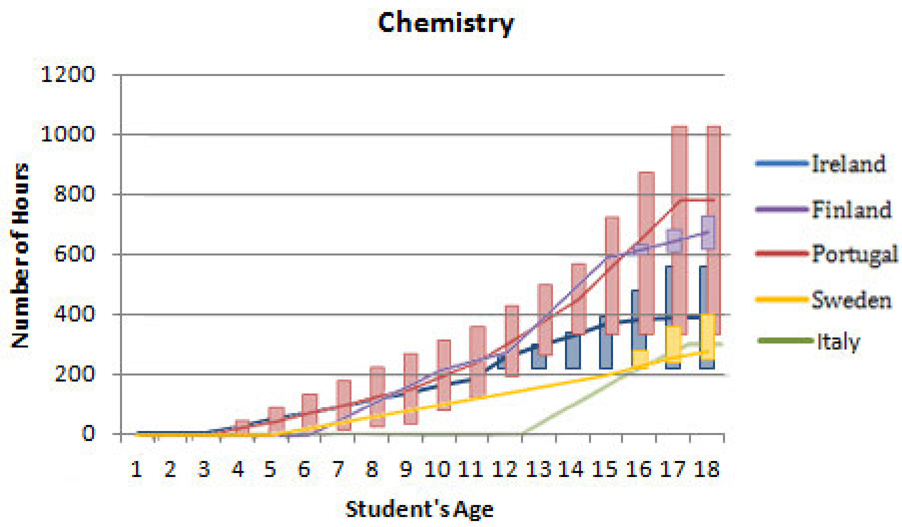


Figure 7: Students exposure to Biology over time

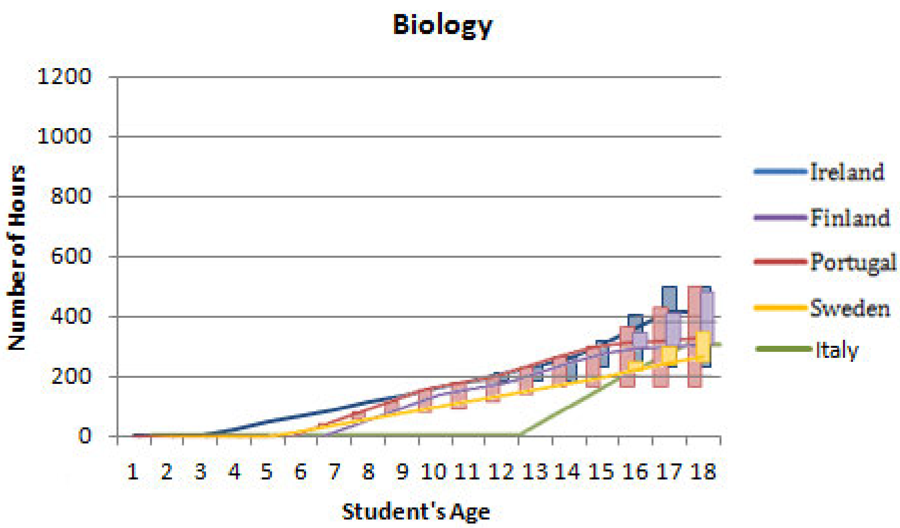
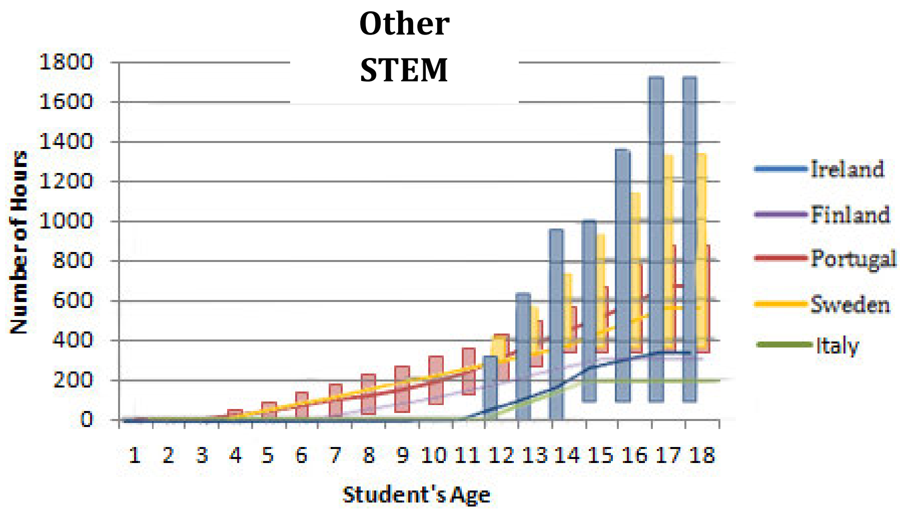


Figure 8: Students exposure to other STEM subjects over time



Note: 'Other STEM' covers engineering-relevant subjects such as technology, metalwork, technical graphics, engineering, construction studies, design and communications graphics and ICT

Reference for Figures 5 - 9

Belgium: Eurydice (2012). Recommended annual taught time in full-time compulsory education in Europe, 2011/12. http://eacea.ec.europa.eu/education/eurydice/documents/tools/taught_time_11-12.pdf

Finland: Finnish National Board of Education (2001). Distribution of lesson hours in basic education. http://www.oph.fi/download/47491_Distribution_of_lesson_hours_in_basic_education_2001.pdf

Sweden: Eurydice (2012).

Ireland: Eurydice (2012); State Examinations Commission Statistics 2011. http://www.examinations.ie/index.php?l=en&mc=st&sc=r11; Department of Education (1999). Leaving Certificate Chemistry Syllabus. http://www.curriculumonline.ie/uploadedfiles/PDF/lc_chemistry_sy.pdf

Italy: Eurydice (2012).

Portugal: Ministry of Education (2012). http://www.min-edu.pt/index.php?s=sistema-educativo)

Gender breakdown of students studying STEM subjects at upper-secondary level

There are variations in student take-up of STEM subjects between countries and subjects, as is highlighted in the following graphs. There is a clear trend across partner countries whereby male students are more strongly represented among those studying certain STEM subjects such as Physics and Other STEM, while female students are the majority about those studying Biology.

Figure 9: Gender breakdown in Higher/Advanced Mathematics at upper secondary level

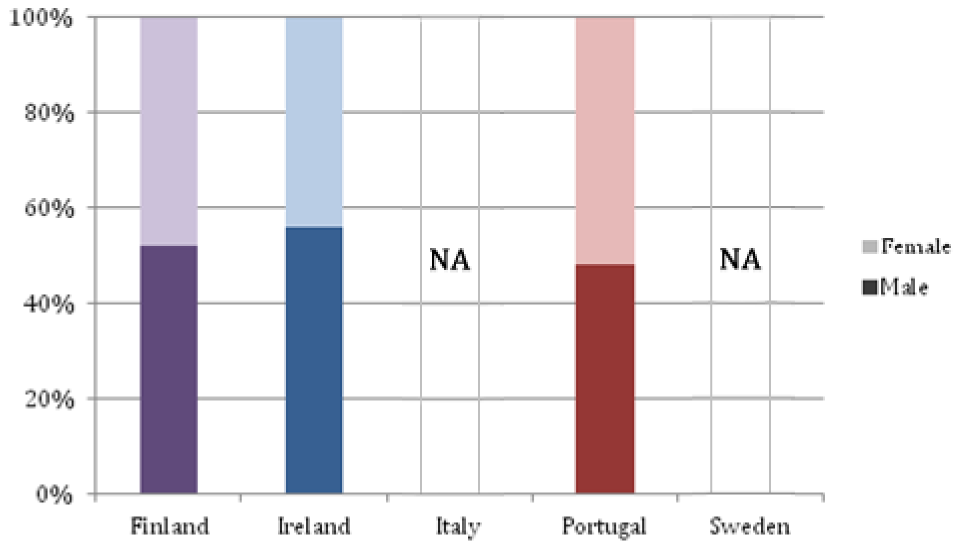


Figure 10: Gender breakdown in Basic Mathematics at upper secondary level

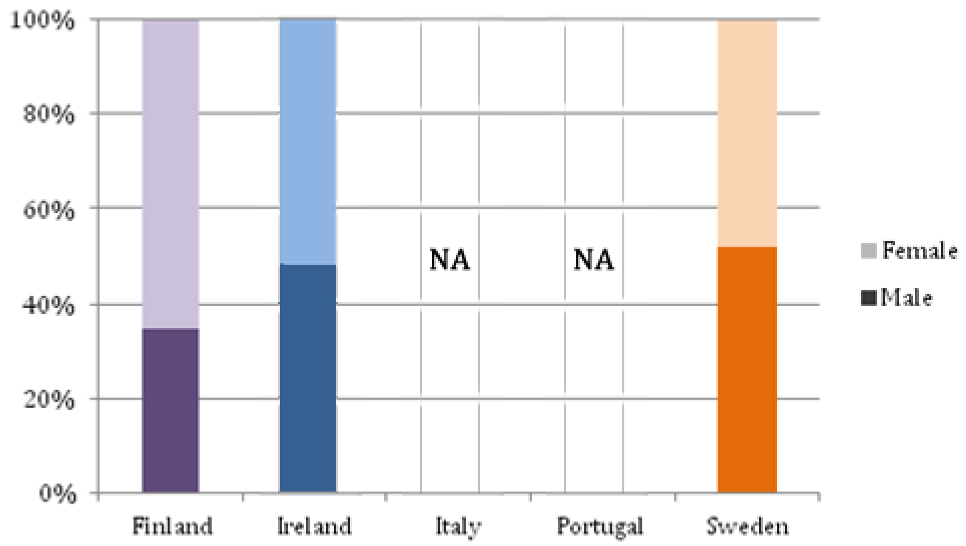


Figure 11: Gender breakdown in Physics at upper secondary level

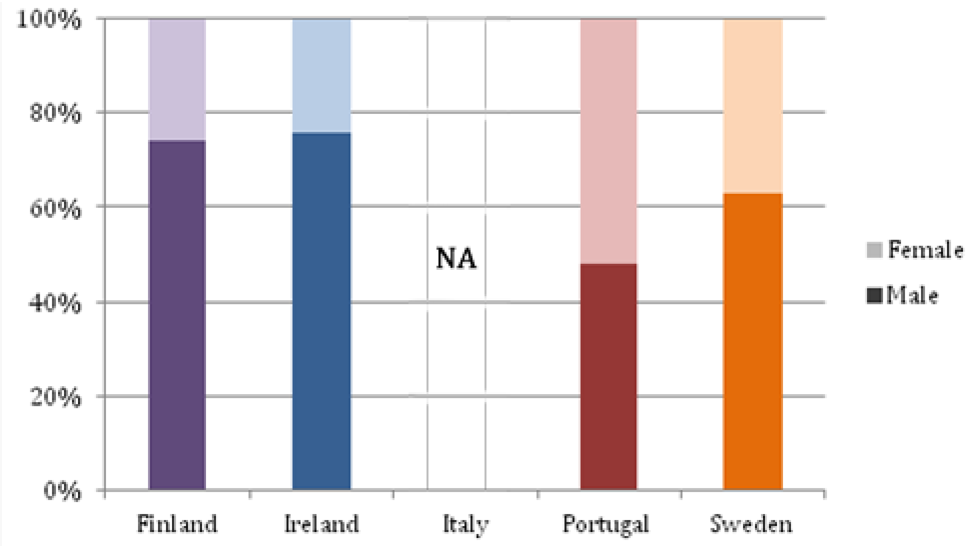


Figure 12: Gender breakdown in Chemistry at upper secondary level

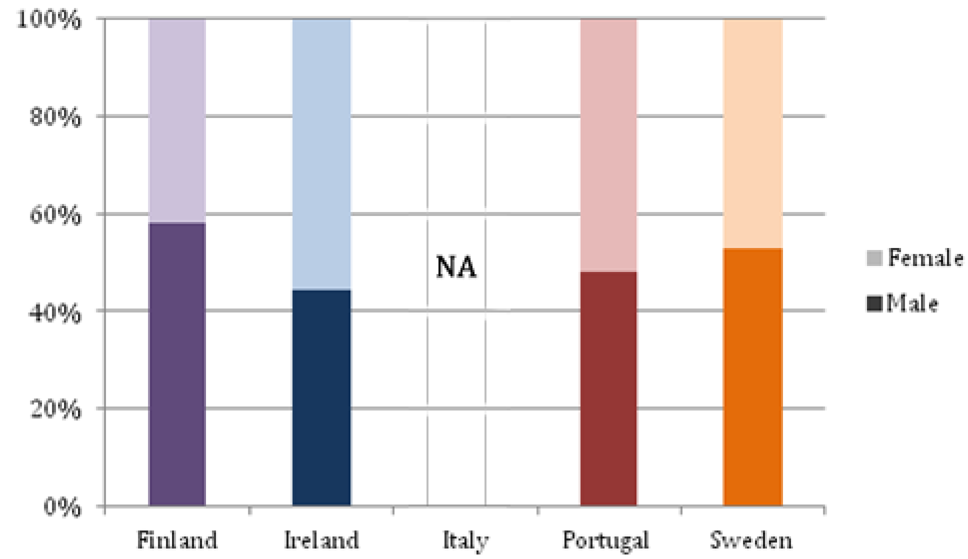


Figure 13: Gender breakdown in Biology at upper secondary level

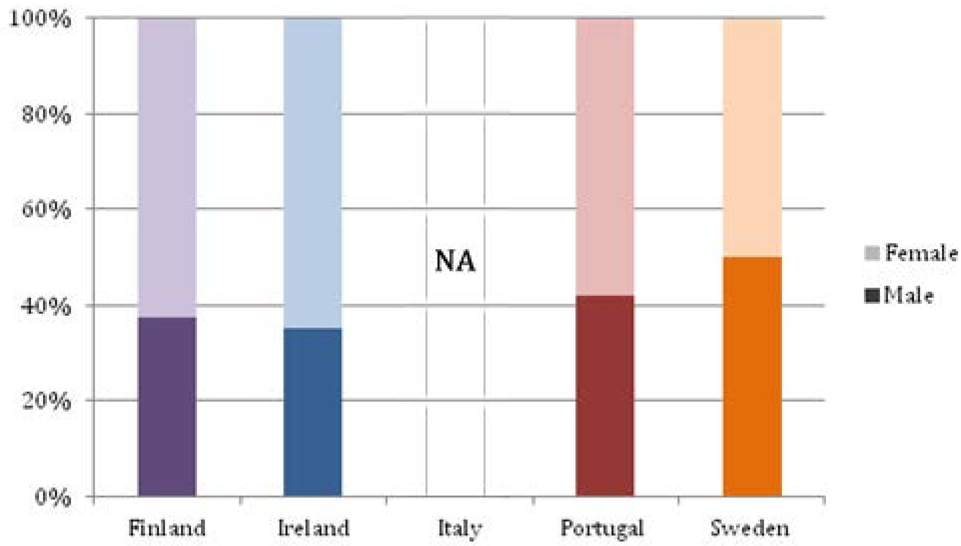
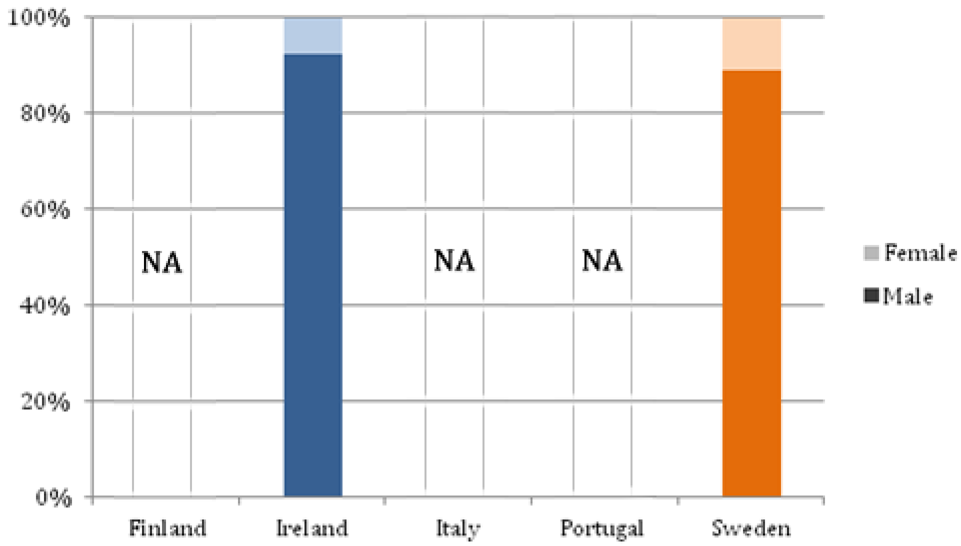


Figure 14: Gender breakdown in 'Other' STEM subjects at upper secondary level



Note: 'Other STEM' covers engineering-relevant subjects such as technology, metalwork, technical graphics, engineering, construction studies, design and communications graphics and ICT.

References for Figures 10 - 15

Finland: ATTRACT WP6 Survey of Partner Countries: Finland (2010)

Ireland: State Examinations Commission, Leaving Certificate Statistics 2009. http://www.examinations.ie

Portugal: ATTRACT WP6 Survey of Partner Countries: Portugal (2010)

Sweden: ATTRACT WP6 Survey of Partner Countries: Sweden (2010)

Data unavailable for Belgium and Italy

Career guidance

This section covers the career guidance systems in operation within schools in the partner countries. In Ireland, anecdotal evidence suggests that career guidance counsellors are less comfortable talking about technical careers when they are not educated with a technical background. No specific acknowledgement of prior education is taken into account during career guidance counsellor training.

Table 2: Career Guidance

	Belgium	Finland	Ireland	Italy	Portugal	Sweden
Standardised Counselling System	No	Yes [i]	No (currently under review)	No	No	No
Qualifications required to become a guidance counsellor	Masters degree in psychology, pedagogy or educational sciences	Teaching qualification with additional specialised training	Primary degree plus 1-year postgraduate	Qualified psychologist	Teaching qualification with additional specialised training	Social & Science specialisation in upper-second level Primary degree (Arts) Work experience
		OR Masters degree in Education			OR Qualified psychologist	
					OR Social Service specialisation in upper-second level	
Primary background	Humanities	Humanities	Humanities	n/a	n/a	Humanities/ Social Science

Note: Finnish upper-secondary school incorporates one compulsory and one specialisation module (worth at least 1.5 academic credits

References for Table 2

Belgium: ATTRACT WP6 Survey of Partner Countries: Belgium (2012); EuroGuidance, Guidance System in Belgium (Flanders), http://www.euroguidance.net/?page_id=2044.

Finland: ATTRACT WP6 Survey of Partner Countries: Finland (2010)

Sweden: ATTRACT WP6 Survey of Partner Countries: Sweden (2010)

Ireland: Institute of Guidance Counsellors. http://www.igc.ie/Membership/How-To-Become-A-Guidance-Counsellor

Italy: ATTRACT WP6 Survey of Partner Countries: Italy (2010)

Portugal: ATTRACT WP6 Survey of Partner Countries: Portugal (2010)

University admissions

Table 3 provides a comparison of the university admissions procedures and requirements in partner countries. Since admissions criteria represent perhaps the single most substantial formal barrier to engineering education at university level, it is important to be able to examine these criteria across each of the countries within the project.

Table 3: University admissions practices in partner countries

		Belgium	Finland	Ireland	Italy	Portugal	Sweden
Centralised Admissions (Y/N) [i]		N	Y	Y	Y	Y	Y
Does the university have power over student selection?		No	Yes	No	No	No	No
Alternative routes of entry to university	Prior experience/ Qualifications (Mature Student Entry)	Yes (for over 21s)	Yes	Yes (for over 23s)	n/a	Yes (for over 23s)	Yes
	Access or Foundation programme	n/a	Yes	Yes	n/a	n/a	Yes
	Aptitude tests	n/a	n/a	n/a	n/a	n/a	Yes
	Other	n/a	n/a	n/a	None	Yes [ii]	n/a
% of students who enter engineering via alternative routes [iii]		n/a	~ 5%	8%	n/a	~7% over all universities	Prior experience: 7.5%. Science Foundation Year: 10% Aptitude test: 33.3%

Table notes:

i. 'Centralised admissions' refers to the practice by which students apply to third-level through a central (usually national) administrative body, rather than by applying directly to individual universities/institutions.

ii. Places are reserved for members of certain groups, but this only applies to a very small number of applicants.

iii. Figures given here for Ireland and Sweden refer to Trinity College and KTH, respectively, rather than the countries as a whole, but reflect approximate figures nationally.

Table 4: University admissions requirements in partner countries

		Belgium	Finland	Ireland	Italy	Portugal	Sweden
General admission requirements	School certificate exams	Yes	Yes	Yes	Yes	Yes	No
		and/or	*and/or*	-	-	*and/or*	-
	Ongoing performance at second-level	Yes	Yes	No	No	Yes	Yes
		-	*and/or*	-	-	*and/or*	-
	Entrance exams (Managed by institution)	No	Yes	No	No	No	No
		-	-	-	-	*and/or*	*and*
	Other	n/a	n/a	n/a	n/a	Yes[†]	Yes[‡]
Additional admission requirements for Engineering programmes	Maths	No	Yes[*]	Yes – 55% +	No	Yes[ɣ]	Yes
	Physics	No	Yes[*]	Approx. 10% of programmes require one additional science subject	No	Yes[ɣ]	Yes
	Chemistry	No	Yes[*]		No	Yes[ɣ]	Yes
	Biology	No	No		No	No	Required in certain programmes
% of students who meet STEM requirements		n/a	Advanced mathematics: 42% Physics/ Chemistry: 17%	12%	n/a	38%	11%

Table notes:

* These requirements refer to entrance exams which must be taken in these subjects. Students must achieve the required scores in Mathematics and in either Physics OR Chemistry

ɣ These exams require the student to score a minimum of 50% for admission

† Additional pre-requisites may be required by certain programmes, as decided by the institution

‡ Language requirement: proficiency in English [Note: in the case of all ATTRACT universities applicants whose native language is not the same as the language of instruction are required to demonstrate proficiency in that language]

References for Tables 3 and 4

Belgium: ATTRACT WP6 Survey of Partner Countries: Belgium (2012)

Finland: ATTRACT WP6 Survey of Partner Countries: Finland (2010)

Sweden: ATTRACT WP6 Survey of Partner Countries: Sweden (2010)

Ireland: Central Applications Office, data for 2010. http://www.cao.ie; TCD Senior Lecturer's Report 2009/10.

Italy: ATTRACT WP6 Survey of Partner Countries: Italy (2010)

Portugal: ATTRACT WP6 Survey of Partner Countries: Portugal (2010)

Financial situation of students

The financial circumstances of students attending university are a significant factor which can impact on the accessibility and availability of third-level education to students seeking to enter it. The following tables and charts provide information on the costs to the student involved in attending university, as well as the financial assistance available.

This is divided into two sections. Table 5 uses the actual euro value of the costs in each country, while in tables 6 and 7 these figures are normalised across all countries according to purchasing power to allow for easier comparison. All figures are per year unless otherwise specified.

Table 5: Third-level fees and available financial assistance

	Belgium	Finland	Ireland	Italy	Portugal	Sweden
Typical university fees	Typically €578, but varies according to income, programme, university, nationality	None	€2,250	Min: €184 Max: 20% of state grant Average: €880	€996	None
Grants available (min. and max. ranges) [i]	€ 234-€3,622	€38 - €298 per study month	€305 - €5,915 + Payment of student contribution	see below	€1,190 - €7,900	€3,000 - €4,750 per year
Average amount of yearly grants	€ 1,770	€2,682	€2,750	€1,772 (resident student) €2,592 (commuter student) €4,701 (non-resident student)	€1,637	€3,000
Annual cost of living for independent EU student (includes accommodation)	€9,850	€8,040 - €11,400	€8,000 - €12,100 (excl. fees)	€5,450 (resident student) €9,700 (non-resident student)	€6,900	€9,000
Housing supplement	-	80% of rent paid, to a maximum of €201.60 per study month (= approx. €1,814.40)	€3,640 - €6,240	-	Included in grant	€1,596 - €3,156

Additional funding	Via Student Services	Study Loan: €300 per study month (= €2,700 per academic year)	Student Assistance Fund	Educational materials: €500 - €1,500 University services: max €1,710	Student loans	Study loan: approx. €6,000 per year
GDP per capita [ii]	€32,787	€34,554	€35,954	€26,449	€16,729	€38,194
Tuition fees as a % of GDP per capita	2%	0%	6%	5%	6%	0%

Table notes:

i. In most countries, students must meet certain criteria in order to be eligible for grants. Details are given in Table 6, below.
ii. As given by the International Monetary Fund, 2010 (www.imf.org, accessed 23rd January 2012)

Note: In the following tables, all figures given have been normalised to Purchasing Power Parities[1] All figures are in US Dollars[2].

Table 6: Third-level fees and available financial assistance

	Belgium	Finland	Ireland	Italy	Portugal	Sweden
University fees	$667	None	$2,682	Average: $1,114	$1,573	None
Grants available (min. and max. ranges)	$270 - $4,178	$41- $319 per study month	$364 - $7,050	See below	$1,880 - $12,480	$2,832 - $4,485
Average amount of yearly grants	$2,042	$2,872	€3,278	$2,243 (resident student) $3,281 (commuter student) $5,951 (non-resident student)	$2,586	$2,832

[1] As given by the OECD for 2011 (http://stats.oecd.org/Index.aspx?DataSetCode=PPPGDP, accessed 05/09/2012). See Appendix for details.
[2] Euro – US Dollar conversion rate of 1 EUR = 1.27877 USD as of 7th September 2012

Annual cost of living for independent EU student (includes accommodation)	$11,361	$8,608 - $12,206	$9,535 - $14,422 (excl. fees)	$6,899 (resident student) $12,278 (non-resident student)	$10,900	$8,496
Housing supplement	-	approx. $1,943	$4,338 - $7,437	-	Included in grant	$1,507 - $2,980
Additional funding	Via Student Services	Study Loan: $321 per study month (= $2,891 per academic year)	Student Assistance Fund	Educational materials: $633 - $1,899 University services: max $2,165	Student loans	Study loan: approx. $5,665 per year
GDP per capita [i]	$37,817	$36,996	$42,853	$30,367	$26,428	$36,060
Tuition fees as a % of GDP per capita	2%	0%	6%	5%	6%	0%

Table 7: Eligibility factors for student grants

		Belgium	Finland	Ireland	Italy	Portugal	Sweden
Factors determining grant eligibility	Income	Yes	Yes	Yes	Yes	Yes	-
	Family dependency	Yes	Yes	Yes	-	-	-
	Proximity to university	-	-	Yes	Yes	Yes	-
	Credits gained	Yes	Yes	-	-	-	-
	University programme	Yes	-	-	-	-	Yes
	Disability	-	-	-	Yes	-	-
	Age	-	Yes	-	-	-	Yes
% of students qualifying for grants		17%	100% of those who meet credit requirements	31%	13%	18%	~100%

% of students who live in parental home during term time	37%	4%	33%	Data not available	66%	Data not available
Average proximity to university	45 mins	Data not available	<30 mins (52% of students) <1 hour (75% of students)	Data not available	<30 mins (42% of students) 1 hour (30% of students) >1 hour (18% of students)	Data not available

References for Tables 5 – 7

Belgium: ATTRACT WP6 Survey of Partner Countries: Belgium (2012); Study in Belgium website, http://www.studyinbelgium.be/en

Finland: ATTRACT WP6 Survey of Partner Countries: Finland (2010); Study in Finland, http://www.studyinfinland.fi/tuition_and_scholarships/tuition_fees

Ireland: Citizens Information, http://www.citizensinformation.ie; Irish Council for International Students, http://www.icosirl.ie/eng/student_information/cost_of_living/; Student Finance website, http://www.studentfinance.ie/mp7586/eligible-expenses-for-student-assistance/index.html; Eurostudent Survey II: Irish Report on the Social and Living Conditions of Higher Education Students 2003/2004;

Italy: ATTRACT WP6 Survey of Partner Countries: Italy (2010); MIUR, Decreto Ministeriale 28 febbraio 2010 "Aggiornamento importi borse di studio anno accademico 2010/11"; Study Abroad Universities, http://www.studyabroaduniversities.com/Cost-of-Study-and-Living-in-Italy.aspx.

Portugal: ATTRACT WP6 Survey of Partner Countries: Portugal (2010)

Sweden: ATTRACT WP6 Survey of Partner Countries: Sweden (2010); CSN website, http://www.csn.se/en/2.135/2.624/2.625/2.700/studiemedel; Study in Sweden website, http://www.studyinsweden.se/Living-in-Sweden/Cost-of-living/.

The Attractiveness of Being an Engineer

Work Package 5

Defining an Engineer

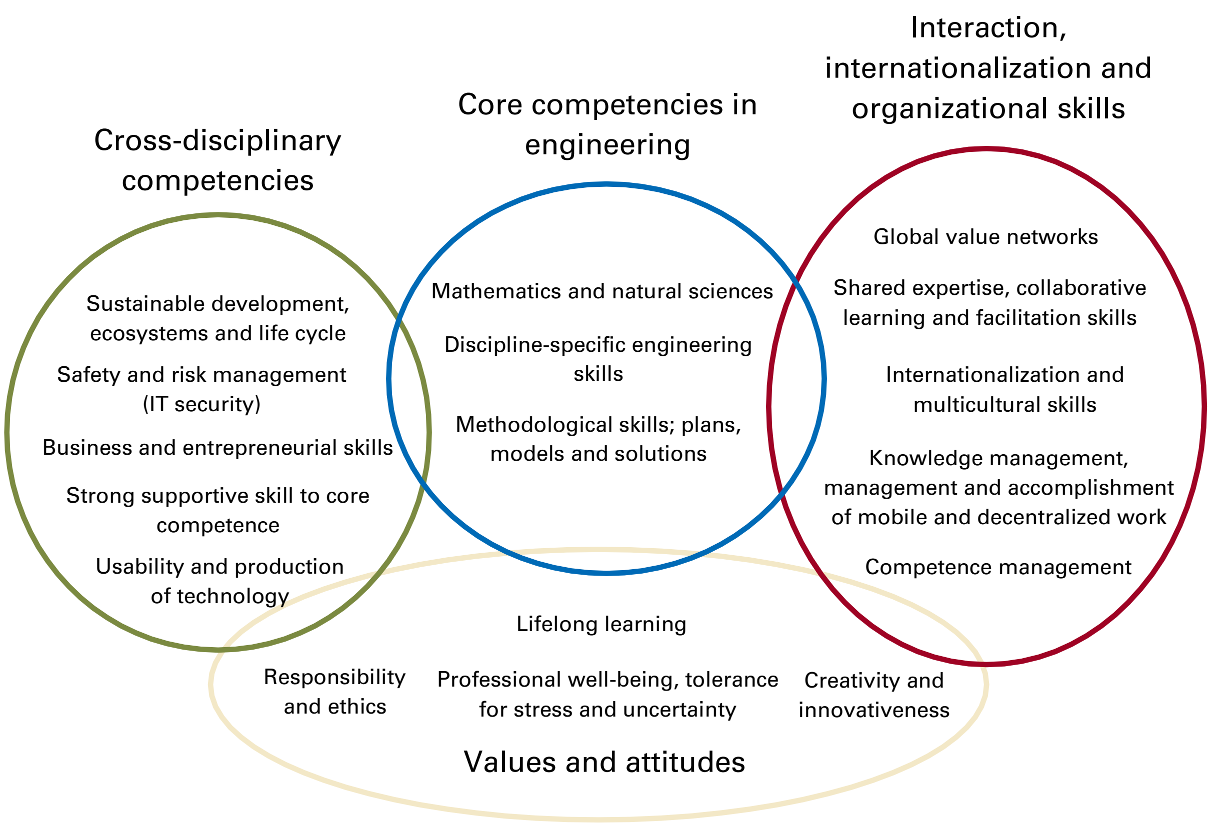
Let us start from the beginning; it's not completely out of the blue to trace the origins of engineering back to the origin of mankind. The first hominids possessed no physical attributes like claws or sharp teeth that allowed them to hunt for animals. As soon as evolution allowed, the first hominids started to develop and to use tools to compensate for the lack of physical advantages over other creatures. The advantage they had was the ability to use and transform what nature gave them. Fast forward a couple of million years and you reach the technological age, the age where mankind bends the elements and nature to reach places that were unreachable, cure diseases that were incurable and build structures that were unbuildable. In the middle of this evolution and peak are the engineers. A fast search on the internet leads us to the definition of an engineer as being a *"professional practitioner of engineering, concerned with applying scientific knowledge mathematics and ingenuity to develop solutions for technical problems"*[3].

The purpose of this report is to shed some light on how attractive engineering is in Europe and in order to achieve that goal, it is necessary to understand what engineering really is and what being an engineer implies in terms of education, skills and professional life. What is indeed an engineer? Each of the partners involved in this project offered different points of view and focus on this matter but one can easily see how these converge and complete each other. For instance, in Portugal, it´s national order of engineers[4] defines the practice of engineering as the use of the knowledge of laws of nature to design, to analyse, to promote, to manage or to control an achievement of something economically profitable, technically predictable and of social interest[5]. It clearly shows a focus on "What engineers do" and a wide area of intervention in different aspects of society and social life. This focus fits right in on how the present role of the engineer is defined by the Swedish Government[6]. In Sweden, no formal requirement or certificate is needed to work as an engineer. Engineers can work in a variety of areas as engineers are needed in all industries and not just in traditional technology. Environmental, health, design, energy, information, medicine, manufacturing and food are other examples of engineering versatility. Engineers can virtually be found everywhere in the community both in private and public sectors, large and small companies, both employed and self-employed. The possibility to choose guidance is large and many doors are opened with an engineering degree. In Finland, many engineers work in projects nowadays, often as managers or project managers while other engineers are providers and specialists, among several others domains that will be addressed in this report. In Finland according to a project entitled "Competence through Learning[7]". This was conducted as part of the National Strategy Project for Higher Engineering Education with the purpose of developing higher engineering education; the special strength of Finnish engineers is their excellent problem solving capacity, which is based on in-depth knowledge of technology, and on their mathematical and scientific competence.

If a very brief summary on what is an engineer, based on the different points of view from all the partners involved is allowed, one can say that engineers have the knowledge and ability to manipulate and to incorporate technological, scientific and mathematic elements while contributing to Many of societies domains and to develop new means of improving performances. This link to a wide spectrum of society areas demands the engineer not only to possess the technical attributes mentioned before but also a set of skills to operate and interact within those areas, meaning that the engineer in the 21st century needs other skills aside from the core competencies which define him/her as an engineer. The activities of engineers changed, from developing new technical components, units, and equipment to advanced problem-solving requiring competence in project planning, implementation, and integration of complex systems of hardware and software. Engineers must complement their professional and technical expertise with non-technical competencies such as systematic problem solving, communications, management, and leadership skills. Mielityinen[8] proposes the following diagram in order to understand how all the skills are combined:

[3] Wikipedia
[4] www.ordemdosengenheiros.pt
[5] Formal definition by the Portuguese Order of Engineers; www.ordemdosengenheiros.pt
[6] www.hsv.se
[7] Mielityinen 2009
[8] Mielityinen 2009

Figure 1: Competencies and skills of future engineers. Source: Mielityinen 2010.



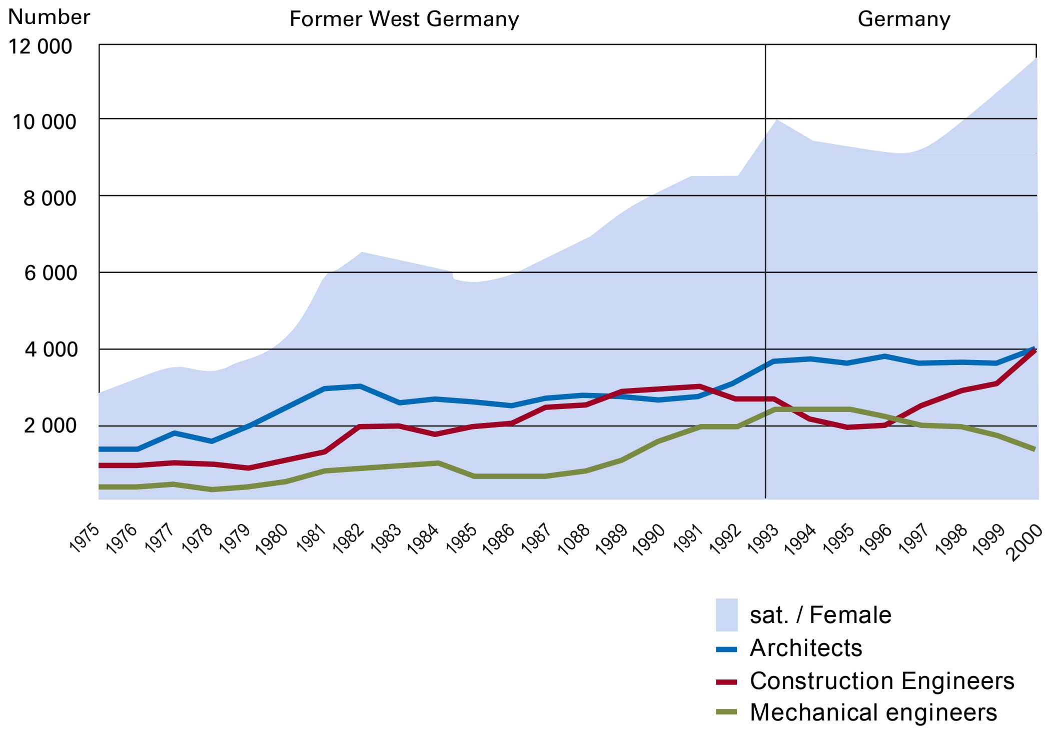
This kind of knowledge and skills are provided by higher education institutions such as university and polytechnic institutes. These institutions work both as knowledge transmission agents and also as legitimation agents by conferring academic degrees which certify before society that a person is indeed an engineer and is able to perform his or her role as one. Both in Portugal and in Finland, engineers are defined as graduates at Master degree from a university. For instance: Master of Science Degree in Technology in the Finnish case or a 2nd cycle or integrated master degree in Portuguese case. The engineer is then a combination of skills and knowledge gained during his/her training/academic path and by a formal degree obtained in a higher education institution, meaning that one might even have the technical skills and competences but without the higher education degree he cannot be considered an engineer.

The Portuguese Order of Engineers presents a scheme which depicts the evolution from the training stages of an engineer up to his/her advanced professional career, concerning the more focused skills on each stage:

Figure 2: Formal of concept structured by Portuguese Order of Engineers, 2010

It can easily be seen that the core engineering competencies are more present at the training stage and with the practice development the more interaction and organization skills start to gain relevance. Both practice and education are constantly evolving to adapt to the turmoil and fast paced changes of the modern 21st century world.

Figure 3: First-year students in the 1st Semesters in selected engineering subjects 1975-2000.
Ref. Statistisches Bundsamt, 2001. Quelle: Statistisches



The engineering profession and education have changed and will continue to change in the future in order to adjust to the fast paced evolution of the demands of society and the planet itself.

This evolution path followed by engineering profession and education (and its needed joint evolution) can be verified in the current situation in Germany. The activities of engineers have also changed, from developing new technical components, units, and equipment to advanced problem-solving requiring competence in project planning, implementation, and integration of complex systems of hardware and software. Engineering teams follow the so-called product lifecycle: ideation, product conception, product planning, product development and design, production planning, manufacturing, marketing and distribution, maintenance, repair, and overhaul to recycling and demolition. Consequently, engineers must complement their professional and technical expertise with non-technical competencies such as systematic problem solving, communications, management, and leadership skills. A typical profile of engineers expected by industry covers four main areas:

- Technical and methodical competence (technical knowledge and know-how in natural sciences, engineering sciences, engineering expertise, and the ability to apply modern information and communication technologies);
- Personal competence (flexibility, profound general education background, willingness to perform, willingness to engage in lifelong learning, mobility, credibility, and readiness to take responsibility);
- Management competence (managerial qualification, ability to assert oneself, decision-making ability, ability to analyse and to evaluate, strategic thinking, and negotiating skills); and
- Social competence (persistence, intuition, intercultural competence, ability to communicate, ability to negotiate compromises and trade-offs, and ability to work in teams).

Interestingly, engineering education typically has not focused on areas such as decision making, strategic thinking, negotiating skills, and readiness to take responsibility. This deficit has been recognized, how- ever, and steps are being taken to solve it.

Interdisciplinary study programs like industrial engineering and business management improve the skills of engineers in these areas by combining engineering and management education. Students can also gain practical experience, foreign language skill, and cross-cultural competence through compulsory internships as well as by studying abroad.

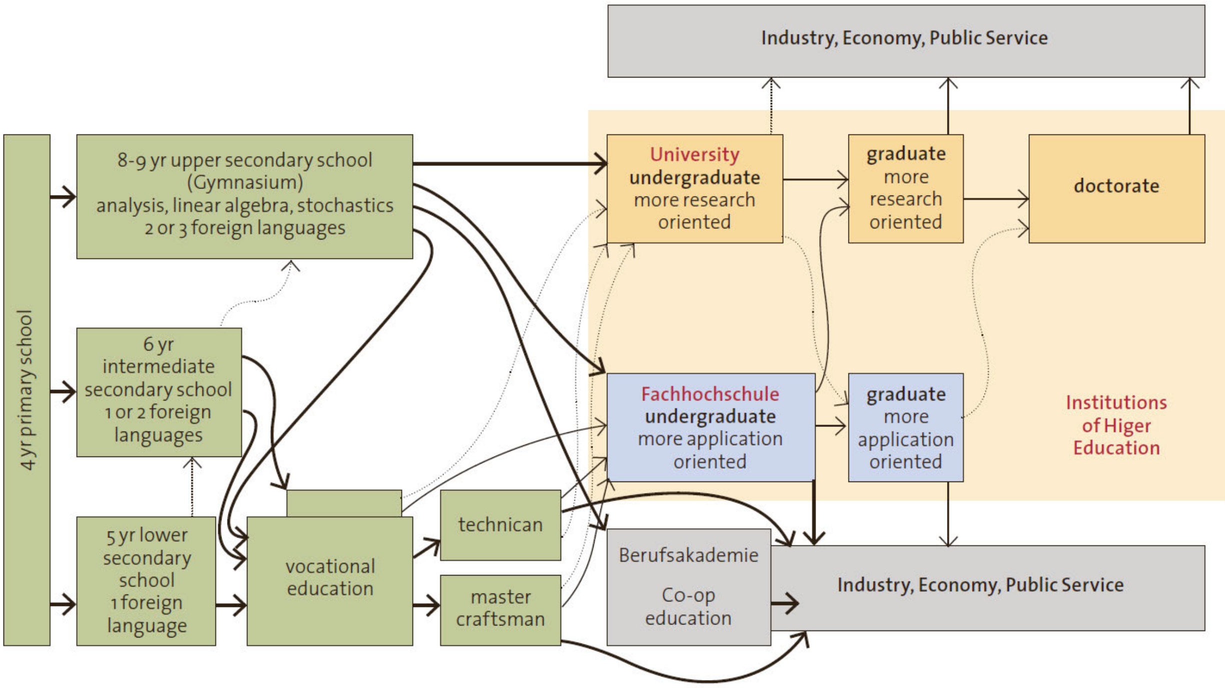
In 2005, roughly 19 percent of all engineering students enrolled in Germany spent at least one semester abroad at a foreign university or in foreign internships.

In Germany, women have always represented the minority among engineers. This graphic illustrates the development of the number of female first-year students in engineering in comparison to the total freshmen over a period from 1975 to 2000.

Figure 4: Proportion of female first-year students in engineering in comparison to the total freshmen over a period from 1995 to 200

	1995	1998	2001	2004	2007
University Engineers	12	21	21	26	24
Mechanical Engineer	8	11	12	24	18
Electrical Engineer	3	5	8	6	6
Civil Engineer	15	20	25	34	44
College Engineers	13	18	18	21	18
Mechanical Engineer	8	7	10	10	10
Electrical Engineer	3	3	5	3	9
Civil Engineer	20	27	28	34	35

Figure 5: CESAER-Declaration-Picture Unterschied zwischen universitärem und Hochschulstudium. Educational System for engineers in Germany (Hampe, presentation: EU-US Partnerships to Attract Young Talent – The TU Darmstadt – Virginia Tech Example [10].



A scientific study to cover the attractiveness and quality of engineers conducted in Germany by BMBF lists the development of female students in engineering studies in percentage of the last 25 years.

This table shows that research orientated universities attract female students more than universities of applied sciences.

Current data (from the end of September 2010) shows about 384.000 engineering students in Germany. Only 20 % of the students are females. The fact is that female engineering students are still underrepresented in Germany.

The engineer’s role has changed a lot in Sweden as the business has changed character. Today many engineers work in projects, often as managers or project managers. Other engineers are providers and specialists. For an engineer’s ability to work in teams together with others is necessary. It requires a good ability to communicate and collaborate. Also, an engineer needs to be independent. Engineers can work in a variety of areas. The possibility to choose orientation is large. Many doors opened with an engineer degree. Engineers are needed in all industries– not just traditional technology: environmental, health, design, energy, information, medicine, manufacturing and food are just some examples. You will find engineers virtually everywhere in the community both in private and public sectors both in large and small companies.

Common to all engineers is that their work is creative and that they are helping to build community. For the engineers you meet in the society is it’s about building environmentally friendly and healthy buildings, developing new medical equipment to save lives. An engineer may often see clear results of their work – a house, a drug, a new way to communicate. It is a key motivation for many engineers.

In the late 1990s collaboration between MIT in Cambridge USA and three Swedish technical universities started with the objective to reform the engineering education [9]. The global engineering companies were concerned about the engineering graduate’s professional knowledge and skills. The engineering education was too academic. The industry needs engineers who can engineer! The CDIO project started. CDIO stands for Conceive, Design, Implement and Operated. The life-cycle of engineering systems and products.

The CDIO community developed the CDIO syllabus which defines core knowledge, skills and attitudes that define an engineer.

In summary, there is no global or European formal definition of engineering or the engineering profession. Also the perceptions of engineers vary from country to country. One observation is that many countries have two types of engineering education. One that leads to engineers that have a more theoretical academic research based education on a master or PhD level and another that have a more practical focus and also end up with a bachelor degree.

Another observation is that global engineers need to have a broader set of skills, especially personal and inter- personal skills like oral and written communication, teamwork, ethics etcetera. These demands are now changing the perceptions on engineers and the engineering curricula.

The formal requirement or certificate to work as an engineer is different from country to country. For example, Portugal has a system where University degrees are combined with formal requirements from a professional association. In other countries, like Sweden, no formal requirement or certificate is needed to work as an engineer.

Common for all engineers in all countries are a deep knowledge of technology, mathematics and scientific competencies. Some countries, for example Sweden and Germany, point out academic and vocational type of engineers by different education system.

Engineering subject areas have developed over the years. From research specific areas like Civil, Electrical and Mechanical Engineering complemented with more interdisciplinary areas such as Industrial, Energy, Environmental, Media, Industrial Design and Medical Engineering.

Engineers must complement their engineering skills with non-technical competencies such as system problem solving, oral and written communications, teamwork, management, language and leadership skills.

[9] www.cdio.org

Perceptions on Engineering in Society

It has already been mentioned that engineers dwell deep into different realms of society, which may or may not provide a certain amount of social visibility. It is important to shed some light on the way engineers and engineering are looked upon by a variety of social factors and areas. This light comes not from a common source but from different studies and analysis done by WP5 partners. Being the ATTRACT Project a collaborative effort from multiple partners, and considering the lack of a global and unified view on the subject, it has been attempted a way to combine the work and information provided by each partner. This chapter provides a review of some of the most relevant results for the main goal of studying the attractiveness of engineering.

As would be engineering students, secondary school students are an important group to be dealt with, as measures taken to improve the recruitment of new students to engineering courses must contemplate this particular group. A study of Irish secondary school students published in 2004 assessed their attitudes towards engineering [10]. Overall, the students regarded engineering as a secure and well-paid profession, offering opportunities to travel and work abroad, deal with environmental issues, work in a creative environment, and obtain a job without too much difficulty. In order to gather more details about these perceptions. These students were also asked to identify both personal characteristics and skills they associate with engineers. We can say that a positive image surfaced, engineers were mostly considered to be creative, clever and knowledgeable. It is true that to a lesser extent, they were considered to be “anti-social/shy” and “geeky/ nerdy”. Still the main picture is quite positive. Concerning the skills, “Hard Working”, “organized” and “smart” are the ones that stand out the most. While some are more traits or behaviours (Hard working and smart) than skills, it is clearly an indicator of a very positive image about performing an engineering profession. Other mentioned skills include analytical, eager to learn and team player among others.

Other interesting aspects mentioned by the Irish secondary school students were the personal characteristics and skill associated with engineers. The majority considered engineers to be creative, clever, knowledgeable and doing something important for society. Overall we can say that a very positive image of engineers was present among these students.

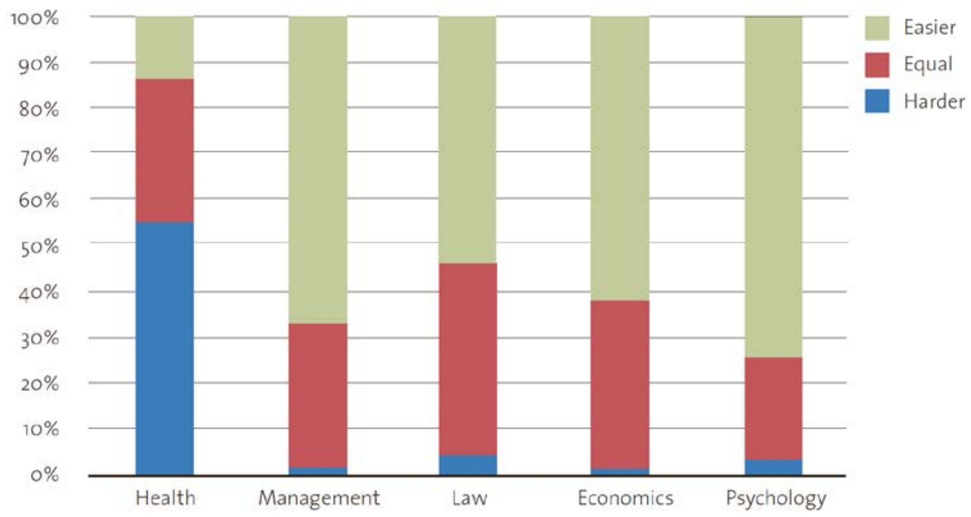
As for the possibility to enrol in an engineering course, the primary reasons these students gave, for accepting a place on an engineering course at third-level if offered, come under three main headings: interesting field of study, good career prospects and interest in math and problem-solving.

Reasons given for not choosing to study engineering were primarily students not knowing enough about it, or perceiving it as difficult. Although there are strong motivations for the students to enrol, the perception of the engineering courses as being difficult, place significant barrier for students. A study[11] assessing the future supply of engineers in Ireland found additional barriers in students’ perceptions of engineering. A perceived heavy and difficult workload and long contact hours were key factors that deterred students from choosing to study engineering. A further deterrent associated with these factors was that students would have little time remaining to take up part-time work, which is the norm among third-level students in other disciplines. Furthermore, the “considerable ignorance about what is involved in studying and practicing engineering, both among male and female students” was observed as a significant barrier.

[10] Drew, E. and Roughneen. C. (2004). Danger! Men at Work: A Study of the Under-Representation of Women in Third-Level Engineering. Dublin: Department of Education and Science.

[11] McIver Consulting (2003). The Demand and Supply of Engineers and Engineering Technicians. Dublin: Expert Group on Future Skills Needs

Figure 6: Engineering education difficulty issues compared to other subjects.
Ref. Engineering Perceptions Inquiry 2010, IST ; Websurvey: 233 Answers



Also on the subject of difficulty, the Engineering Perceptions Inquiry [12] made in Portugal, also addressed to the engineering education difficulty issues, by comparing it with other major areas.

One can notice, aside from Health, all other areas are considered to be easier than engineering. It converges with the Irish results from 6 years before concerning the difficulty of the engineering courses. We can see in different countries and in different time periods (2004 vs. 2010) that the study of engineering is perceived as something difficult.. Looking through the different areas in the chart, one can point out that all the ones mainly considered easier do not deal within a very advanced technological or exact sciences context. This is a factor to point out when dealing with the "how difficult it is" subject since the key competences required both in education and profession deal with those contexts. One action point concerning the attractiveness of engineering should focus on analyzing the technological, mathematical and scientific skills of the potential engineering students. Are the courses hard? Are the students not prepared to deal with the course contents? Is it a confidence issue? These are questions, among several others, that the stakeholders need to answer in order to improve the attractiveness of engineering.

Although important, the difficulty issue is not a monster and the fact is that engineering has a positive image and aspects that are identified by, not only secondary school students, but by a other different social groups. In Sweden, for instance, it was concluded that those who want to become engineers believe it is a dream job because it allows them to do so much with their lives[13].

They can both earn quite a good amount of financial income while improving society. There is a strong correlation between choosing the engineering profession as a dream job and to justify its opportunities for high pay:

- 40 % of those who dream of the engineering profession say that salary is one reason.
- 78 % says it is an exciting job with personal development.
- 43 % says that it provides high status and that there is a possibility to improve and transform society.

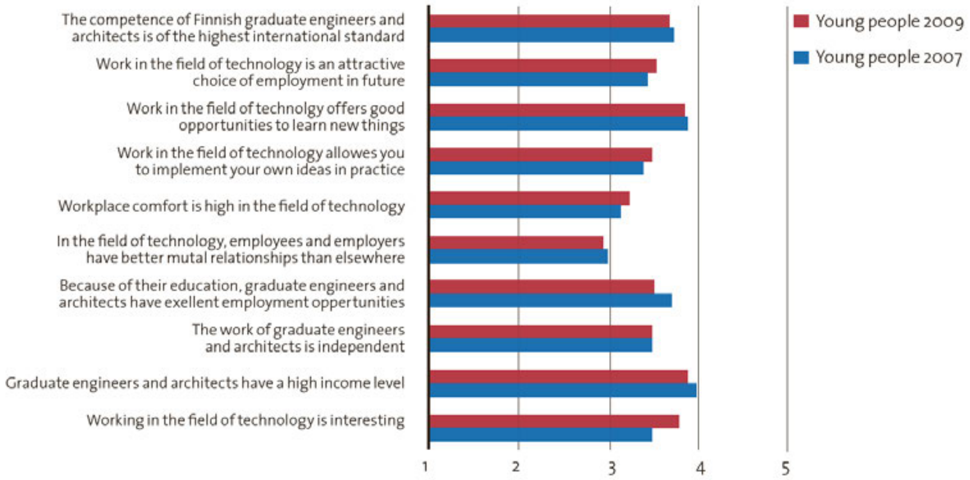
Throughout examples of positive views on engineering can be found. Turning over to Finland and on how engineering & technology are doing among the young Finnish people, the following table[14] shows the appreciation young people have on various professions.

[12] Engineering Perceptions Inquiry 2010, IST ; Websurvey: 233 Answers

[13] http://www.iva.se/mi

[14] Techbaro 2010

Figure 7: List of statements on working in the field of technology, plus typical features of engineering work 5 = Agree entirely, 4 = Agree by and large, 3 = Difficult to say, 2 = Disagree by and large, 1 = Disagree entirely).
Source: TECHBARO 2010



As for the reasons on why a particular profession was chosen as the most preferable and appreciable, salary, interesting and agreeable work were the main ones mentioned. The following chart provides the results concerning young People's views on the field of technology and engineering work[15]:

High income level is the main incentive among young people, followed closely by the opportunities of learning something new while performing their profession, by seeing technology as an interesting field of work and recognition of the competence of engineers and architects.

Another example of a positive view [16] on engineering comes from Portugal, where engineers are considered either important or very important (25, 3 % and 74, 2 % respectively). This view gathers not only secondary school students or young people, but also people from different backgrounds and professions; it is a mixed general view. Also some of the most common traits and characteristics associated with engineers generate a quite positive image of engineers. Engineers are seen as dynamic, creative, affirmative, active and entrepreneur.

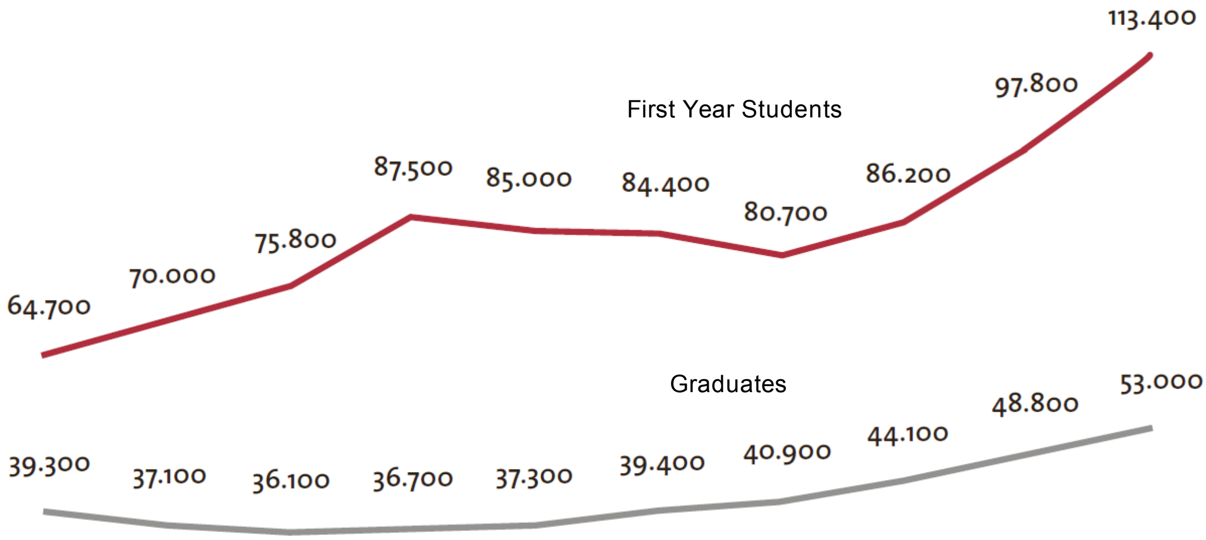
A different point of view comes from France where a study [17] was made in order to capture views of engineers on themselves and how they feel about their career. One of the most relevant subjects is to know where these engineers draw their satisfaction from, the table provides interesting results on this issue.

As it may be noticed there are huge differences between the perception by young students and the experience of young engineers, particularly related to expected responsibilities, careers opportunities, income, international opportunities and challenges. It is also interesting to notice that young students have a better perception of technical satisfaction they could expect from their early engineering career. These perceptions and views from engineers themselves is also an issue to point out in the sense that current engineers, both old and new, should have a key role in projecting a positive and attractive image of engineering to potential and current engineering students in order to minimize potential differences between reality and students perceptions and to ease the transition between school and the labour market, and also to capture the interest of younger people in engineering and technology.

The reputation of Finnish HEIs was studied in The HEI Reputation Survey 2009 conducted by T-Media together with the Finnish National Board of Education and Finnish upper secondary schools during 16.2.–15.3.2009. The survey was answered by 5 709 upper secondary school students (aged between 16 and 18) from all over Finland. The previous HEI Reputation Surveys were conducted in 2006 and 2008.

[15] Question presented: The following list sets out statements on working in the field of technology, plus typical features of engineering work. What is your opinion on each of the following statements? 5 = Agree entirely, 4 = Agree by and large, 3 = Difficult to say, 2 = Disagree by and large, 1 = Disagree entirely). Source: TECHBARO 2010
[16] Engineering Perceptions Inquiry 2010, IST ; Websurvey: 233 Answers
[17] CNISF, CEFI

Figure 8: Graduates and students in the 1st Semester in the Subject Group Engineering Germany Study or examination years 2000-2009



Main findings from the surveys

Women were not interested in studies in science and technology (engineering) either in polytechnic level or in university level. Similar results were also obtained in The HEIs' Image Survey 2007 conducted by Taloustutkimus Oy, a privately owned market research company in Finland. According to the survey the top 10 branches out of 8 polytechnic and 12 university branches among young (17–29 -year-old) women included:

1 Polytechnic: humanities/education (49 %)

2 University: humanities (44 %)

3 University: education (43 %)

4 Polytechnic: social and health care, sports (40%)

5 Polytechnic: culture (33 %)

6 University: arts (32 %)

7 Polytechnic: hotel, restaurant and tourism (31%)

8 University: medicine (30 %)

9 University: health sciences (30 %)

10 University: natural sciences (28 %)

The bottom 10 branches in turn were:

1 University: military science (77 %)

2 University: S&T, engineering (72 %)

3 Polytechnic: engineering (68 %)

4 University: agriculture and forestry (62 %)

5 Polytechnic: social science, business economics and management (52 %)

6 University: political and social science (51 %)

7 University: economics (50 %)

8 University: law (50 %)

9 Polytechnic: nature, natural resources and environment (49 %)

10 University: arts (46 %)

On university level, studies in psychology, humanities and education (psychology, humanities and natural sciences both in 2006 and in 2008) were the most interesting branches among all respondents; 20 % (also in 2008) of the respondents were either interested or very interested in studying science and technology (engineering); 66 % (65 % in 2008) of the respondents were not at all interested in engineering studies.

Interestingly, even though the field of natural sciences has been among the top3 most interesting branches among upper secondary school students in Finland both in 2006 and in 2008, the percentage of applicants who actually attend the entrance examinations (47 % in 2007) as well as the percentage of admitted students who enrol at the university (48 % in 2007) have been relatively low (source: Haapamäki et al. 2008).

Additionally, dropout rates – the ratio of dropouts[18] to all students – in the field of natural sciences has been among the highest (12,8 % of students in the field of natural sciences did not continue their studies in the field in academic year 2006/2007 against 7,4 % in total; and 8,0 % of students in the field of natural sciences did not continue university level studies at all in academic year 2006/2007 against 5,6 % in total) (source: Statistics Finland).

According to the 2008 survey, among those students who had in their own opinion done either well or really well in upper secondary school, 69 % of the respondents were not familiar with Helsinki University of Technology (TKK). In total, 13 % of the respondents were either interested or very interested in studying at TKK. There were differences between genders; female students were more interested in studies in e.g. medicine and dentistry, whereas male student were more interested in studies in science and technology, military science and natural sciences.

According to the 2008 survey, upper secondary school students who were interested in studies in science and technology (engineering) represented

- 20 % of all respondents, 36 % of male respondents, and 8 % of female respondents
- 47 % of those students who in their opinion had done either well or really well in upper secondary school, and 22 % of those students who in their opinion had done either bad or really bad in upper secondary school
- 23 % of those students who were going to apply to a university, and 17 % of those students who were going to apply to a polytechnic

According to the 2008 survey, upper secondary school students who were interested in studies in science and technology were more competitive, theoretical, inquisitive and ambitious, but less social and creative.

They were interested in working as experts (74 %) in the private sector; in big/medium size companies (84 %), and their favourite field of business was consultancy and engineering (54 %). 48 % of the respondents who were interested in studies in science and technology (engineering) were familiar with Helsinki University of Technology; 39 % of them were also interested in studying at the university. University of Helsinki and

Tampere University of Technology (both 31 %) were the second most popular universities among the respondents. Institute of Demoscopy annually ranks the prestige of professions in Germany. By a given choice of professions, the participants of the investigation were asked to rank the professions by their popularity. Engineering is one of the most popular professions in Germany. Engineers are highly respected people in Germany.

The rising popularity of engineers in German society affects the interest in technical study courses. This graphic illustrates the increase of freshmen and alumni in engineering sciences over the last years, see figure 6.

The perceptions on engineering in society are mostly positive with some different aspects from country to country. High income, exciting job, high status and highly respected are normally positive thoughts from what people think about engineers and engineering. Graduate engineers have a key role to show an attractive and realistic image of engineering profession for the younger generation. Reasons for not studying engineering and being an engineer are the picture of something difficult and heavy. This is also the case to attract women to study some engineering subject areas.

Other sources:
Finnish National Board of Education. The Curriculum [online] [retrieved 30.12.2010]. Available: http://www.oph.fi/english/education/general_upper_secondary_education/curriculum

Finnish National Board of Education (2003). National Core Curriculum for Upper Secondary Schools 2003. Regulation 33/011/2003 [online]. Available: http://www.oph.fi/download/47678_core_curricula_upper_secondary_education.pdf

Haapamäki, J. Mäkeläinen, U. & Piiroinen, K-M. (2008) Korkeakoulut 2007: vuosikertomus [online]. Opetusministeriön julkaisuja 2008:30. Available: http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2008/liitteet/opm30.pdf?lang=fi

Myllymäki, T. (2007) Korkeakoulujen Imago 2007. Taloustutkimus Oy.

Statistics Finland. Student attrition in certain fields of study in academic year 2006/2007 [online]. Available: http://www.tilastokeskus.fi/til/kkesk/2007/kkesk_2007_2009-03-11_tau_003.htm

[18] Students are followed for one year, from September of one year to September of the next year. A person is considered as a dropout, unless he/she has not continued his/her studies or graduated during that time (Statistics Finland).

Labour Market

Attractiveness is a concept that cannot be dissociated from a labour market analysis. The relation between both is as simple as one might guess: if a certain area of expertise really does not pay off in terms of getting a job, why should people spend time and effort in learning how to do it? Isn't that why the old ways of craftsmanship are fading and struggling to gather younger generations to carry on with the craft? It does not pay off.

One important action point in attracting students to the engineering areas is to show them that it does payoff to be an engineer. Not only in terms of economy capital but also when it comes to social or cultural capital. Considering the current global economy the labour market for engineers still looks good. The main purpose of this chapter is to confirm this statement and to seek means of capitalizing this advantage engineering has into an attractiveness enhancement tool. The premise behind the ATTRACT Project is that today– contrary to what people think– there is a shortage of engineers in several fields. Projections show that the need for engineers will grow strongly in coming years. But just as for other professions labour market for engineers can vary. Demand can go up and down. Eventually, the engineering profession is a safe choice.

Each country has own characteristics and particular social, economic and political contexts, and therefore has different focus when analysing the labour market. The statistics from respective country has therefor to be compared with a little care. Different definitions of unemployment and ways to gather statistics are for instance used. Considering this, what is presented in this chapter is an overview of the most relevant variables related to labour market by country. Altogether it any- how gives a good overall picture about the labour market for engineers in seven of the European countries.

Portugal

Engineering and related techniques present one the lowest unemployment rates (3,4%, being the total rate 4,1%). The debate whether 3,4% is a high or low rate isn't the main issue here, the focus is that considering the whole, we can say that engineering and related techniques has one of the lowest rates, making it safe to say that the working prospects for engineering are better than in the majority of areas[19]. Considering the increase in the percentage of engineering graduates and enrolled students[20] in the last years we can verify that this smaller unemployment rate echoes in the search for engineering courses. One action point concerning this matter will be to verify if this is intentional and if Portuguese engineering HEI are marketing the good job prospects in order to recruit students and, if so, to identify what good practices are at use.

From an employer perspective and demands, an analysis of job offers was made[21]. The results are provided bellow:

Type of offer	%
Only for Engineers	20
General request	51
Not for Engineers	29

Table 1: Job Offers poster between the 7th and 14th of September 2010 at a Portuguese journal

About 20 % of the job offers asked specifically for an engineer. The general request job offers did not specify any sort of education area but an engineer could apply for it if needed. The rest of the offers, request specific education areas like for instance health, business or management.

In 66 % of the engineering offers employers required the engineers to have some sort of professional experience and also core engineering skills. Aside from the engineering skills, some of the most mentioned were: planning and organization, leadership, good command of the English language and goal orientation.

As for the main activity areas where engineers perform their skills and expertise, we can turn over to the IST students[22], who were inquired about their employment conditions in 2009. The main areas where these students are employed are the following:

- Consulting, Scientific & Technical activities (35 %)
- Information & Communication (15 %)
- Construction (11 %)
- Education (11 %)

[19] GPEARI/MCTES 2009
[20] Reference to statistics chapter, where the enrolled and graduate students in PT will be
[21] Job Offers poster between the 7th and 14th of September 2010 at a Portuguese journal www.expressoemprego.pt
[22] IST Graduates Survey 2009

France

Figures for 2007 and 2008 are positive. The number of recruited engineers was 62 800 in 2007 and 71 700 in 2008. Obviously, young engineers (less than 30) accounts for more than a half of these recruitments. However the unemployment rate among these young engineers is greater than among older ones as it can be seen from figure 9 below. It should be stressed that the legal minimum age for retirement was 60 in France in 2008. Many of older engineers retired then before 65 (the upper age limit for retirement). However the unemployment rate among 60/64 years old engineers remains very high, see figure 10. It should also be mentioned that preliminary results for the year 2009 are worse, especially for young engineers graduated in 2008. The most recent inquiry about this was conducted by the National Agency for Executives Employment (APEC) and states a 16 % increase of the unemployment rate among these new engineers (graduated in 2008). The employment rate for these young engineers is 72 %, compared with 73 % in Business Schools and 61 % in Universities. The

2009 recruitments distribution in the different fields of activities for engineers are represented on figure 10. The three main domains for recruitments of engineers were SSII (computer engineering companies), engineering consulting firms ("Ingénierie") and the industries related to energy production and transportation. They account for about 40 % of the total recruitments of young engineers (less than 30).

Figure 9: Breakdown of unemployment rates among engineers (source: CNISF)

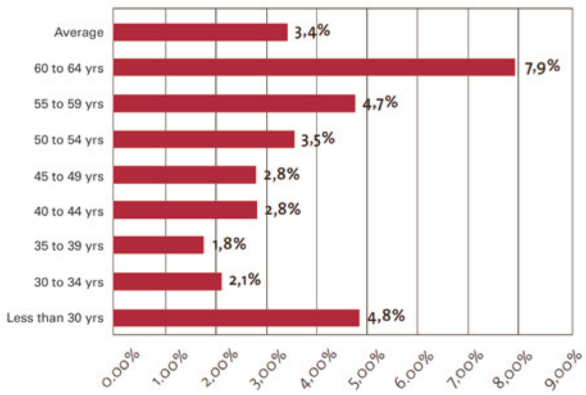


Figure 10: Main fields of recruitments for young engineers (less than 30) for 2009 (source: CNISF)

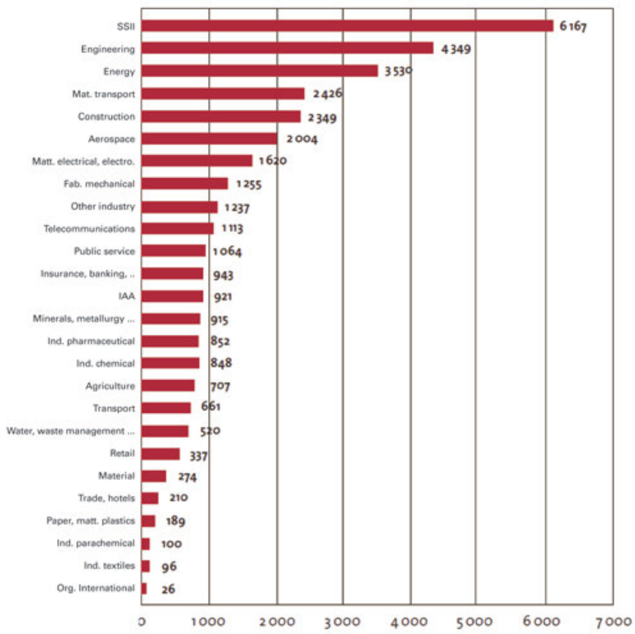
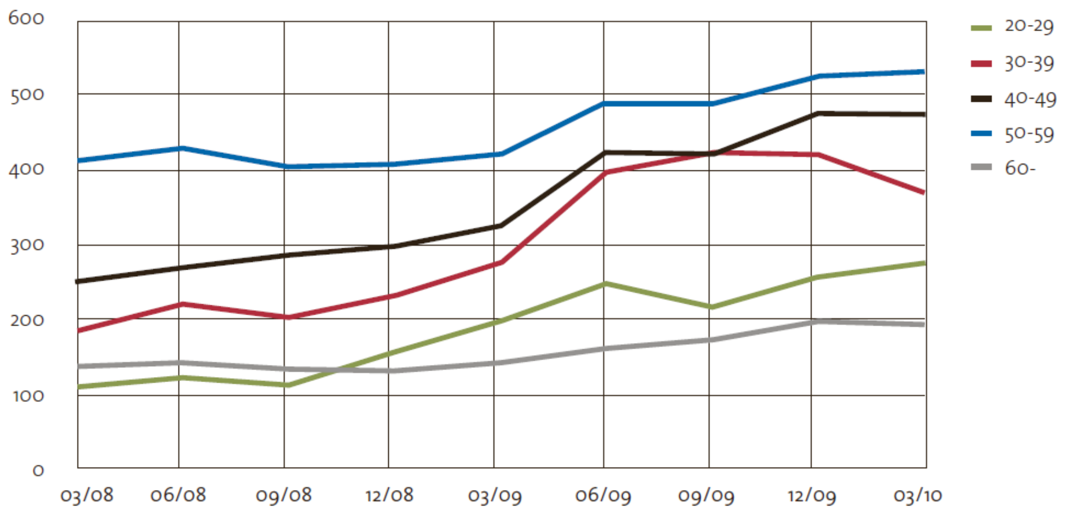


Figure 11: The number of unemployed university graduate engineers and architects by age group between March 2008 and March 2010. Source: Employment Report I/2010.



Finland

Most university graduate engineers work either as specialists or in the middle/top management. According to the Labour Market Survey 2009 of the Finnish Association of Graduate Engineers TEK, the employment sectors of polytechnic graduate engineers are distributed as follows:

- Manufacturing (52 %)
- Services (27 %)
- State (15 %)
- Municipalities (6 %)

Main fields of responsibilities among the members of TEK include research and development, and planning and expertise. One third of the members have also worked abroad at some point. The five biggest employers among the members of TEK (2008) include Nokia, Nokia Siemens Networks, Metso, Aalto University School of Science and Technology (former Helsinki University of Technology), and Technical Research Centre of Finland. Also the polytechnic graduate engineers mostly work as specialists or in the middle management either in the private (87 %) or in the public (13 %) sec- tor. According to the Labour Market Survey 2009 of the Union of Professional Engineers in Finland [23], the responsibilities of most polytechnic graduate engineers include planning (24 %), other engineering tasks (22 %), IT tasks (13 %), and commercial tasks/ services (12 %).

According to the Employment Report I/2010 of the Finnish Association of Graduate Engineers TEK, the number of unemployed university graduate engineers and architects was 1850 in March 2010, which equals to an unemployment rate of 3,5 %. Between March 2009 and March 2010, the number of unemployed university graduate engineers and architects increased by 483 (0, 8 percentage points).

Figure 12 represents the number of unemployed university graduate engineers and architects by different age groups, and figure 2 the number of unemployed university graduate engineers by field of study. Among the polytechnic graduate engineers, unemployment is the biggest problem among newly graduated students (over 25 %) and engineers of over 30 years (over 10 %). According to the Labour Market Survey 2009 of the Union of Professional Engineers in Finland, however, most polytechnic graduate engineers have a steady job (85 %) and work fulltime (89 %). Most polytechnic graduate engineers also find that their work corresponds really well to their education.

[23] The Union of Professional Engineers in Finland UIL promotes the interests of engineers, engineering students and other experts in the technical field. Through its member organisations, UIL's total membership is approximately 62,000. UIL comprises thirty regional branches and five national branches through which engineers and other experts in the technical field belong to the union.

Germany

Engineers enjoy considerable social standing in German society, respected for their creativity, innovation, and high degree of responsibility. A 2005 study by the Allensbach Institute ranked engineers eighth among professions in terms of respect and social prestige. Annual salaries for engineers are conspicuously higher than average compared with other professions that require a university degree, depending on the industry, position, type of degree, etc. Salaries have recently begun to rise slightly for practicing engineers as well as for new engineering graduates.

Germany is a leading global competitor in scientific research and in the production of innovative techno- logical products. Engineers work in virtually every branch of German industry and services, pioneering developments in nearly all facets of electronic and information technology, energy technology, microelectronics, micro- and nanotechnology, and in interdisciplinary fields such as automation and medical technology.

The latest engineering study by the Association for Electrical, Electronic, and Information Technologies (VDE) shows that German businesses could fill only 80 percent of their job offers for engineers. As of 2004, Germany's workforce included about 1 million engineers, 360,000 of whom were self-employed or working as civil servants and 640,000 who were employed by companies. The number of engineers working in public and private enterprises has decreased by about 20,000 since 2001. This is partly due to global competition and partly the result of the declining number of engineering graduates over the last decade. The cohort of 37,000 engineering graduates of 2004 is 25 percent less than the cohort in 1996. This trend is expected to reverse, however, as a result of the increased engineering enrolments during the past five years. In fact, a recent study by the German Kultusminister- konferenz forecasts rapid growth in engineering graduates through 2015, reaching 49,000 per year. At this level, engineering students would represent 18.6 percent of total graduates from all disciplines, up from 17.8 percent in 2004.

Table 2: The average (starting) salaries of engineers in different fields in 2010 [1].

Industry	Average salary (€)	Starting salary (€)
Machinery and plant construction	56,066	41,600
Vehicle	59,150	43,025
Electronics & Electrical	58,237	42,000
Energy	55,511	42,075
Chemical & Pharmaceutical Industry	66,652	44,920
Construction	47,275	36,025
Engineering and planning offices	44,312	38,115
Information Technology	51,010	39,996
Industry average	54,900	41,235

Table 3: The average (starting) salaries of engineers in different fields in 2010 [1].

Position	upper quartile	mean	lower quartile
E-technology engineers	54,865	47,830	42,274
Engineers in construction	54,105	45,329	39,245
Engineers in project execution	55,801	48,092	40,880
Engineers in production	60,610	53,962	45,340
Engineers in maintenance	60,113	51,861	42,137
Sales engineers	63.288	53,128	45,802

In response to the increasingly global characteristics of the marketplace, German engineers are expected to be more mobile and flexible, to move to different work sites both nationally and abroad, and to change job responsibilities as new needs arise. In the past, engineers may have worked within one company and perhaps even in one department for decades. Today's engineers may change companies two or three time during their careers – and specific positions even more frequently. In Germany, 15,000 engineering jobs go unfilled each year although 65,000 German engineers are unemployed. This gap is due in part to the lack of mobility and flexibility by German engineers to adjust to changing work environments or expectations. Thus, Germany must fill the gap with engineers from foreign countries.

In comparison to other branches, the starting salary of engineers is relatively high (November 2010).The starting salary of mechanical and electrical engineers highly depends on their field of work. In this table the salaries are listed differentiated by for example sales department, product development and project management. Furthermore salaries in engineering are influenced by the enterprise size. In small enterprises (up to50employee) assistant engineers earn about 38.400 Euro per year, whereas an engineer within the same position in a large enterprise (more than 5000 employees) has 7 000 Euro more per year.

In comparison to the total unemployment rate in Germany the unemployment rate for engineers is relatively low, in 2009. In Germany the majority of engineers are working in the industrial sector. However, the service sector should not be underestimated as a further working area for engineers.

Table 4: Basic data about the working situation of engineers in 2009 [1].

	Social insurance employee	change to In%	Additions 2009 (Annual total)	change to In %	Unemployed persons 2009 (Annual average)	change to In %
Agriculture, horticulture, and forestry engineers	11.700	+2,6	1.000	+34	2000	-12
Engineering and automotive engineers	153.000	+1,1	9.500	-35	5.400	+31
Electrical Engineers	156.100	-2,6	5.900	-22	3.800	+19
Architects, engineers	122.900	+1,3	8.100	+3	8.100	-2
Surveyors	9.200	-0,5	300	-18	400	-9
Mining, metallurgical and foundry engineers	5.600	-2,0	300	-39	500	+3
Other manufacturing engineers	26.000	-2,8	600	-47	1.200	+10
Marine engineers, flight engineers	5.800	-2,6	100	-58	100	+32
Other engineers	217.500	+5,2	4.900	-32	6.600	+56
including industrial engineers	-	-	1.800	-35	2.600	+44
Chemists, chemical engineers	41.200	+0,5	1.100	-22	2.500	+7
Physicists, physical engineers, mathematicians	23.900	+1,0	900	-19	1.500	+5
Engineers total	**774.900**	**+1,2**	**32.600**	**-23**	**32.100**	**+15**
Academic labor markets	**2.858.800**	**+3,5**	**114.500**	**-7**	**161.200**	**x**
Overall, the labor market for	**27.380.100**	**-0,3**	**1.618.300**	**-17**	**3.139.800**	**+6**

Figure 12: In comparison to the total employment rate in Germany the unemployment rate is relatively low (2009).

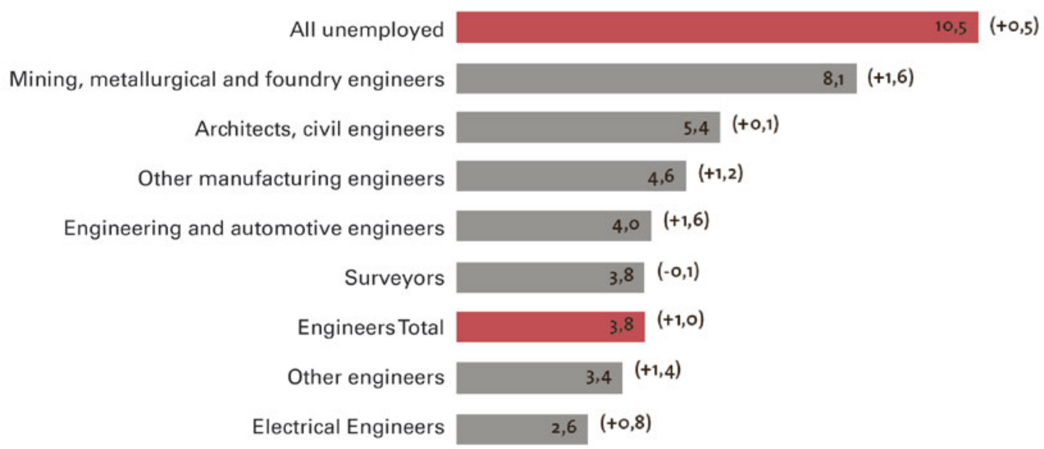
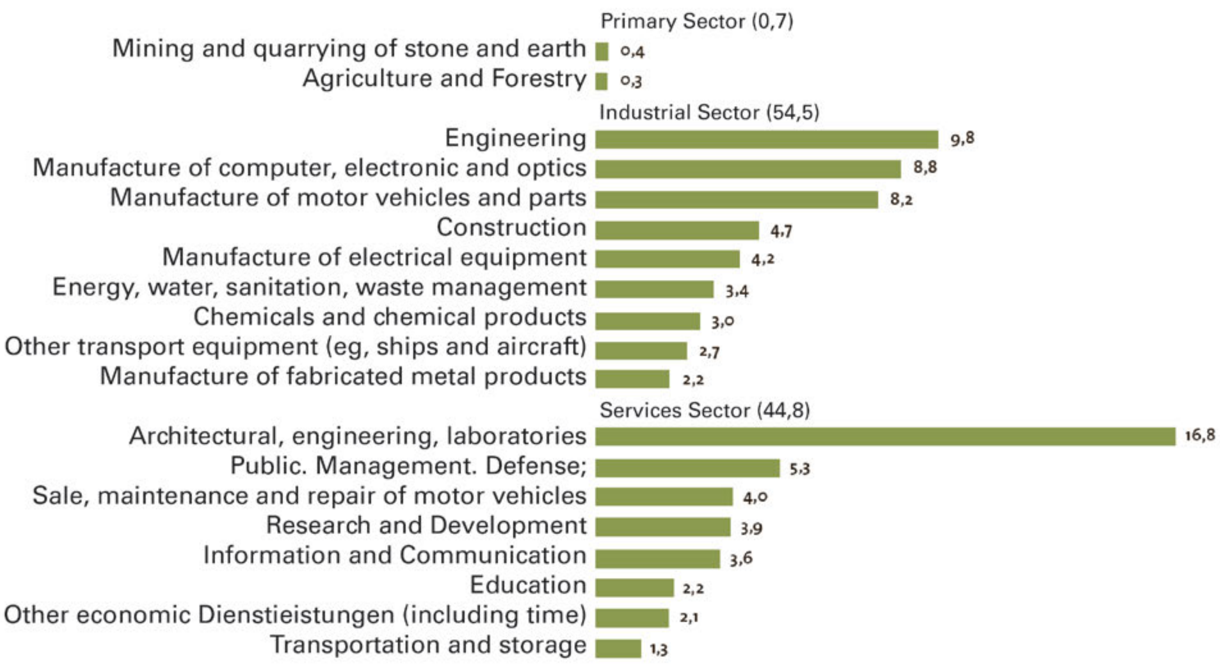


Figure 13: Social insurance contributions for Industries, percentages, June 2009



Sweden

In the Swedish industry, the availability of skilled employees is crucial to competitiveness. Today the industry is working on a global highly competitive market that requires access to staff with qualified skills. It is the advanced technology, the new unique solutions and the high quality which is the main competitive advantage for the Swedish industry. According to statistics from the Swedish Engineering Union the unemployment (members that obtains financial support by the union because of unemployment) among their members over the last 10 year period has varied between 0,6 % (2008) and 3,4 % (2004). In general the unemployment for engineers has been significantly lower than the average in Sweden.

According to the latest figures from 2010 the unemployment rate is currently 1,2 % for engineers. The unemployment rate differs between different engineering areas. The lowest rate (0,6 %) can be found for Civil Engineers. The highest (1,5 %) unemployment is within Chemical Engineering but 1,5 % is still a very low unemployment rate.

The unemployment decreases for all ages but is lowest (0,8 %) for the 35-39 years old engineers. The highest unemployment (1,6 %) can be found among the 60-65 years old. So in general, unemployment among Swedish Engineers is very low in all engineering fields with relatively small differences between different age groups.

According to the latest forecast by Statistics Sweden there will also be a lack of engineers on the labour market in the future. This is due to a combination of demographics and the estimated number of examined engineers in the future. In other words, the Swedish labour market needs more examined engineers in the future than currently. Looking at different sectors in a short term (2011) the greatest demand with a lack of engineers will be within the construction, civil engineering and electrical engineering area according to the Swedish Public Employment Service (Arbets- förmedlingen). The lowest demand with no lack of engineers is within chemical engineering.

Reference 1: Sveriges Ingenjörers arbetsmarknadsrapport 2010, http://www.sverigesingenjorer.se

Referens 2: http://www.scb.se/statistik/_publikationer/UF0515_2006I30_BR_01_AM85BR0901.pdf

Referens 3: http://www.arbetsformedlingen.se/download/18.2ebc5f7e12dc1feecae8000224/varfinnsjobben2011.pdf

Italy

A relevant fact that may help to explain the anomalous trend of Politecnico di Torino with regard to the national situation is connected to job and salary prospects. As the data below shows both for graduates in general and for graduates in engineering, Politecnico graduates reach higher employment figures and higher salaries.

Depending on latest survey data in 2009 the population holding an academic degree in Engineering reached the number of 547.000, of which 417.000 employed. In the 73% of cases these workers are employee, while the sector which absorbs the greater number of graduates in Engineering is still that of services (about 64%). Compared with 2008, the unemployment rate increases significantly, shifting from 3,1 to 4%, as a consequence of the crash of hirings in private enterprises, which were

16.210 in 2009. However, in 2010 already, graduates in Engineering got back to a substantial "full employment" condition. The Unioncamere-Ministry of Work Excelsior Information System noticed a significant increase in the hirings of graduates in Engineering, who were over 20.000 units, in such year with a consequent saturation of the output of the faculties of Engineering.

As far as the salary aspect is concerned, five-year graduates in Engineering keep on getting higher salaries compared with other graduates: in fact, after one year from the graduation, they get on average about net 1.300

Euros per month, whereas the average of all graduates is little over 1.100 Euros. However, such salaries are still significantly lower than foreign Countries, where they exceed, for graduates after one year from the graduation, net 1.800 Euros per month. After five years from the graduation the gap with foreign Countries widens further: for the graduates in Engineering employed in our Country the monthly net salary is on average about 1.650 Euros, for those employed abroad it comes close to 2.500 Euros.

In 2009 13.497 graduates overall obtained the professional qualification, 3,3% more than what registered in 2008 (13.067 qualified). It is an increase completely due to the qualified of A section of the register (engineers), shifted from 11.508 in 2008 to 11.906 in 2009, while the qualified for the profession of junior engineer record a further slight drop (1.551 qualified compared with 1.668 in 2008).

Figure 14: Job prospects of graduates one year after graduation.

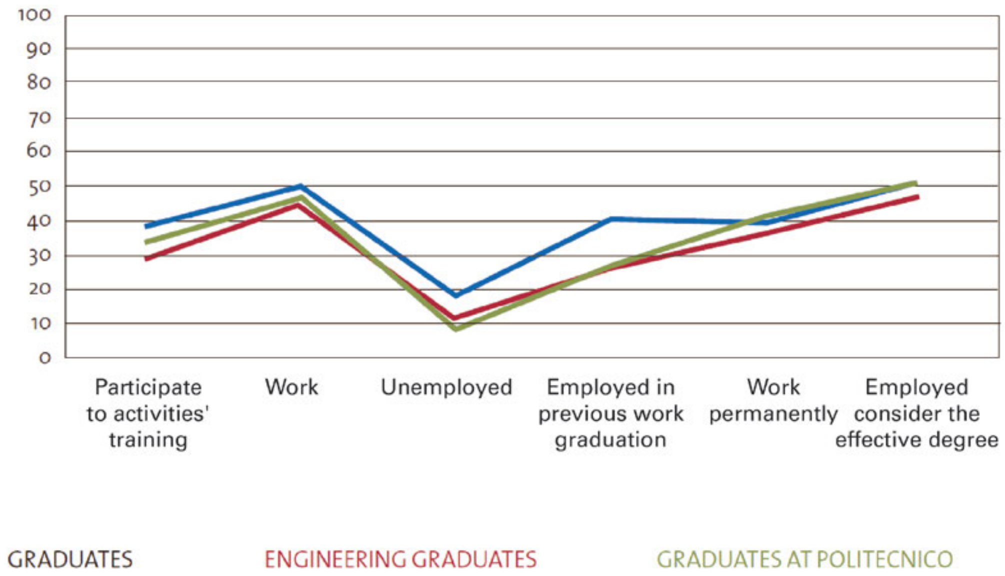
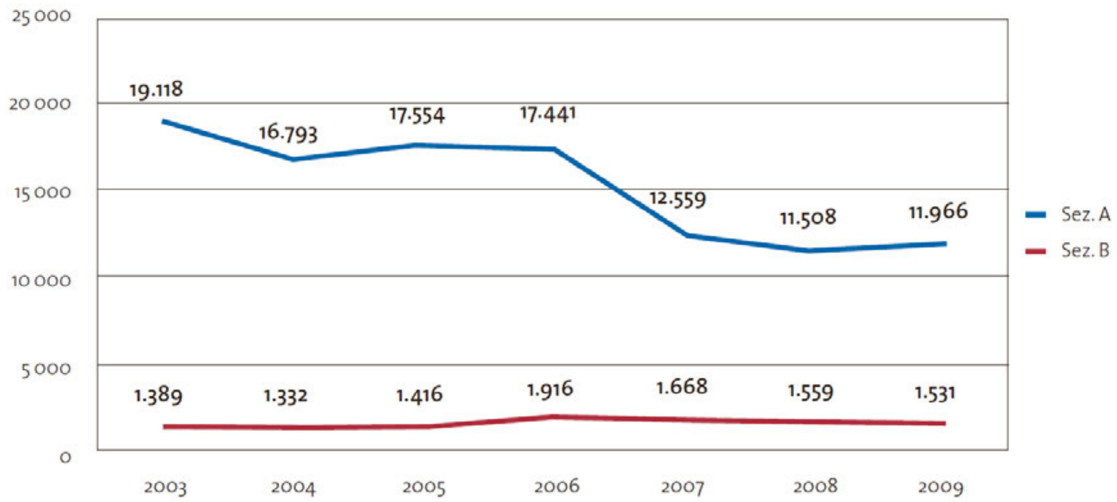


Figure 15: Professional qualification: qualified for the profession of engineer and junior engineer. Years 2003-2009. Source: processing of Centro studi del Consiglio nazionale degli ingegneri, 2010



The number of applicants who pass successfully the professional qualification is always very high: 89% for the A section (five-year graduates) and 80,3% for the B one (three-year graduates), in confirmation of the absence of entry “barriers” for the access to the profession of engineer. In consequence, engineer free-lances keep on increasing: in 2010 they are 70.200, 21% more than what registered in 2006. We have to add to this number over 24.000 engineers, who exercise a professional activity and have a salaried job. A third of five-year graduates is not interested in obtaining a professional qualification. Until 2006 this number oscillates between 10 and 11%, while now it is about 32-34%.

This drop in interest must be linked to the higher number, among the applicants, of the graduates belonging to the New University Order (the so-called “3+2” years) who must opt for the qualification for only one sector of the register and cannot benefit from the all- comprehensive qualification, for all the three sectors of the register, which is still possible for Old University Order graduates (pre Bologna process). In fact, the qualification for the profession of industrial engineer and information engineer does not guarantee the acquisition of competencies stated by law, which are essentially typical of civil and environmental engineers only. This determines the lower motivation of graduates coming from Information Engineer for the obtainment of professional qualification. Three-year graduates’ situation is very different: only 8,4% obtained the professional qualification. It is a little increase, compared with 7,7% in 2008, in a context where the first level degree is considered insufficient to support the start-up of a professional activity in the field of Engineering.

The engineering education is not confined only to the Faculties of Engineering: in fact, there are 87 first-level courses and 86 second-level courses allowing access to the Engineers Register, even being activated by other non-Engineering faculties (for example Architecture, Mathematical, Physical and Natural Sciences). Further- more, there are 8 first- and 10 second-level courses that have been activated by the Faculty of Engineering in collaboration with other schools (the so-called “cross- faculty” courses): only half of those provide access to the Register (2 top-level, 7 second-level). At the current state of affairs, a graduate of the Faculty of Architecture or of Mathematical, Physical and Natural Sciences (only for certain courses) can take the national state examination for a license to practice as an Engineer. This is because the requirements for the access to the state examination are still those defined by legislation in 2001, which identified the degrees for access to the professions without linking them to a specific faculty.

Figure 16: Qualified for the profession of engineer and junior engineer every 100 graduates – Years 2002-2009 Source: processing of Centro studi del Consiglio nazionale degli ingegneri, 2010

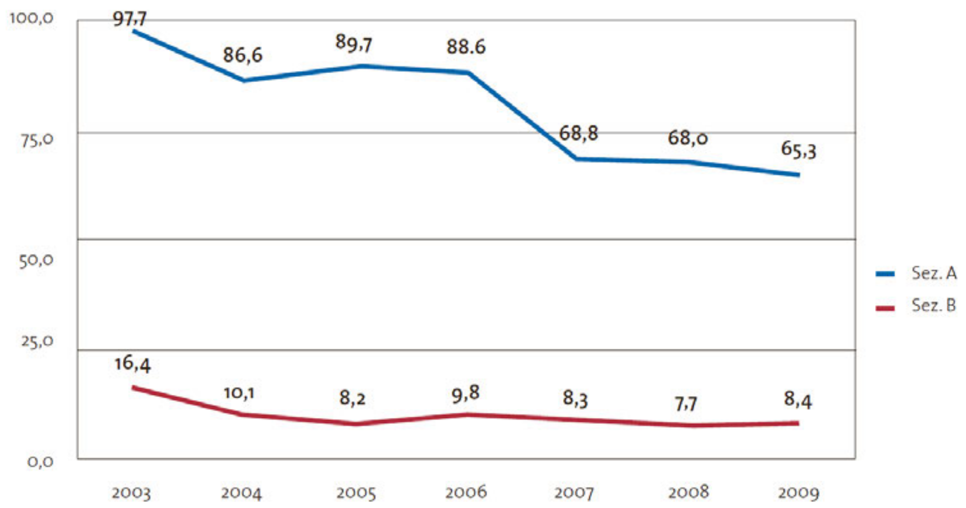


Table 5: Level 8 Honours Bachelor Degree 2008 Irish Graduate Salaries by Faculty. Source: HEA, 2010

Salary Bands	Arts, Humanities& Social Sciences %	Science %	Commerce& Business Studies %	Medicine, Dentistry &Paramedical Studies %	Engineering %	Law %	Agriculture %	Veterinary %	Architecture %	Food&Science Technology %
< €12,999	16.3	8.7	4.2	1.4	2.4	0.0	7.1	0.0	0.0	***22.2***
€13,000 - €16,999	11.0	5.4	6.3	0.6	1.5	5.6	0.0	0.0	7.7	5.6
€17,000 - €20,999	18.3	7.5	13.1	2.5	6.3	16.7	7.1	6.7	23.1	16.7
€21,000 - €24,999	***22.1***	12.4	***43.1***	14.1	10.2	***27.8***	***28.6***	0.0	7.7	16.7
€25,000 - €28,999	12.5	19.0	19.4	5.9	19.5	16.7	***28.6***	0.0	15.4	16.7
€29,000 - €32,999	8.7	***21.3***	8.8	25.1	***33.7***	11.1	21.4	13.3	***30.8***	16.7
€32,000 - €36,999	4.5	18.7	2.6	***34.4***	16.6	11.1	7.1	***26.7***	7.7	5.6
€37,000 - €40,999	3.1	4.7	0.8	10.2	5.4	5.6	0.0	20.0	7.7	0.0
€41,000 - €44,999	0.8	0.9	0.5	1.0	2.0	0.0	0.0	6.7	0.0	0.0
€45,000 +	2.8	1.4	1.2	4.8	2.4	5.6	0.0	26.7	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100
Total Respondents (excl. uknown)	738	427	648	786	205	18	14	15	13	18

Ireland

Globally, the impact of engineers on the labour market extends far beyond traditional roles. An analysis of CEOs of S&P 500 companies reveals that 20% are engineering graduates, making engineering the most common course of study among this group.[24]

In Ireland, engineers have become an increasingly significant cohort within the labour force. Between 1991 and 2002, the number of people working as engineers grew by over 7 per cent per year.[25] While unemployment levels have increased dramatically in Ireland in recent years, the rate for engineers has remained considerably lower than the overall unemployment rate. Engineers Ireland, the professional body for engineers, reports an unemployment rate of 6% for its members in April 2009, when the national unemployment rate was 10.4%. Of the engineering jobs that had been lost, 46% were in the civil/structural sector.[26]

This reflects the downturn in the construction industry. An examination of employment rates among new university graduates shows that engineering is well placed relative to other disciplines. Engineering graduates demonstrate the third highest rate of graduate employment (behind medical and related professions, and veterinary medicine).[27]

Research into attitudes among secondary school students tells us that there is a general perception among this group of engineering as a well-paid profession. 95% of students surveyed believed that engineers are well paid.[28]

In reality, engineering compares very well to other sectors, particularly at the level of graduate starting salaries. Engineering graduates are the third highest paid graduates, behind medicine and other healthcare disciplines. Within engineering disciplines chemical and processing engineers are the highest paid in their first year of work, with 23% earning in excess of €33,000.[29] Salary progression is also good.

The average salary for a Chartered Engineer with 16-20 years of experience is €86,627. As well as enjoying comparatively high salary prospects and employment rates, engineers demonstrate strong levels of job satisfaction. A survey of members of Engineers Ireland showed that 94% are happy with their choice of career.[30]

[24] SpencerStuart, 2006
[25] Irish Academy of Engineering and Engineers Ireland, 2005
[26] Engineers Journal, 2009
[27] HEA, 2010
[28] Drew, 2004
[29] Forfas, 2006
[30] Byrne, 2009

Market Conclusions

Globally, the impact of engineers on the labour market extends far beyond traditional roles. Each country has own characteristics and particular social, economic and political contexts, and therefore has different focus when analysing the labour market. The statistics from respective country has therefore to be compared with a little care.

It seems to be a shortage of engineers in several fields so the labour market looks good for most countries. Figures also show low unemployment rates.

One important action point in attracting students to the engineering areas is to show them that it does payoff to be an engineer. Not only in terms of economy capital but also when it comes to social or cultural capital.

The Bologna process points out the mobility and employability as important factors in higher education. Most universities are in the process to change the curricula to fulfil the objectives in the higher education area. This should increase the possibility to get a job on a global labour market.

Others sources:
Byrne, G. (2009). Engineering Your Career. Dublin: Engineers Ireland and Discover Science and Engineering.

Drew, E. and Roughneen. C. (2004). Danger! Men at Work: A Study of the Under-Representation of Women in Third-Level Engineering. Dublin: Department of Education and Science.

Engineers Journal (2009). Volume 63: Issue 3, April 2009. Irish Academy of Engineering and Engineers Ireland (2005). Engineering & Knowledge Island 2020.

Forfas (2006). Comparative Starting Salaries and Career Progression of Graduates in Science, Engineering and Technology.

HEA (2010). What do Graduates Do? The Class of 2008. Dublin: Higher Education Authority.

SpencerStuart (2006). Leading CEOs: A Statistical Snapshot of S&P 500 Leaders.

Media Coverage

Besides spurring efforts to define and identify the professional, social and cultural characteristics of an engineer, and assess the degree of attraction of his/her social role, an additional goal has been set: to determine the degree of visibility of engineers in the media, and the media's perception of them. This section is therefore an attempt to assess the image of an engineer and engineering, conveyed by the media in a given period from each different partner. In other words what we want to know is: "What is the image of an engineer in the media?"

Starting with the basics, a Google search is an obvious choice for a starter. A Google search demonstrates that most engineer-related stories cover the following topics:

- Engineer employment and salary
- Female engineers; women who have chosen a career in the field of technology and engineering
- Engineering students and engineering student culture
- Student recruitment
- Engineer jokes
- More features on technology than on engineers

Moving away from the starter, a more in-depth analysis of media was made by some of the partners involved in the project which are enough to show a reliable image of engineering in media throughout Europe. In the context of the ATTRACT Project, an analysis of media content was made in Portugal[31]. A first approach were taking by focusing on the observations of engineers and engineering in the media discourse, both professionally and in terms of their collective, social, cultural, institutional, political and symbolic action, by recording the references made in the chosen media to engineering and engineers, considering the circumstances under which those references occur, in order to find out the way those images are ranked and the type of existing major associations.

Such task was achieved by a collection and indexation of news items with references to engineering that was made from the common search engine to 3 of the top news agents in Portugal[32]. 92 pieces of news were validated, which were produced between 1 and 30 November 2010 and despite the fact that the data only covered one month, it shows that engineers and engineering are positively involved in 47.8% of the news items. Negative references do not account for more than 14.1%.

During the period analysed, the most mentioned news theme including engineering were in the field of social and political action representing 33,7% of the news as show in table 6 below.

Table 6: The most mentioned news themes covered during the analysed period.

Theme	%
Social and Political Action	33,7
Manufacturing/Industry/Trade/Distribution	18,5
S & IT + Engineering and expert areas	15,2
Safety	9,8
Culture, Arts, Sports and Shows	8,7
Biography	6,5
Renewable Energies & Environment	5,4
International	2,2

Considering the breakdown of positive references to engineers and engineering by the news coverage, according to the these news themes it is worthwhile mentioning that the subject area associated with "S&TI and Expert Engineering Areas" ranks first, with 13% of all references A summary of this breakdown can be seen in table 6 below.

Table 7: Breakdown of positive, neutral and negative references.

	% of total		
Theme	Positive	Neutral	Negative
Biography	3,3	3,3	0
Social and Political action	9,8	16,3	7,6
Manufacturing/Industries; Trade/Distribution	8,7	5,4	4,3
S&IT + Expert Engineering Areas	13	2,2	0
Culture, Arts, and Shows	4,3	3,3	1,1
Safety	2,2	6,5	1,1
International	2,2	0	0
Renewable Energies & Environment	4,3	1,1	0

Secondly, most of the positive references belong to themes associated with manufacturing, industry, trade and distribution, representing 8.7% of the total.

[31] PressCoverageAnalysis2010_IST
[32] Diário de Notícias (www.dn.pt)
Jornal de Notícias (www.jn.pt)
TSF (www.tsf.pt)

Thirdly, positive references are made to subjects within “Social and Political Action”, with a total of 9.8% It should however be pointed out that it is within this category that almost half of the references considered as “neutral” were made, which were mostly com- posed of news associated with the way Courts and Justice operate.

The positive image of engineers and engineering in media stands out for the period analysed. In fact, it is mainly polarized around subject areas associated with, on one hand, expert engineering areas, scientific research and the development of cutting-edge technologies, and, on the other hand, with the productive areas of society, industry and services.

In Sweden, a survey on how engineers are portrayed in Swedish newspaper was made in the project “Tomorrow´s engineer from year 2003. Out of 555 articles only 122 (20%) had a positive image of an engineer.

Engineers are often considered, by non-engineers, as cold, insensitive technocrats and deep specialized and perform highly repetitive work with little or no social contact. The engineers themselves emphasize however creativity, problem-solving skills and responsible freedom as typical feature of the professional role. (http:// www.iva.se/mi)

A media analysis in Germany shows that engineers enjoy a high esteem followed by generally positive representation in media. Engineers are described as highly qualified experts and their inventions are seen as the moving power for Germany`s economic wealth. Thus media convey that engineers in Germany are co-responsible for and actively involved in bringing forward the economy in Germany.

By collecting articles it was high-lighted that especially the outstanding job offers in the labour market and the superior wages are consistently part of coverage.

Despite economic crisis in 2008/2009 good employment outlook for engineers was predicted. In addition, media permanently cover a shortage of skilled engineers in labour market. In a content analysis was carried out to cover, how news communicate engineers` picture in Germany. From November 2005 to August 2007 five dailies and two business papers were basis of media coverage. The frequency of articles from the different sources dealing with topics about engineers is listed in table 1. To draw a conclusion, the topic “engineer” enjoys intensive reporting with all up to 196 articles.

The topics are arranged in 50 categories (table 7), which can be summarized in 5 main topics:

1 Describing the shortage of qualified engineers in Germany,
2 Discussions about the reasons of this labour shortage,
3 Representing the industrial and economic consequences,
4 Analysing the image of the engineer’s profession,
5 Others.

Table 8: Frequency of articles published from November 2005 to August 2007 in Germany.

Medium	Häufigkeit der Artikel (Anzahl der Fälle, N = 196)	durchschnittliche Wortzahl (Mittelwerte; Standardabweichung in Klammern)
Frankfurter Allgemeine Zeitung	53	701,30 (401,96)
Di Welt	53	654,21 (454,18)
Handelsblatt	37	627,59 (269,50)
Süddeutsche Zeitung	21	273,71 (209,63)
Financial Times Deutschland	15	407,27 (206,49)
Frankfurter Rundschau	11	487,10 (431,18)
taz	6	291,50 (268,71)
gesamt	196	581,77 (389, 64)
	(x^2 = 82,93; df = 6; p = 0,000)	(F = 5,160; df = 6, p = 0,000)

The outcome shows that 27 % of the articles deal with shortage of qualified engineers in German`s labour market and 12.7 % of the articles describe the reasons. 9.3 % prognosticate good prospects in labour market for young engineers. As a result of the labour shortage, 6.4 % of the articles advise to advance children`s interest in technology or deal with the recruitment of students. Eye-catching was, that only few articles report about the image of engineers.

Current key topic of engineers in media in Germany deals with the abolition of the German title of "Dipl.- Ing." in connection with the bologna process. Over the last 100 years the academic degree "Dipl.-Ing." has been developed to a distinctive brand label in Germany. Through numerous inventions made by German engineers, the engineer has gained prominence in public and industry. Numerous current articles resist against the abolition of the academic degree "Dipl.-Ing".

It is by now widely recognised that prospective and current students absorb a perception of the field of engineering through sources other than their lessons and career advisors. A large proportion of that influence can be contributed to the general media to which students and their families are exposed. It is important, therefore, to investigate how the 'Engineer' is defined through the press, and if (and how) this portrayal should be amended. This definition was extended to include all aspects of the 'Engineer', including their professional, social and political life, as well as their attitude or response to any global or regional issues – both as an individual and as an organisation.

In response to the press coverage analysis initiated by the IST, a similar task was undertaken with regards to the media coverage of engineers and the engineering field in three main sources in Ireland. The objectives defined for this analysis were not only to determine the level of visibility of engineering within the media, but also the perception which this visibility was conveying to the consumer. The period of time selected for the analysis was the calendar month of January, 2011.

The publications targeted for the purposes of this analysis were the primary national newspapers; The Irish Times and The Irish Independent, as well as the main radio station; RTÉ (Raidió Teilifís Éireann).

Collection of data was conducted through a review of both the online content and text archives of the sources. The 'ENG' radical was initially used during source reviews, but due to the inordinate amount of resulting articles concerning motoring, this was amended to the root term 'engineer'.

The IST report on press analysis was utilised as a template as regards the codification for the data review. The data collected from the source review was initially scanned and either retained or discarded with respect to the articles' relevance to the engineering field. One inherent problem with the data review was that quite often persons mentioned within an article were identified through their profession (i.e. an engineer), although the article concerned would have no other mention or relevance to the field. These articles were therefore disregarded for the analysis. 88 news articles were reviewed, which were produced between 1 and 31 January 2011.

Table 9: Valuation of representations of engineers and engineering

Media analysed

Media	Frequency	Percentage
Irish Times	54	61.4
Independent	23	26.1
RTÉ	11	12.5
Total	88	100

Table 9 – Breakdown of news items per media type

Valuation of News Items

	Frequency	Percentage
Positive	51	58
Neutral	11	12.5
Negative	26	29.5
Total	88	100

It is clear from the resulting data that the predominant amount of mentions of engineers and the engineering field are in fact positive, at 58%. Most articles were biased in some direction when discussing the aspect of engineering, with only 12.5% remaining neutral in their discussion. Drawbacks due to the short term nature of this media review can be countered with the fact that the results show such a strong inclination towards positive mentions – therefore validating the overall result.

The majority of articles regarding engineering were discovered under the 'Home News' sections of each publication. As a result, this title was sub-divided under the headings 'Employment', 'Manufacturing and Industry', and 'Social and Political'. Considering the recent interest in emigration and the state of the Irish economy, it is not surprising that employment-related articles are ranked as most frequent, after business and marketing. It is noteworthy, however, that recent developments in technology and renewable energy – as well as health and bio-medical diagnostic devices – account for a very small amount of the articles discovered when engineering was reviewed. The primary subject matter in the articles reviewed, therefore, were business, market-rates and employment– topics which tend to amass more attention when a negative view of the general fields is discussed, rather than a positive. Subjects that have not appeared as frequently throughout the month in question, (health- related engineering, bio-engineering etc.) and scientific innovation tend to gain attention when the articles concern a more positive issue.

Table 10: Aggregation of the 50 initial categories in 11 subject groups.

Themes Aggregated

	Frequency	Percentage
Home News:	34	38.6
Employment	16	18.2
Manufacturing/Industry	12	13.6
Social/Political	6	6.8
Business/Markets	22	25
Technology/Innovation/ Renewable Energy/ Science Today	11	12.5
Education/Bang.com	9	10.2
World News	8	9.1
Arts / Health	4	4.5
Total	88	100

While mentions of engineering in sectors regarding employment, manufacturing and business are primarily positive (as shown in Table 12), it is this tendency which can account for the inordinate amount of negative mentions of engineering through these sectors. As regards areas such as innovation, science and education – engineers are clearly portrayed in a primarily positive light by these media, but the articles do not occur with as much frequency.

Overall, from these results it can be concluded that engineers are represented in a generally positive light by the primary media in Ireland, with 58% of the articles reviewed considered as positive. Several aspects of the review are also noteworthy:

For the purposes of this media analysis, articles regarding major accidents or engineering-based faults are considered as portraying the engineering field as ‘negative’. For example; hip replacement recalls by the DePuy Corporation due to faulty components.

There are also two articles of interest due to strong statements made concerning the engineering field;

“A good example would be Mark Flanagan, who is doing engineering. Some courses are more demanding than others and engineering would be one of the most demanding.”

This quote is taken from an article “The School of Hard Knocks” in the Irish Times, under the topic of sports. The article concerns the subject of semi-professional rugby players returning to college studies before continuing with their sporting career, and clearly portrays the study of engineering as especially challenging.

“Page, who has the engineer’s dislike of public speaking and social engagements, will now be thrown into the spotlight at Google.”

This quote is also taken from the Irish Times, this instance from the Business section of the publication. The article is “Page thrown into the spotlight at Google”, and concerns the new position of Larry Page in the company. This article is also not concerning engineering, yet delivers a very strong image of an engineer as an introverted, social misfit – a portrayal definitely not accurate or desirable for the field.

Conclusions on Perception

The picture of engineers in media is different in different parts of Europe. Based on our results the overall picture on engineering in media is positive.

In Germany, Ireland and in Portugal engineering is often mentioned in a positive way in relation to the labour market since it has for long been put in relation to a good employment outlook and a high salary. In these countries engineers are also described in a positive way as experts and co-responsible for bringing forward the economy (Germany). In Sweden on the other hand, engineers are often considered, by non-engineers, as cold, insensitive technocrats, deeply specialized with highly repetitive work and with little or no social contact.

Taken together we have been analysing the picture of engineers and engineering in media in different countries within the context of the ATTRACT project. The countries represented in this survey corresponds to different parts of Europe, north (Sweden), central (Germany), west (Ireland) and south (Portugal). One question arose whether the picture of engineers in media is different in different parts of Europe. Based on our results the overall picture on engineering in media is positive. In Germany, Ireland and in Portugal engineering is often mentioned in a positive way in relation to the labour market since in has for long been put in relation to a good employment outlook and a high salary. In these countries engineers are also described in a positive way as experts and co-responsible for bringing forward the economy (Germany). In Sweden on the other hand, engineers are often considered, by non-engineers, as cold, insensitive technocrats, deeply specialized with highly repetitive work and with little or no social contact.

To sum up, one question that can be raised within the project is the following; we have found the picture of engineering to be overall mostly positive in media in the participating countries, so, how come that we find it difficult to attract young people to engineering? Are we really using the best ways of communicating with the young generation? And if not, how can we do that better?

Attracting Students to Studies in Science Technology

Working Package 7

Attracting Students to Studies in Science and Technology/Engineering Education

The benefits of science, technology, engineering and mathematics (STEM) to society are widely recognised, since, to remain competitive in the global economy, the education system must provide an ever expanding and highly talented pool of STEM workers[33]. However, the graduate number of science and technology is not increasing fast enough to keep up with demand from industry and academia[34].

How to attract students to science, technology/engineering education? In order to begin answering this question we identified overall goals that consist on identifying ways:

To arouse young people's interest in Science and Technology

According to the Eurobarometer[35], 36% of the inquired population strongly agree that (natural) science classes at school are not sufficiently appealing and 33% tend to agree with that. So, since the youth of today are the leaders of tomorrow it is crucial to find an effective way to arouse young people's interest in Science & Technology so that there are candidates to Science and Technology/ Engineering (S&T/E) programs in the future.

To attract candidates into tertiary education S&T/E programs

Recruiting students to S&T/E programs is seen as a major problem in most European countries[36]. There are significant country-to-country differences in terms of the number of students that choose these programs. This is why the project aims not only at finding ways to attract students into S&T/E programs, but also to attract the top students into this type of programs.

To balance the gender representation in S&T/E programs

Although women represent the majority of students and graduates in almost all OECD countries, the proportion of women in engineering is still inferior to men[37]. In general, it is observed that STEM fields are most likely to be chosen by men, even though there are specific and more interdisciplinary areas that contradict this trend (e.g. chemistry and biology). This pattern is also observed across the teaching staff.

Moreover, according to PISA[38], in recent years girls, in many countries, have surpassed boys in science proficiency. However, better performances in science or mathematics among girls does not necessarily mean that girls wish to pursue all types of science-related careers. In fact, in every OECD country more girls than boys reported that they wished to pursue a career in health services, a science profession with a caring component, while only fewer than 5% expected to work in engineering and computing as adults, 18% of boys expect to work in this field, see Figure 1.

[33] Wells, B. Sanchez, H., Attridge, J. (2007). Modelling Student Interest in Science, Technology, Engineering and Mathematics. IEEE.

[34] OECD (2006). Changing Supply and Demand for S&T Professionals in a Globalised Economy. OECD Publishing.

[35] Eurobarometer (2008). *Young people and science: Analytical Report,* European Commission.

[36] EU (2004). *Europe needs more scientists!,* European Commission, Directorate-General for Research, High Level Group on Human Resources for Science and Technology in Europe, Brussels.

[37] OECD (2011). Education at a Glance 2011: OECD Indicators, OECD Publishing.

[38] PISA IN FOCUS (2012), OECD.

Figure 15 - Ratio of boys to girls who plan a career in engineering or computing. Source: PISA IN FOCUS (2012).

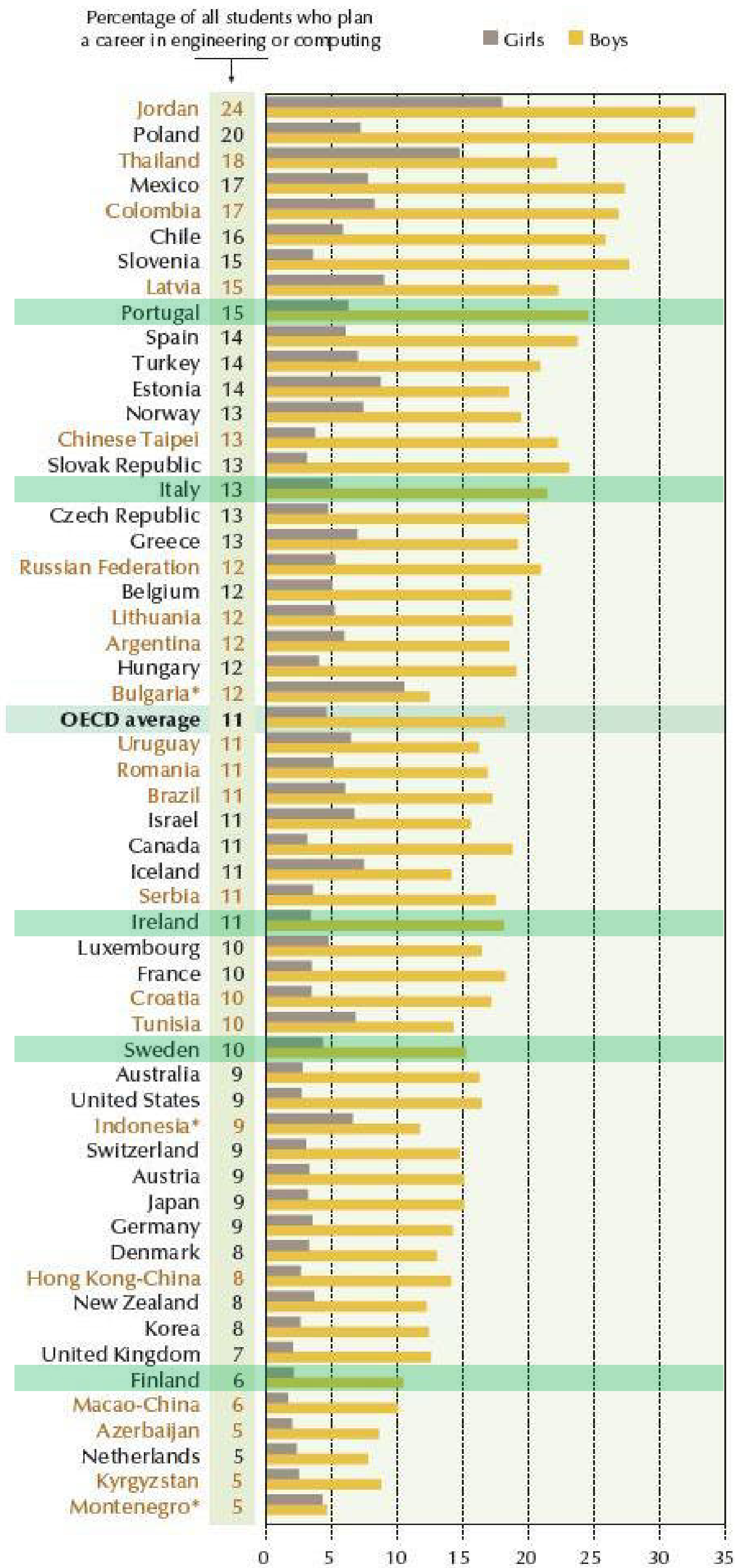


Figure 16: Graduates in Science and Technology per 1 000 of population aged 20-29 years. Source: Eurostat (2008).

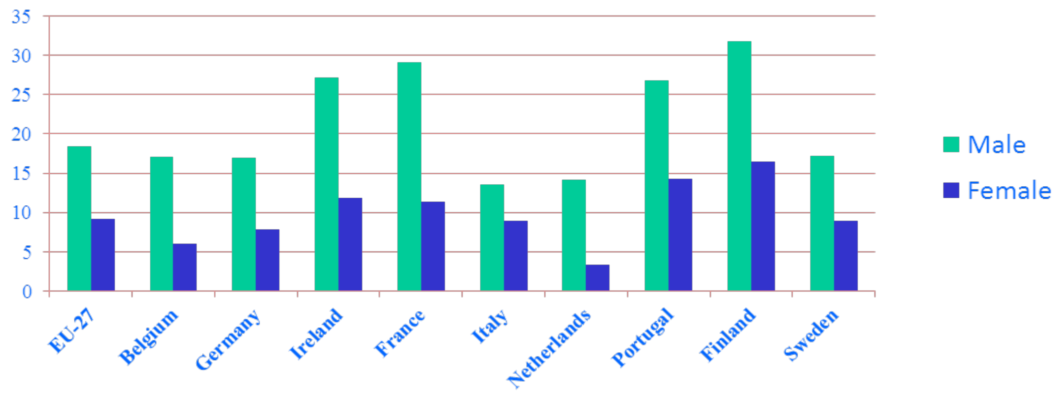


Figure 2 shows that the sampled countries show different realities, particularly when it comes to female S&T graduates. For instance, in Italy the ratio of female to male S&T graduates is rather balanced, while in other countries, such France, there is a significant difference between both genders.

In light of the foregoing, in order to find ways to arouse young people's interest in S&T or to attract candidates into S&T/E programs, even to balance the gender representation in S&T/E programs, it is important to understand how young people perceive S&T/E education. Therefore, it is vital to understand what motivates students to take up science and technological programs and why the ratio of men to entering at these programs remain so unbalanced.

Recruitment and access system

A first approach to attractiveness of S&T/E studies calls for understanding how the recruitment and access to tertiary education is run in each country. The first step towards this aim was to analyse the requirements to apply for such programs in the partner countries in order to identify the degree of freedom that each partner institution may have in shaping the recruitment system. Four specific degrees of freedom were considered:

- Whether there is a *numerus clausus* and to what extent it is decided upon by the institution;
- What background qualifications give access to the engineering programs;
- To what extent each institution may define the selection criteria.
- When recruitment activities, applications and enrolment take place.

Most of this information was gathered within the framework of WP6. However, as this is important under WP7, some of the most relevant aspects will only be pointed out herein. The access calendar is based on partners' contributions.

Places, Required Qualifications and Selection Criteria

The existence of the *numerus clausus,* which limits the number of students who may take an engineering program differs among ATTRACT member countries, see Table 1.

Typically, there is a *numerus clausus* defined by the Ministry. Exceptions to this are the partners from Belgium and Italy. To undertake an engineering program a student has to meet some requirements, such as holding a secondary diploma.

Table 6: *Numerus Clausus* in engineering, according to the country's partner.

	Numerus Clausus	Decision
Belgium	N	
Finland	Y	Negotiated with Ministry
Ireland	Y	Central Applications Office (HEIs)
Italy	N	
Portugal	Y	Proposed by institution, decided by Ministry
Sweden	Y	Institution, but dependent on the budget and decided by Ministry

Table 4 on Framework for institutional comparison in partner countries, in WP6 report there are no significant differences among the sampled countries for students who come from secondary school. Broadly speaking, students must hold a secondary certification and, in some cases access, do exams in specific subjects.

It is important to notice that for mature students there are alternative procedures to undertake an engineering program.

The selection criteria between applicants represent perhaps the most formal barrier to engineering education at university level. Therefore, it is crucial to examine these criteria across each country partner.

As detailed in see table 4 on Framework for institutional comparison in partner countries, in WP6 report, there are several differences among the selection criteria in the partner countries. However, in general, in order to undertake an engineering program students must pass an exam, whether an entrance exam or a national exam. Some universities have additional requirements for students who intend to pursue S&T/E programs. In Sweden, for example, students must give proof of proficiency in Swedish and English.

Calendar of Access Activities

Since there are significant differences in the recruitment processes among partner countries, it is important to analyse the calendar of university access activities in each country.

This calendar differs among institutions (see Table 2), which anticipated an increased difficulty to bring into line field trials among the several partners.

Programs and dissemination activities typically start at the end of previous year and last until the final exams season. Besides Portugal, these activities begin in October in most of the partner countries.

As expected, the field trials development period had to be adapted to each country.

Table 7 – Calendar of access activities X by institution.

Tasks		Year X-1							Year X									
Activities	Partners	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Recruitment/ activities	Finland																	
	Portugal																	
	Sweden																	
	Ireland																	
	Italy																	
Exams/ Apllications	Finland																	
	Portugal																	
	Sweden																	
	Ireland																	
	Italy																	
Enrollment	Finland																	
	Portugal																	
	Sweden																	
	Ireland																	
	Italy																	

Initiatives

This section presents a summary of initiatives undertaken to attract students into science technology/engineering studies in tertiary education in partner countries and institutions.

These initiatives were collected among the project partners between 2010/11 and 2011/12. This is not intended to be an extensive research, but just to provide examples of activities that could be undertaken to meet the project goals. It would be interesting to conduct further research on the impact of these initiatives in students at a national level.

These activities are usually designed for secondary students, although there are also events for younger students in order to arouse their interest in this area of studies. There are also some initiatives targeted to teachers so that they can promote science, technology/engineering among their students in a funny and interesting way.

The objective of this chapter is threefold: the first section presents national initiatives, which aim at promoting science, technology/engineering, followed by the local initiatives undertaken by the partner institutions in order to promote this area of studies among students, especially in the secondary education and, finally, initiatives that aim to attract female students to this area of studies are explored.

National Actions

In all the partner countries there are activities carried out nationwide to promote and raise the national interest in Science &Technology/Engineering, which could be summarized in three categories:

1. Actions promoting S&T/E education

As previously mentioned, it is generally believed that scientists and engineers can contribute for Europe's future economic and technological development, which makes it so important to carry out actions to promote STEM occupations and careers.

2. Actions enhancing the public image of S&T/E

The actions to raise the population's awareness about S&T/E importance are usually carried out by the partner countries so that people are able to understand S&T related issues with a positive attitude towards them.

3. School guidance

Secondary schools have sometimes guidance offices where students can find educational and professional supervision to help them explore the future career opportunities.

Examples of actions carried out nationwide in the partner countries are given below:

- Science Centres/Museums

with interactive areas of S&T, which are designed to introduce and disseminate scientific and technological concepts among the population. For instance, in Portugal, the program Ciência Viva supports science centres, with the purpose of promoting scientific and technological culture. In turn, Ireland has an Exploration Station, which aims at raising the level of science awareness among young people by providing visitors a hands-on experience and a deeply understanding of science.

- Information and Communications Technologies (ICT),

in schools through the development of teachers' skills on Information and Technologies (IT), by increasing the number of computers in schools and the use Internet access services. For example, both Irish and Portuguese governments have encouraged the development of ITC in schools by either increasing the number of computers or developing teacher IC competence.

- University offered Courses and Workshops,

which are particularly carried out in summer where students (commonly secondary school students) can take an active part in learning, observing, reflecting under teachers' guidance and supervision. In Italy, for example, the *National Plan for Science Degrees* aims at consolidating science knowledge and skills among the students by offering several workshops in which students can actively participate, by observing and reflecting under tertiary teachers' supervision about daily-life situations.

- Teaching programs,

which are designed to provide teachers with tools to make science interesting and more appealing and funny to young people. For instance, some programs offer a number of practical examples so that teachers can promote in-class science experiments. Sweden and Finland, for example, offer programs to support teachers in secondary schools to stimulate pupils' curiosity, interest and knowledge in S&T.

- Students' competitions

are a reality in many countries, which challenge students to develop new science-related concepts and ideas, while promoting fun learning opportunities. For instance, in Finland there is a competition called *Tämä Toimii! Teknologiakilpailu* (This Works! Technology Competition) which consists in making young children familiar with technology.

- Conferences, Seminars, fairs

are very commonly used to promote scientific occupations and careers. Engineering professionals usually give talks to students about their careers providing some insight into their work.

- Websites and Media Coverage

is used to disseminate S&T/E advice, information and support for people interested in these topics.

- Career guidance offices,

are available at secondary schools, which offer educational and professional guidance, by promoting a conscious decision about the future options.

Institutional Initiatives

At an institutional level, initiatives to recruit students among the partners are very similar. Thus, almost all institutions organise:

- Visits to secondary schools,

which are usually supported by student ambassadors. Ambassadors are current University students well equipped with information on programs and admissions procedures. Typically, this kind of activity involves a presentation of the university and clarification of doubts about the programs. In some cases, brochures and leaflets with institutional information are also handed over;

- Secondary schools open days/visits

generally consist of a tour across the campus, where students are able to experience the institution's environment, by participating in a set of activities (e.g. seminars, open classes, hands-on experiments, etc.). Students are also encouraged to ask questions and clarify any doubts that still remain about the programs or the admissions procedures;

- Fairs,

which are an effective way of disseminating S&T programs among young students, who seek to learn more about tertiary education opportunities.

- Internships and Summer Programs,

which are designed to motivate secondary school students, who would like to get a jump-start on their tertiary education and gain enrichment in a variety of interesting and challenging S&T subjects. Thus, students may therefore experience what life in a college campus is like and have the chance to explore new fields.

- Websites,

which provide information about the programs and the admissions requirements for tertiary education students and for those wishing to apply.

Besides the previous set of activities undertaken by the partners' institutions, some of them also develop other initiatives in this context, which are summarized below.

Table 8: Other type of institutional initiatives developed by the partner countries.

Institution	Activity	Aim
KTH, Aalto	Together with Stockholm University, KTH offers primary and secondary schools to carry out exciting experiments in order to attract more young people into science and technology.	To make youngsters garner interest in S&T studies.
UPPSALA, Aalto	1st year students or teachers back to home school.	To stimulate the relationship between university and home schools.
IST, TCD, Aalto	Media Advertising through social networks (IST) and applications for mobile phones (TCD).	To promote the University among the general public.
TCD	Attract students from social minorities.	To further equal opportunities among secondary students.
KTH, UPPSALA, Aalto	Courses & Laboratories in secondary schools promoted by universities.	To reinforce the relationship between secondary and university education.
KTH, TCD, LiTH, Aalto	Workshops and Exhibitions.	To disseminate S&T careers.
LiTH	Mathematics coaching.	To improve mathematical skills among youngsters.
Aalto	Dreams contest.	To support young visionaries so that they can achieve their goals, in STEM areas.

Breakdown by Gender

Likewise, there are some actions designed specially to promote S&T/E as an attractive and realistic career option for girls, namely:

- Summer Courses or Girls' Week/Day,

which are events aimed to invite girls to participate in science experiments and to raise their awareness about women achievements in S&T/E fields.

- Mentoring Programs,

which seek to support women to forge a career, particularly in the technological fields. Usually, most skilled women are chosen as mentors and provide guidance based on their own previous experiences.

In Italy, for instance, the program *Donna Professione Ingegnere* (women in engineering) also aims at increasing the number of women in engineering courses, removing any gender discrimination present in engineering studies and raising the issue of equal opportunities in academic world. Therefore, female students attending last years of high school and female students enrolled in first and second year at PoliTo receive scholarships, as well as vocational guidance.

Field Trials

According to OECD [39], differences in young people's study choice can be attributed to traditional perceptions of gender roles and identities as well as the wide acceptance of cultural values associated with particular fields of education. Therefore, in order to gather the students' perceptions of STEM it was decided to survey secondary and STEM freshman students in all partner countries so that a comparative analysis could be done. The survey is designed to identify differences between students who choose to undertake STEM studies and to identify the different perceptions that male and female students have of STEM.

While creating the survey, particular effort was made to its methodological validation. Therefore, several questionnaires, which aimed at gathering information on entrant students, in each institution, were harmonized with the WP5 questionnaire so that they could be used to compare secondary and entrant students' perceptions of the engineering profession.

As a result, a first draft was sent to the partners for suggestions and recommendations, and adaptations to their country reality. For instance, in Finland the questionnaires were structured on the basis of this draft and on the recommendations provided by Anderson[40] (recommended to have a broad view of the items usually analysed in this scope in the several partner countries).

Therefore, each partner had the freedom to adapt the questionnaire to its own country provided that the minimum dimensions were satisfied, namely:

- The area of study in secondary education;
- The parental background;
- The efforts required to undertake an engineering program;
- The perception of the engineering profession, in terms of the:
  - Importance for the country development;
  - Difficulty;
  - Pay level;
  - Recognition by the employers;
  - Access to the labour market;
- The moment in time when students decided to undertake an engineering program (only for entrant students);
- The decision to follow tertiary studies, more precisely engineering (only for secondary students);
- The area of studies chosen (for secondary students only).

Some partners had already developed surveys in some of these topics, which were used for this project (e.g. Italy and Sweden).

Sampling Process

The current research involved sampling and analysing secondary and entrant students' perceptions of the engineering profession in ATTRACT member countries. Knowing how these perceptions diverge may shed some light on new approaches to attract students for S&T/E programs.

In Belgium, only the secondary students' questionnaire was applied, which collected a total of 161 answers. The participants were visitors of the Faculty of Engineering on an information session concerning the engineering programme. They answered the questions a few weeks after this visit.

In Finland, the secondary students' questionnaire was conducted in ten upper secondary schools in the Greater Helsinki area and in Turku and Oulu during October–December 2011. The ATTRACT questions were a small portion of a larger questionnaire delivered by OTUS, an association that promotes and supports research related to higher education and the students' economic, cultural and social status and their way of life. The total sample covered 1015 students in their final year of upper secondary school. The response rate was 60% (607 students). Altogether, the number of students in their final year of upper secondary school in Finland is about 32 000. Five of the schools that participated in the survey were identified as so-called regular (general) schools, four are so-called top (general) schools and one is a mathematics-oriented school. The sampling process was carried out with the guidance of school counsellors. Both electronic (6 schools) and paper (4 schools) questionnaires were used.

[39] OECD (2011). Education at a Glance 2011: OECD Indicators, OECD Publishing.

[40] Anderson, S. (2011). *Beginner Questionnaire Suggestions*, Uppsala University.

In turn, the beginners' questionnaire was conducted in the four technology schools at Aalto University during the first two weeks of September 2011, using an electronic questionnaire in a freshman introductory course. Altogether, 485 students responded to the questionnaire. In the 2011/12 academic year, about 1100 new students started their studies in the four schools of technology.

In Ireland, secondary school students, who responded to the survey, came from secondary schools that visited TCD to attend presentations on engineering and those schools have been selected from a list used by TCD. Before or after the presentation, students have been asked to attend those presentations to complete the questionnaire.

A short oral introduction to the ATTRACT project was made as the question sheets were distributed. Response rates were close to 100% (among attendants). Attendance varied depending on the school. For example, some schools took all students from an age group to visit the University to attend talks, while other schools took a small number of students, who probably had already an interest in that particular university. Results of all questionnaires have been uploaded onto the computer later on.

As for entrant students, a lecture slot, at which all students in the year group were expected to attend, was selected. A 15-minute time segment was requested, during which a short outline of the ATTRACT project and the questionnaire rationale were given. Students then completed the questionnaire, after which results have been uploaded onto the computer.

In Italy, the survey covered the students that entered an engineering degree program (4829) in 2011/12, who were asked to complete an online survey. Among those, 1338 students completed the questionnaires.

Portuguese data from 2009/2010 suggests that the national high school system comprises 918 establishments and almost 198 thousands of students[41]. Therefore, it would be impossible to inquire every school. Based on a convenience criteria (proximity and previous collaboration), seven secondary schools, whose students are likely to come to IST, were invited and accepted to participate in this field trial. This means that the collected data is not representative of the entire population, as this study cannot cover the Portuguese high school universe. However, this information will provide deeper insight on secondary students' motivations to choose tertiary education and, in particular, an engineering program.

Regarding the university entrants' questionnaire, the population at issue was the students that entered IST in 2010/2011 and 2011/12 for the first time. This population, which totalled 2826 student, had been asked to complete an online survey and the response rate achieved 64% (1796 students).

In Sweden, only the entrant students' questionnaires were applied. Overall, 844 answers were collected.

The data collection can significantly differ across ATTRACT members. As such, Table 4 summarizes the main aspects related to this.

Table 4 shows that the sample significantly differs from country to country. For instance, in Finland, the sample gathered around 600 secondary students, while in Ireland almost 100, which makes it mandatory for us to carefully interpret the results. Moreover, among the 1338 Italian student respondents, only 255 answered questions related to their perceptions of the engineering profession.

It is important to notice that the used criterion to collect the secondary students sample was not uniform among the partner countries. While in some countries secondary students were S&T oriented, in others there were a high percentage of students from other fields of study. Therefore, the sample cannot be considered representative and data resultant from this approach has to be looked at with some caution.

Notice also that some variables had to be adapted for comparison purposes. For further details on variables definition and extended results, please see the Variables Definition in the report appendix.

[41] Gabinete de Estatística e Planeamento da Educação (GEPE). *Estatísticas da Educação 2009/2010*, 2011.

Table 9: Sample summary.

Country	Institution	Questionnaire Language	Secondary Students' Sample (% Female)	Entrant Students' Sample (% Female)
Belgium	K. U. Leuven – Faculty of Engineering	English	161 (34%)	---
Finland	Aalto	Finnish	607 (55%)	485 (26%)
Ireland	Trinity College Dublin	English	98 (84%)	176 (23%)
Italy	Politecnico di Torino	Italian	---	1338 (not available)
Portugal	IST	Portuguese	583 (55%)	1796 (29%)
Sweden	Uppsala	Swedish	---	844 (33%)

Secondary Students

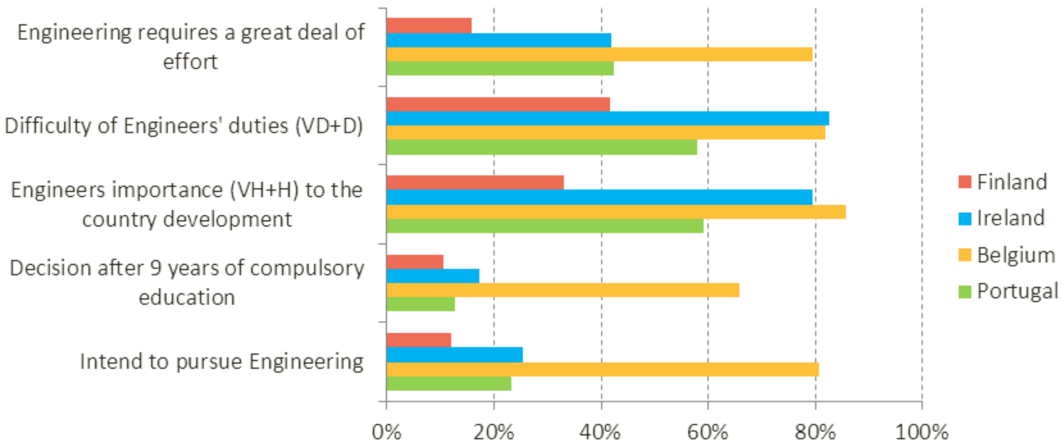
This section provides an insight on how secondary students perceive an engineering program and the engineering profession

Figure 3 shows that secondary students in different countries have different perceptions of engineering.

In Portugal, Ireland and Finland the number of students who wish to undertake an engineering program is 23%, 26% and 12% respectively, which is considerably lower than in Belgium, where approximately 80% of the inquired students are in the same condition. These differences might be explained by the different types of sampling processes.

Few students decide that they wish to take up engineering after nine years of compulsory education, except for Belgians. This might mean that even though a student considers entering an engineering program before secondary education, he/she only makes his/her mind after having the secondary results.

Figure 17: Secondary students' perceptions of engineering.



As for the importance of engineers for the country's development, Finnish students seem to have the most pessimistic view on this subject, even though around 30% of them believe that engineers are important to the country's development. Belgians are the most confident students in terms of the engineers' contribution to the countries' development.

It is widely accepted that the engineering profession entails a great deal of difficulty, particularly for approximately 80% of Belgian and Irish students. In turn, more than half of the Portuguese secondary students share that opinion but, in Finland, only about 40% of the students take that view.

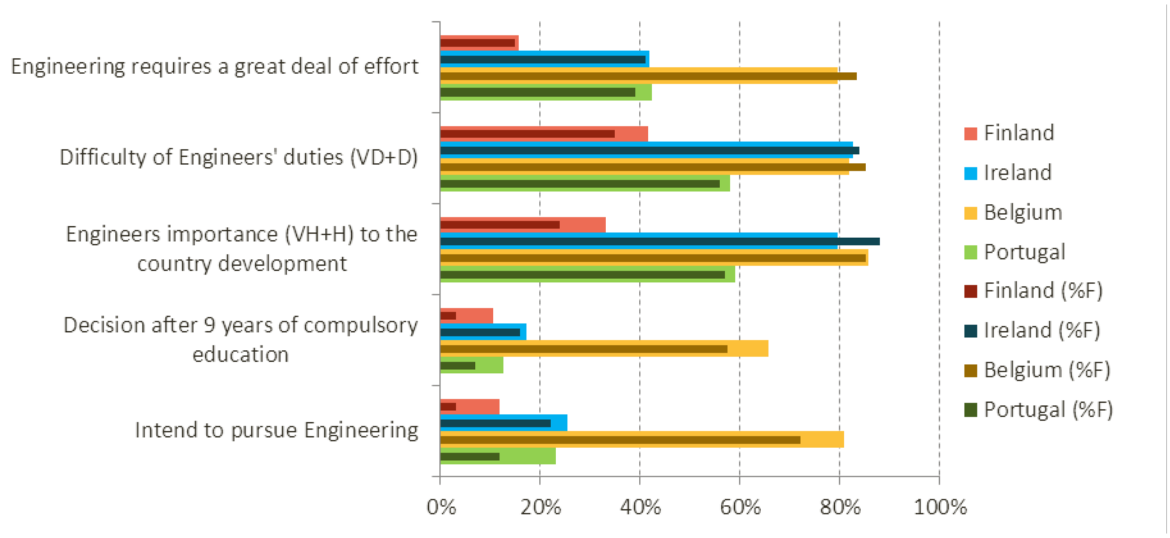
It is interesting to note that only the Belgian students seem to have a similar opinion about the level of difficulty required to perform engineering duties and the level of effort required to undertake an engineering program. While in the remaining countries under analysis, students seem to think that undertaking an engineering program does not require the same deal of effort as performing engineers duties, especially in Ireland and Finland.

Secondary students are in general optimistic about wages in engineering, but the Finnish students are the most pessimistic.

Figure 4 shows that female students' opinions tend to be similar to the total of secondary students analysed.

However, it is important to notice that female students tend to be less likely to undertake an engineering program, especially in Portugal. This is in accordance with PISA findings (see page 6). Also, female students tend to make their decision previous than male students.

Figure 18: Secondary students' perceptions of engineering, with females' perception.



Moreover, in some countries, female and male students tend to have divergent perceptions of the degree of importance of engineers to the country's development. For instance, in Ireland female students tend to attach a higher degree of importance to the contribution of engineers to the country's development, whereas in Finland it is the other way round. Female students have a more pessimistic vision about the contribution of engineers to the country's development.

It should be noticed that, in Finland, female students are more likely to have different perceptions of the engineering profession. They seem to consider that engineers' duties do not involve a high level of difficulty.

Figure 19: Weight of factors on taking up a university program

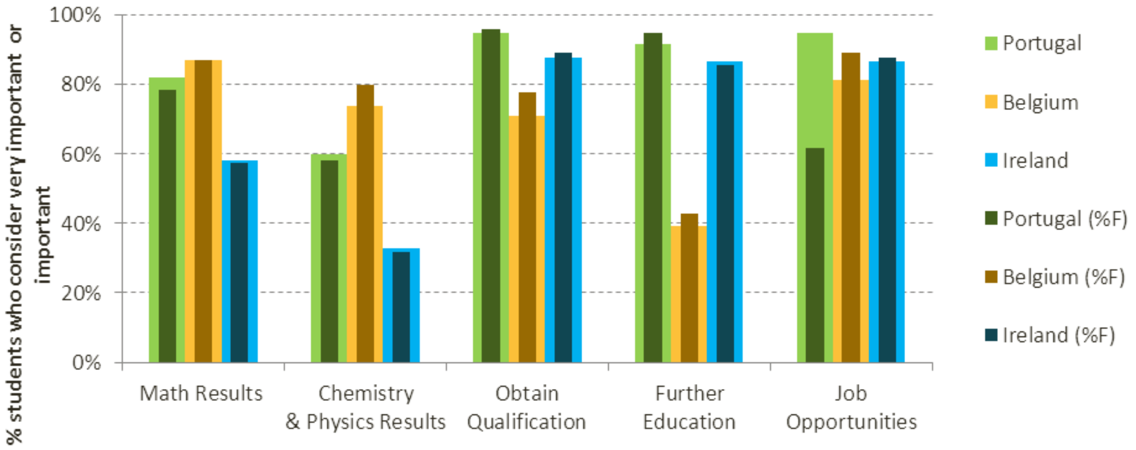
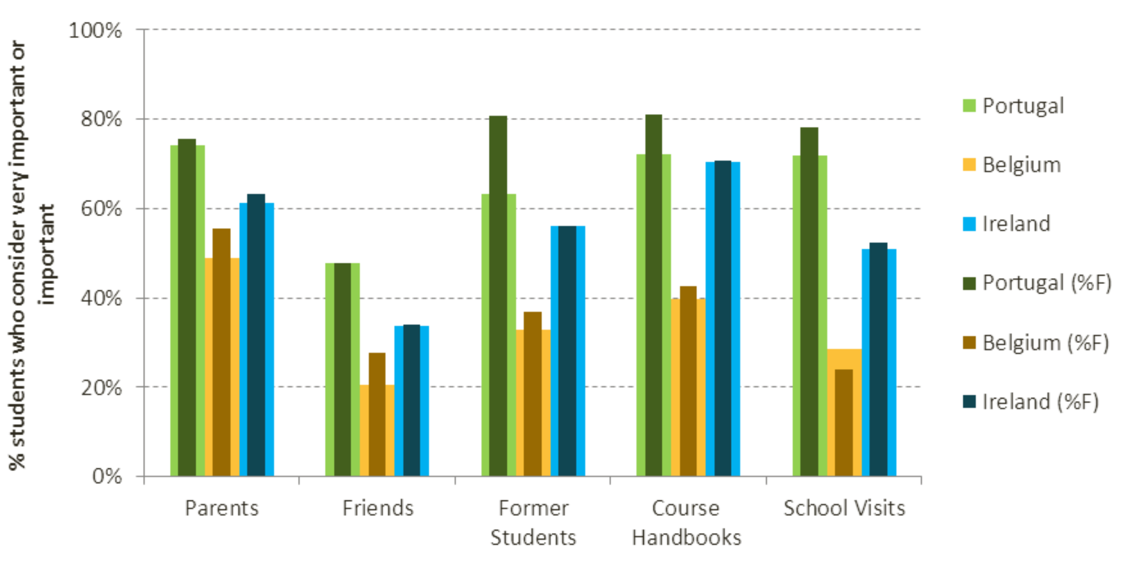


Figure 5 shows information about the students' decision to attend a university program, which portrays the degree of importance that secondary students attach to each of the factors mentioned.

Once again, students from each country seem to rely on different aspects to decide whether to attend a university program. Moreover, female students seem to rely on the same kind of indicators to make a decision to attend a university program.

In fact, secondary students are more like to attach a high degree of importance to job opportunities as a result of tertiary education, as the factors they rely on for the decision to attend a university program. The factor that seems to be the least significant to the students' decision is Chemistry and Physics, probably because students do not need to undertake these subjects in secondary education in some programs.

Figure 20: Weight of factors on taking up a program.



Once again, Figure 6 shows that the importance attached to each factor by female and total secondary students does not significantly differ among them, despite some country-to-country differences.

Portuguese students are more likely to rely on others, while Belgians are less likely. In general, female students give more importance than total students to what other people have to say about the program and both take enough account of the opinion of parents and former teachers.

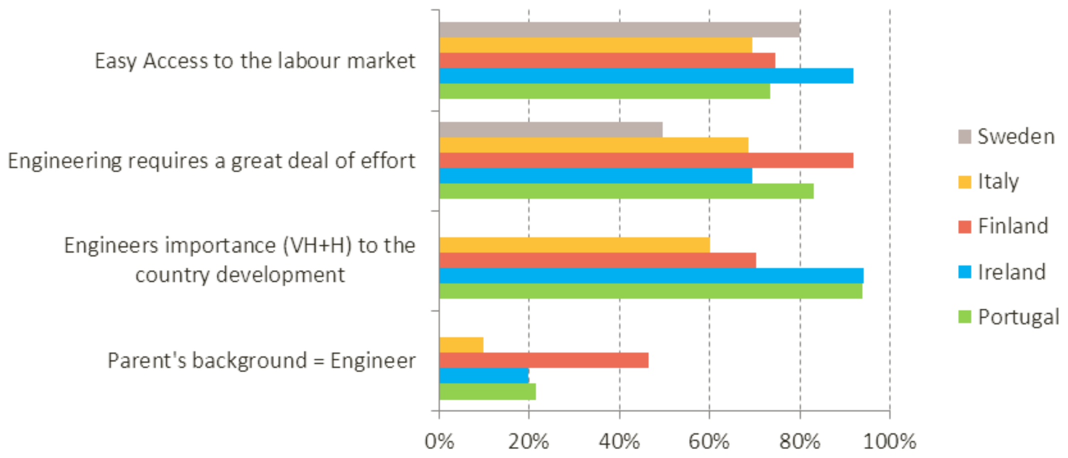
Relatively to course handbooks, Portuguese and Irish students seem to believe that it is an important factor to take into consideration, while Belgian students rely much less on this factor.

Schools visits play an important role in Portuguese students decision since most of them rely on this factor to choose a program, while in Ireland and Belgium students are less likely to take schools visits into consideration.

Entrant Students

This section sheds some light on entrant students' perceptions of the engineering programs and seeks to identify the main motivations to choose a course.

Figure 21: Entrant students' perceptions of engineering.



A glance at Figure 7 may highlight that Finish students whose parents have an engineering background are more likely to pursue an engineering program (almost 50%) than their counterparts. Italy is the country in which fewer students follow their parents' path.

As for the contribution of engineers to the country's development, Portuguese and Irish students strongly believe that engineers play a crucial role in that. On the other hand, Finnish and Italian students are not so sure about that.

Generally speaking, most of the students believe that undertake an engineering program requires a great deal of effort, even though Swedish students are more confident about it.

Most students believe that engineers have an easy access to the labour market, and the Irish students are the most optimistic about it.

Figure 22: Entrant students' perceptions of engineering, with female students' perception.

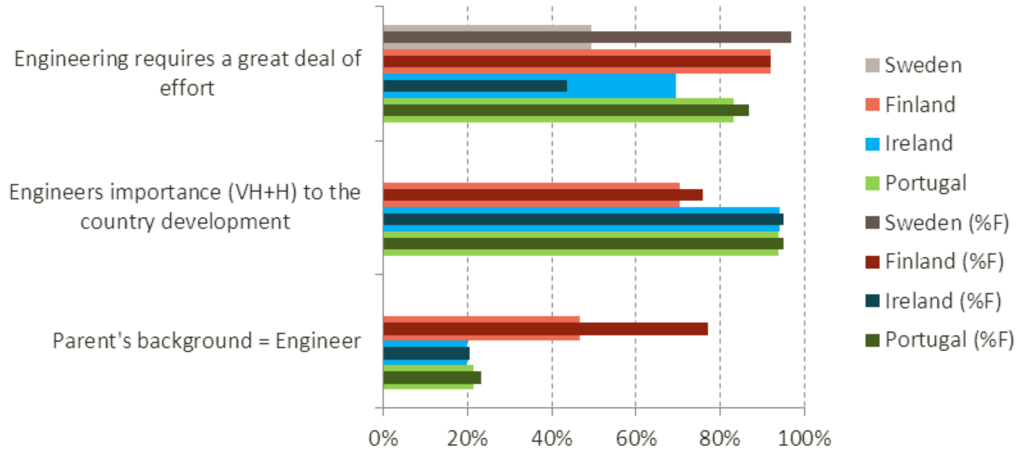


Figure 8 shows that Finnish girls who had undertaken an engineering program are much more likely than boys to have engineers as parents.

Also, Irish girls have a different perception of the effort required to undertake an engineer course, as they seem to believe that it is easier to achieve that goal as compared to male students.

Figure 23: Weight of factors on the decision to attend a university program.

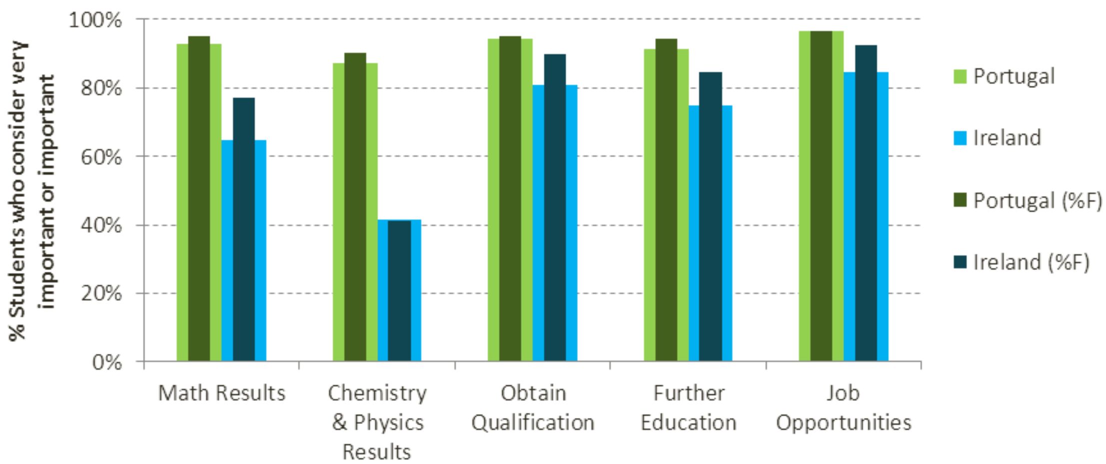


Figure 9 summarizes information about the decision of university entrants to take up a university program. Once again, it is important to notice that each country has its own characteristics and its own social, economic and political context and, therefore, students' decisions to attend a university program might be influenced by the context in which students are included. In addition, there is no significant difference between female and male students regarding the level of importance that these factors play to decide whether to attend a university program.

Students point out that the main reason for choosing to attend a university program is the wide range of job opportunities available.

Figure 24: Weight of factors on the decision of taking up an engineering program.

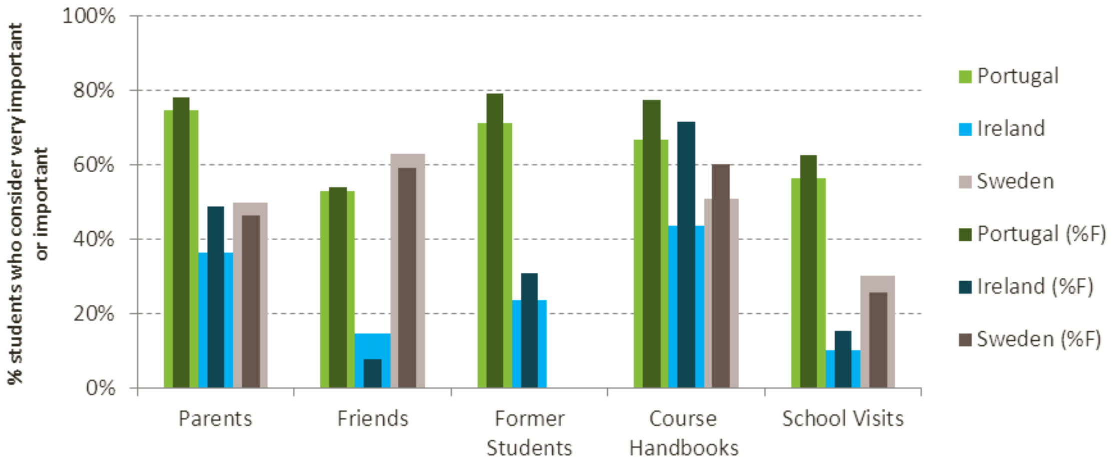


Figure 10 specifies the level of importance that university entrants attach to several factors that influence them to choose to take up an engineering course.

As for the females students' choices, while the Portuguese seem to attach to each factor a high level of importance, Irish and Swedish ones do not. For example, Irish female students rely less on friends and secondary teachers' opinions and more on parents and former students' opinions, as well as on courses handbooks and schools visits. On the other hand, Swedish girls are more likely than boys to attach a higher degree of importance to program handbooks.

Secondary vs. Entrant students' perceptions

The formerly mentioned students are representative of two different taxonomies: Secondary Students and Entrant Students. This section will provide some comparisons and extrapolations for discussion.

Figure 11 shows that the great majority of students, who wish to take up an engineering program, studied S&T at secondary school, which is in accordance with what university entrants have studied in secondary school.

As expected, the percentage of university entrants whose parents have an engineering background is higher than secondary students who wish to undertake an engineering course and whose parents are engineers.

The percentage of university entrants, who enter an engineering program, having decided to take it up after 10th grade, is much higher than the percentage of secondary students who wish to undertake an engineering course, having decided it after 10th grade. This might suggest that a great many students who really take up an engineering program are usually not entirely sure that they want it and postpone their decision.

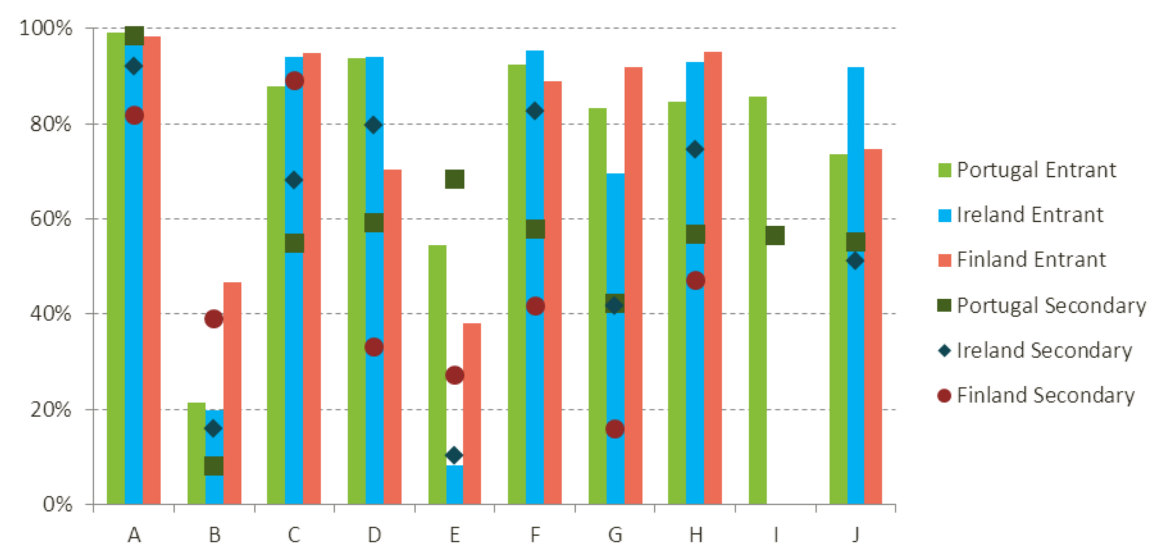
Expectedly, students entering an engineering program are much more likely to believe that engineers are important to the country's development than secondary students, particularly in Portugal and Finland.

In Portugal and Ireland secondary students whose parents have a university background are more likely to believe that engineers are important to the country's development than university entrants in an engineering program in the same condition. However, in Finland it seems to be the other way round.

As expected, engineering students are more likely to believe that engineering duties require a high level of difficulty than secondary students. Moreover, only about 40% of the Finnish secondary students believe that it requires a high level of difficulty.

Once again, while most of the university entrants believe that taking up an engineering program requires a great deal of effort, in the opinion of secondary students it does not require so much effort. For instance, in Finland, while around 90% of university entrants seem to believe that it requires a great deal of effort, less than 20% of secondary students share this opinion.

Figure 25: Secondary vs. Entrant students' perceptions of engineering.



A	Students who studied S&T at secondary school (from students' total).	F	Students who consider that engineering duties require a high level of difficulty and whose area of studies is S&T (from students' total).
B	Students whose parents have an engineering background (from students who want to become an engineer).	G	Students who believe that taking up an engineering program requires a great deal of effort and whose area of studies is S&T (from students' total).
C	Students who decided to take up an engineering program after 10th grade (from students in S&T).	H	Students who believe that engineers are well paid and whose area of studies is S&T (from students' total).
D	Students who believe that engineers are important to the country's development (from students' total).	I	Students who believe that engineers have a remarkable recognition and whose area of studies is S&T (from students' total).
E	Students who believe that engineers are important for the country's development and whose parents have a University background (from students' total).	J	Students who think that engineers have easy access to the labour market (from students' total).

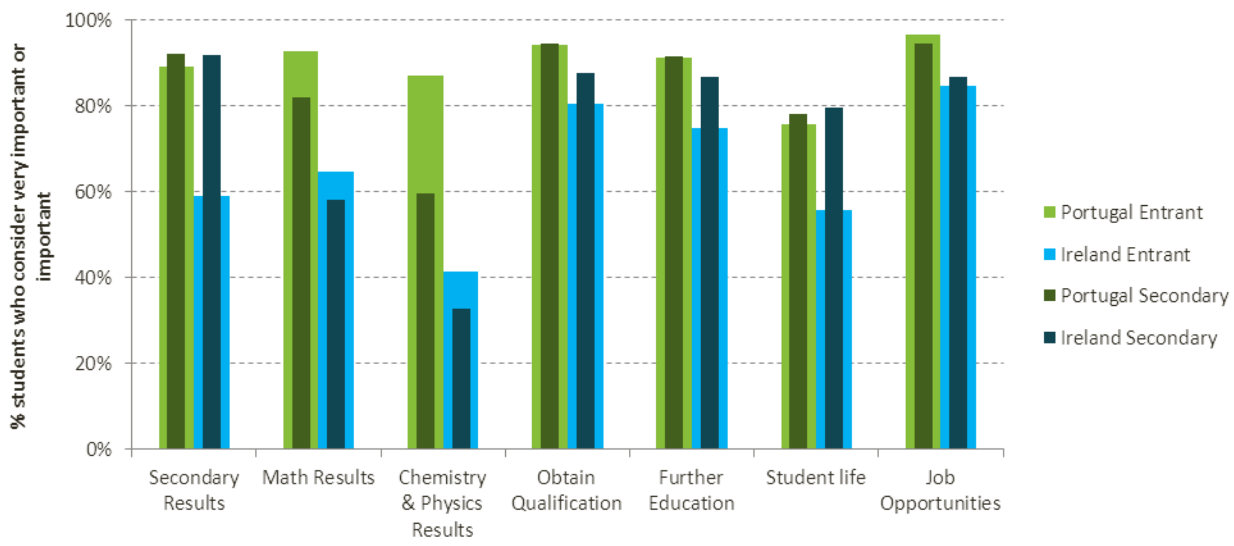
Not surprisingly, there is a higher percentage of university entrants who believe that engineers are well paid than secondary students. Finland appears again as the country in which this difference is larger.

In Portugal, the great majority of students who undertake an engineering program believe that engineers are highly recognised, while only approximately 60% of secondary students seem to share this opinion.

University entrants are more optimistic than secondary students about job opportunities in engineering. For instance, in Ireland, while almost each university entrants believe that engineers have easy access to the labour market, only approximately half of secondary students take this view.

As Figure 12 shows, once again secondary and university entrants rely on different factors to decide whether they will attend a university program. For instance, Portuguese and Irish secondary students attach the same importance to secondary results when deciding to attend a university program, much higher than that of Irish university entrants.

Figure 26: Weight of factors on the decision to take up a university program for secondary and entrant students.



As regards mathematics results in secondary education, university entrants in an engineering program seem to attach to this factor a higher importance in the decision of attending a university program than secondary students. The same applied to the results in Chemistry and Physics.

Regarding the remaining factors' importance in the decision of attending a university program, Portuguese entrant and secondary students seem to share the same view. However, in Ireland, secondary students seem to rely on these factors more than entrant students.

Figure 27: Weight of factors on the decision of choosing a course, for secondary and entrant students.

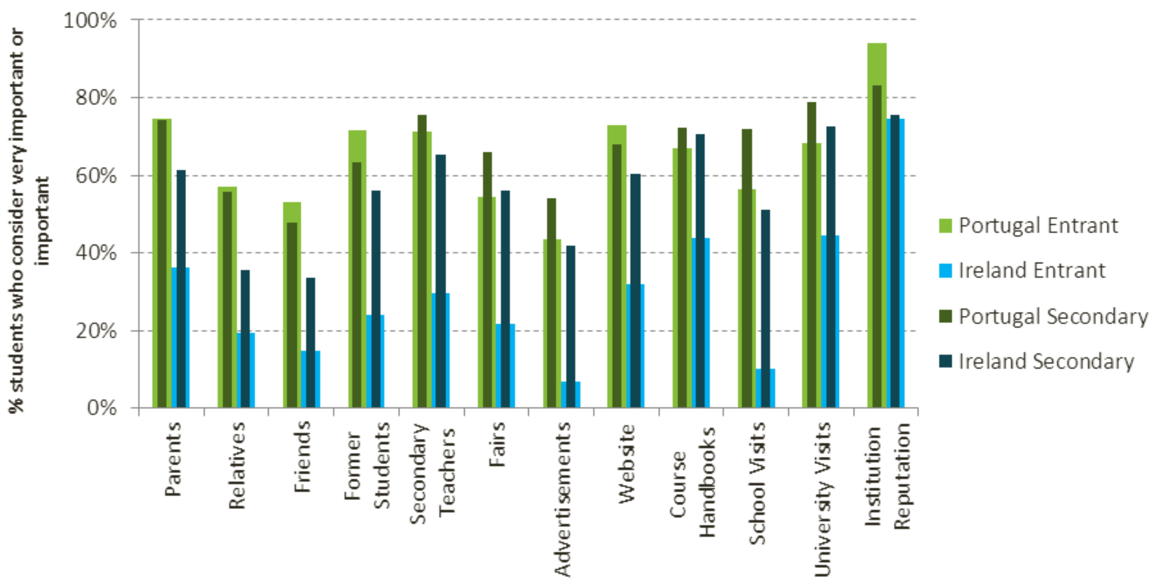


Figure 13 shows that in Ireland, secondary students are, in general, much more likely to rely on every factor than entrant students. However, with regard to the institution's reputation, the answers were very alike.

In Portugal, secondary students are more like to rely on fairs, advertisements, school and university visits than entrant students, as far as choosing a university program is concerned. However, university entrants in an engineering program claim that former students' opinions and the institution's reputation were important for their decision to take up a course.

Conclusions on Recruitment

In order to increase the interest, improve the knowledge and attract young people into STEM studies, this section identifies and discusses good practises to promote STEM studies.

Stakeholders' Recommendations

The usefulness of including stakeholders and program participants in the decision making process has been undeniable[42]. For that reason, secondary teachers, students' ambassadors, students associations, industry professionals and engineering professional associations were invited to take part in some WP meetings.

As a result, the following actions to attract not only students, but also the most highly-motivated and well-qualified applicants to STEM studies have been suggested:

- To develop resources to support key influencers: guidance counsellors, maths and physics teachers;
- To analyse on-going/successful initiatives to attract secondary students to STEM studies;
- To identify best practices in recruiting/training teachers;
- To recognize the importance of peers as influencers;
- To explore the use of engineer role models;
- To explore the value of engineering as an "education" rather than a "career".

The meetings also discussed ways of involving external stakeholders in this project, in particular:

- National workshops organised for engineering students;
- National professional institutions and schools/institutions.

[42] Berger-Bartlett, H., Craig, T. (2002). *The Challenges of Stakeholder Participation: examples of evaluation projects from the Youth Justice context*. Australasian Evaluation Society International Conference. Wollongong, Australia.

Likewise, stakeholders were asked to suggest future projects or collaborations. The result of this was the creation of:

- A database of case studies of successful outreach activities and promotional materials, especially longitudinal studies;
- Tools for evaluating long-term successful activities;
- An identification and effective use of engineering role models;
- Collaboration between professional institutions and engineering schools to develop engineering materials/programs for use in schools.

In light of the foregoing concerns, it is important to understand that when attracting students to engineering studies, the desirable goal is to attract not only students, but the most highly-motivated and well-qualified applicants. Therefore, the following actions are proposed:

To promote STEM courses among the youth

It is the policy of many engineering universities to organise visits to high schools and open days/visits to secondary schools. The two main cohorts targeted for these visits are final-year students (17/18 year olds) and those in the 'transition year' – an intermediate year between the two main cycles (15/16 year olds).

These events can be arranged either by the secondary schools at issue or by the universities. In the latter case, the schools selected are those that have a pre-existing relationship with a university, or have been targeted by the university at issue – typically this would be the case in which the school has consistently provided a large number of university entrants, or conversely where there is a disproportionately low number of attendants.

The main benefit from maintaining such a program is that it creates high quality personal links with key influencers and decision makers in the schools – the teachers (career guidance, science & mathematics, and head teachers/school managers). This level of contact provides information and builds confidence and trust with these individuals who are then happy to recommend the programs to suitable students. A lesser, but more obvious, benefit is the contact with a large number of students and the chance to positively influence them towards engineering.

As pointed out in WP5, it could be important to clarify that being an engineer does pay off, economically, socially and culturally.

To support teachers training and development in S&T

According to the Swedish Cabinet Office[43] and the European Commission[44], the school system lacks the ability to harness the fundamental interest that most children and young people have and does not develop the sufficient level of youngsters' skills. Moreover, mathematics, natural sciences, and, in particular, technology, are extremely undersized in teacher education, despite the schools' substantial needs.

To overcome these problems, it is extremely important to invest in teachers at all levels, in terms of training, educational assistance, e.g. by providing equipment, field trips, study visits and with our own researchers and teachers at the university as role models, and business representatives and entrepreneurs that show how knowledge can be used.

The importance of dedicated and knowledgeable teachers, who convey their subjects in an exhilarating and energizing way, cannot be overestimated, since most of the times they also act as role models. Therefore, teachers are also important as negative role models if they convey a cautious or even negative attitude towards STEM studies.

Alternative teaching methods, designed for children and youngsters throughout the school system should be used, based on their creativity and their own questions and issues. Various tools sharpen different aspects of creativity, and a variety of approaches should be used to optimize outcomes. A proportion of the youth population has the scientific attitude that leads to a continued career in science/technology. However, a larger percentage has the ability, but not the interest, to continue their studies in STEM. Therefore, to reach these young people and to suggest them that studies in technology and/or science might be interesting alternatives, efforts towards this goal are particularly important.

The conclusion is to educate and encourage school teachers to use activating and alternative teaching methods, and sometimes dare to leave the bookish knowledge in order to stimulate children's creativity. Perhaps it would be great to try to combine art and science, working with science centres, universities that provide facilities.

To enhance women's participation and role

Although engineers are considered to have very good labour market prospects, female students in tertiary engineering education still have a low participation[45]. Various socio-economic, cultural and political obstacles continue in many places across the world to impede their full access and effective integration. For instance, interdisciplinary programs with greater focus on Biology and Chemistry tend to attract more female students, while male students tend to be more attracted towards physics and the traditional engineering disciplines. Therefore, to overcome these obstacles and to attract more female students to engineering and computing areas further efforts are required to eradicate the gender stereotyping in tertiary education.

To promote engineers role models

Through role models, such as enthusiastic and skilled teachers, as mentioned above, or doctoral students or even company representatives could play a part in influencing young people to choose a career in a STEM area.

To increase general public awareness about S&T importance

Science and technology has become a critical part of everyday life. Therefore, to increase public interest, awareness and understanding in S&T, particularly among young people could be a way to promote increased interest in science among young people.

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[43] Swedish Cabinet Office (2010). Turning Point Sweden: an increased interest in mathematics, science, technology and ICT.

[44] European Commission (2007). Science Education Now: A Renewed Pedagogy for the Future Europe.

[45] Teaching and Research in Engineering in Europe (TREE) (2007). *Female Participation in engineering studies.* Special Interest Group (SIG).

Concluding Remarks

The recruitment and access to tertiary education is similar between ATTRACT partners, even though some aspects vary from country to country.

In general, there are a restricted number of places (*numerus clasus*) for students who are applying for an engineering program, except for Belgium and Italy.

Typically, most of the students who apply for an engineering program come from secondary school and must pass an exam. However there are some alternative procedures to undertake an engineering course.

It is important to notice that the calendar of access activities differs from country to country. Programs and dissemination activities typically start at the end of previous year and last until the final exams season. Besides Portugal, these activities begin in October in most of the partner countries. Therefore and as expected, the field trials development period had to be adapted to each country.

Globally, each country develops a wide range of national activities aiming not only to raise the public awareness in S&T/E, but also to contribute to garner students' interest in taking up studies in this area. Similarly, tertiary education institutions also have a widespread variety of actions to recruit students to S&T/E programs.

It is important to notice that several institutions carry out several actions aimed at balancing the gender representation in S&T/E programs, particularly designed for girls.

Based on the results, the overall picture of engineering significantly differs from country to country.

In general, the opinion of female students tends to be in accordance with male students' views in secondary school. However, the former tend to be less likely to undertake an engineering program, especially in Finland.

Moreover, female secondary students are more pessimistic about the contribution of engineers to the country's development.

It should also be noticed that, in Finland, female secondary students seem to consider that engineers' duties do not involve a high level of difficult as compared to boys. In addition, they seem to be more pessimistic about engineers' pay level. On the other hand, in Ireland, girls are less likely to believe that engineers have easy access to the labour market.

Once again, in general, the opinion of female university entrants is very similar to the male students' views. Finnish girls who had undertaken an engineering program are however much more likely than boys to have engineers as parents. Irish girls have a different perception of the effort required to undertake an engineer course, as they seem to believe that it is easier, contrary to the male students' perceptions.

It is important to notice that the perceptions of engineering considerably differ between secondary students and university entrants.

The percentage of university entrants who enter an engineering program, having chosen it after 10th grade is much higher than the percentage of secondary students who wish to undertake an engineering program, having decided it after 10th grade. This might suggest that a great many students who take up an engineering program are usually not entirely sure that they want it and postpone their decision.

Therefore, in light of the results, the following actions were proposed:

- To promote STEM courses among the youth;
- To support teachers training and development in S&T;
- To enhance the women's participation and role;
- To promote engineers as role models;
- To increase general public awareness about the importance of S&T.

Formal Barriers

Working Package 6

In-depth Exploration of Barriers

Structures within the school system

The way in which the secondary education system is structured in many European countries can, to varying degrees, impact on the choices open to students upon completion of this stage. This is particularly evident in countries where a clear division exists between academic/general and vocational pathways through secondary education. In many cases, pupils are forced to choose at an early age which pathway to follow, and the choice they make can effectively commit them to a narrowed range of fields later on, i.e. those choosing a vocational specialisation may not be eligible for academic study at third level, or even within the academic pathway those specialising in humanities, for example, may find it harder to access scientific programs at third level. The potential for this early decision to have a limiting effect can be considerable, particularly given the fact that many students will have to choose their area of focus before they have a clear idea of what career path they wish to follow or what the requirements for future study may be.

A recent survey of attitudes among upper secondary students in Finland highlighted the challenges posed by such a system. 35% of those surveyed stated that they did not have enough information to make the decision about their area of specialisation when starting upper secondary school. Worryingly, only 41% reported being aware of the consequences of their choices.

In relation to engineering, therefore, this is significant since it means that students who do not choose to focus on scientific/technological subjects early on may be ineligible to study engineering at third level, or at least may find it more difficult to gain entry.

Figure 1, below, shows the proportion of secondary school students following an academic curriculum at upper-secondary level, compared with vocational or other curricula. This picture is further complicated by the practice of specialising further within each of the categories displayed on the above graph. To examine the Swedish case, while almost half of upper-secondary students enrol in an academic specialisation, in 2009 only 16% enrolled in programs that offer the courses necessary to meet all of the entry requirements for university engineering programs. The choice of which specialisation to follow is typically made at the age of 15.[46] On the other hand in Finland legislations states that all students are eligible to apply for all types of further education, regardless of the branch of upper-secondary education attended (e.g. academic or vocational). This means that a student with a vocational qualification can still apply to go directly to university.

Gender and subject specialisation at second level

While there are regional variations among the countries compared here, they each report a significant gender dimension to the subjects studied by students at secondary school. In Finland, Ireland and Sweden, girls are significantly less likely than boys to study Physics, which is a relevant subject for engineering and even a requirement for entry to some programs (see Table 1, below, for countries where Physics is a requirement).

[46] ANaR (2010). Annual National Review (ANaR) on the Validation of Non-Formal and Informal Learning (VNF-IFL) on the national context: Sweden. Online at: http://www.observal.org/documents/sweden-annual-national-report-2009-2010. Accessed 27th June 2012.

Figure 28: % of upper secondary-level students by type of school/curriculum

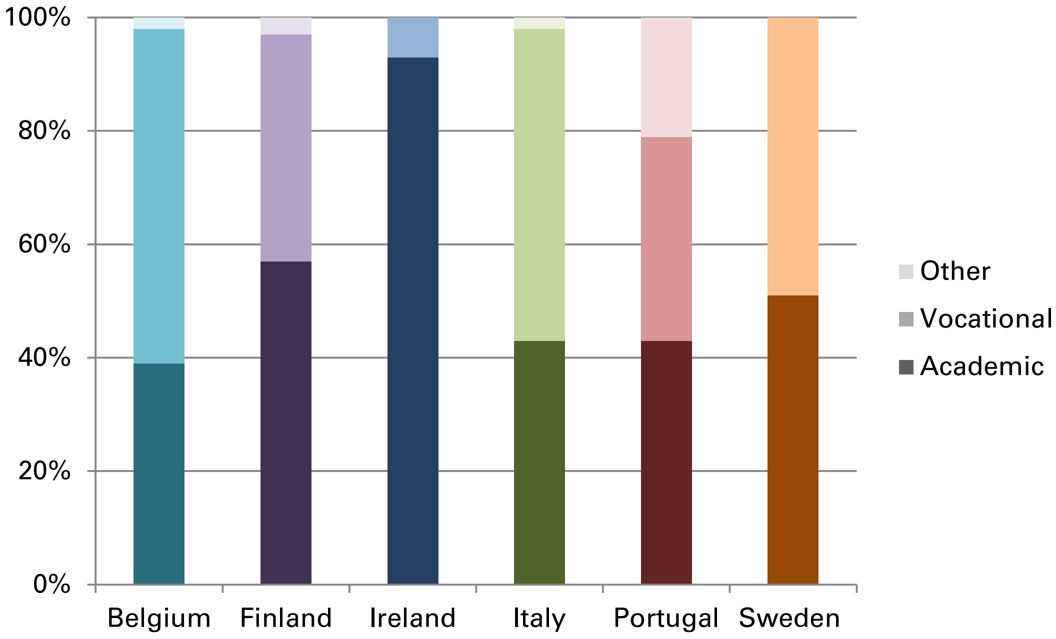
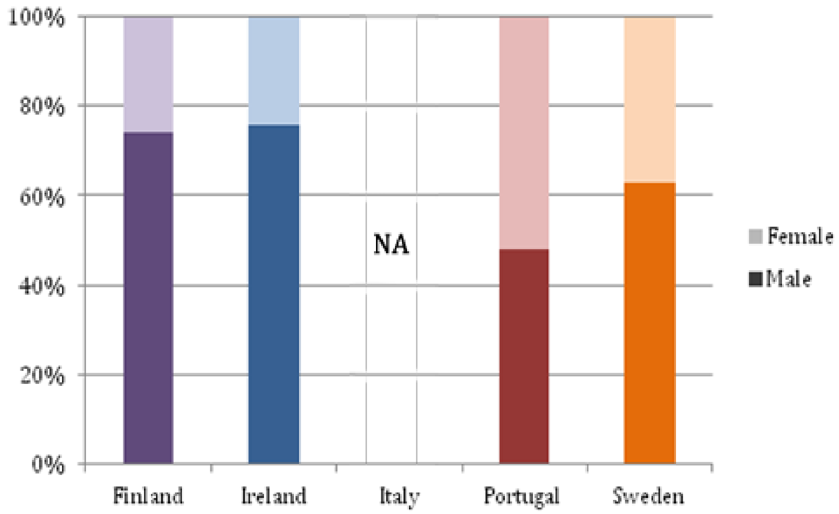


Figure 29: Gender breakdown in Physics at second-level



Note: The figure shown for Portugal refers to the combined subject of Physics & Chemistry which is quite popular with girls. This may explain the much more even gender breakdown when compared to the other countries shown.

In Ireland, where single-sex schools are still attended by the approximately 38% of pupils[47], even the availability to students of certain subjects can be affected by gender. Engineering is taught as a Leaving Certificate subject in one in five all-boys schools, but not in any all-girls schools.[48] Even in the case of mixed schools, where the subject is offered to both boys and girls, take up by girls is significantly lower. A recent report on gender in Irish education noted that:

From early second level onwards, pupils conform closely to the traditional gender stereotypes in terms of the subjects they study. Boys far outnumber girls in the take-up of "practical subjects," such as engineering, technical drawing, and construction studies and girls far outnumber boys in home economics, music, art and European languages.

The report goes on to stress the implications of this for third-level study also, adding that:

In general, there are notable similarities between the subject take-up patterns in early second level education and the subject take-up by gender in further and higher education… In any event, these trends in subject take-up patterns highlight the long-term reverberations of subject take-up at the beginning of second-level education.

Again, this points to a substantial group of the student population who, through structures within the school system, become much less likely, if not ineligible, to go on to study engineering at university. Certainly, evidence in Finland suggests that the relatively small percentage of female students entering engineering education (approx. 25%) is at least partially due to the fact that fewer women specialise in mathematics, physics and chemistry at secondary level.

Of those women who do choose engineering at university, there is a considerable tendency for them to be concentrated in biological and chemical strands of engineering, while they generally remain significantly under-represented in physical, civil, computer and mechanical engineering programs. This reflects the trend for girls to predominate among those studying Biology at secondary and upper-secondary level, while as is shown above, in many countries they are a minority in Physics. Figures 3 to 7, below, depict the variation in gender breakdown across different fields of engineering.

[47] O'Connor, M. (2007) Se Si: Gender in Irish Education Dublin: Department of Education and Science.

[48] Central Statistics Office Education Database, 2010 Figures. Dublin: CSO.

Figure 30: Gender Breakdown – Bio/Biomedical Engineering

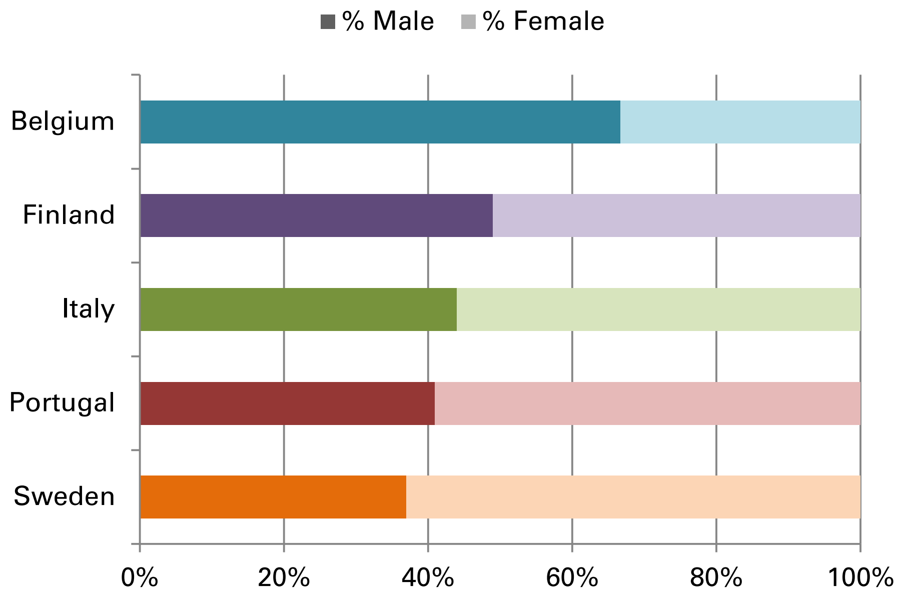


Figure 31: Gender Breakdown – Chemical Engineering

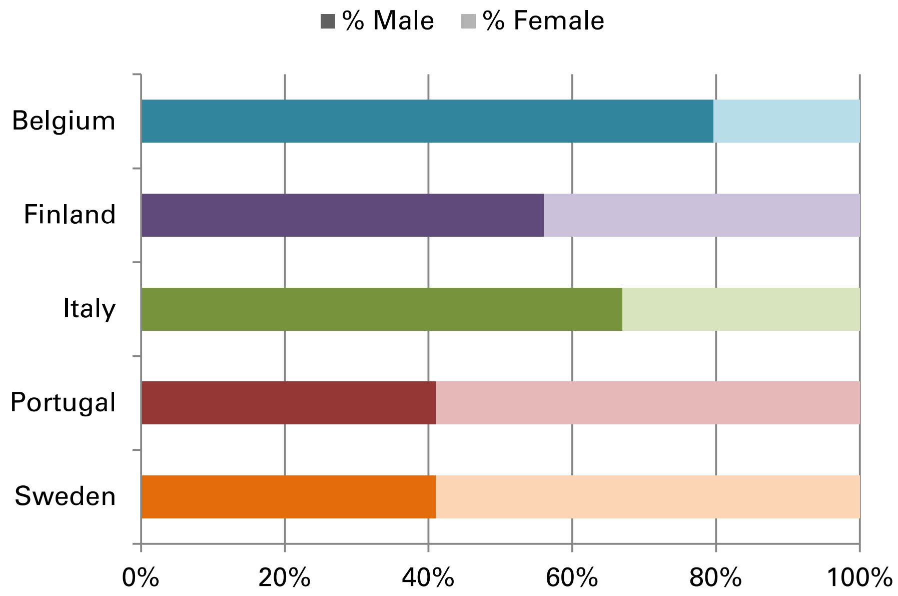


Figure 32: Gender Breakdown – Civil Engineering

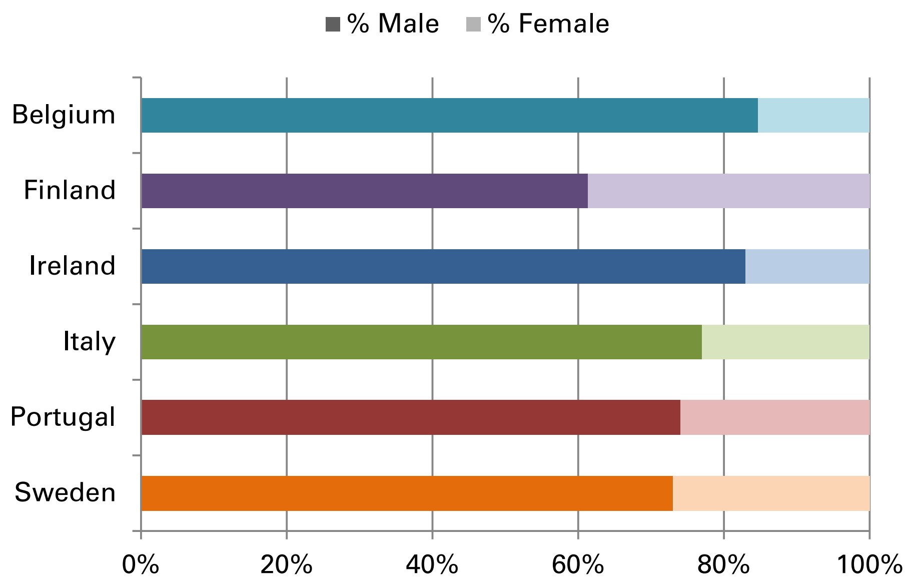


Figure 33: Gender Breakdown – Electrical/Electronics/Communications Engineering

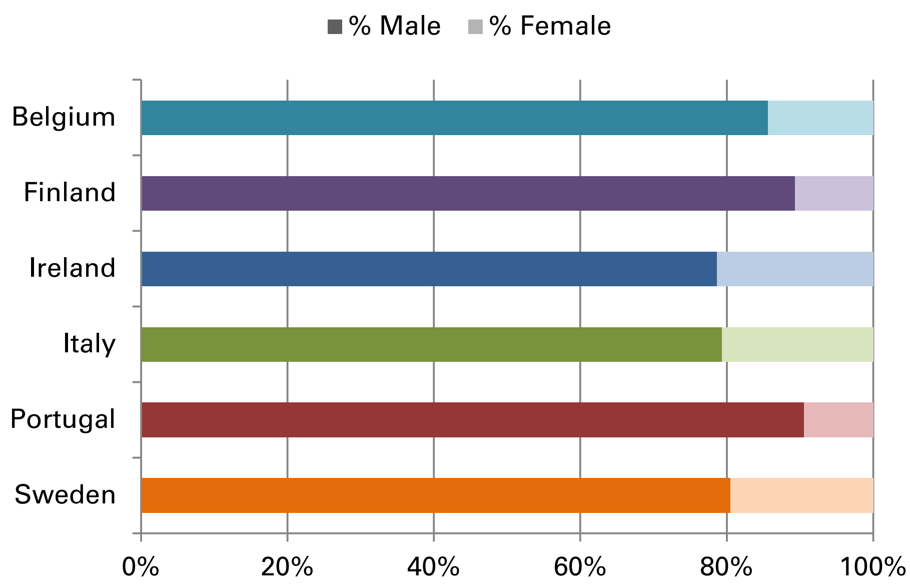
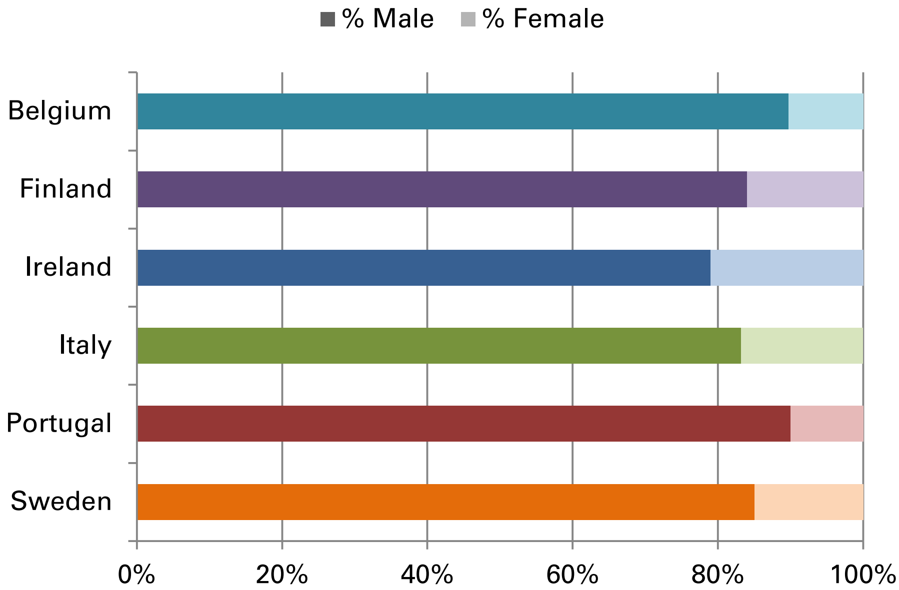


Figure 34: Gender Breakdown - Mechanical/Industrial/Production Engineering



Note: In the above graphs (Figures 3 – 7), figures for Portugal and Sweden refer to national data for those countries. In all other cases figures given are for the ATTRACT partner universities only.

Entry requirements for engineering

Perhaps the most obvious barrier in the path of anyone wishing to study engineering at university is the entry requirements for access to these programs. While these vary from institution to institution, and from country to country, there are certain consistencies across the majority of countries examined here.

Table 1, below, provides an overview of the current entry requirements in each of the ATTRACT countries. With the exception of Italy and Belgium, we see that achievement in mathematics is a requirement in all countries, and that in many cases a certain level of attainment in physics and/or chemistry is also required.

While many of these requirements are similar across countries, the impact they have can nonetheless vary widely, and it is this factor that is of particular concern when considering the ease of access for students wishing to study engineering. For example, in Portugal 38% of school-leaving students meet the eligibility requirements for most engineering courses, while in Sweden and Ireland this figure is only 11% and 12%, respectively. This means that for Swedish and Irish universities wishing to attract more engineering students, there is already an extremely limited pool from which they may draw.

The very low proportion of eligible students under the Irish system can be attributed largely to the low numbers of students choosing to study Advanced Mathematics, which is required for entry. Only 16% of Irish students take this subject in the Leaving Certificate exam, with the remainder opting for Basic Mathematics. Student choice therefore has a significant effect on eligibility, in this case manifesting as a practice of self-exclusion. Students perceive the Advanced Mathematics course to be both more difficult and more time consuming than other subjects, and so choose not to take it. It stands to reason that there may be many potential applicants who are interested in becoming engineers who are rendered ineligible through not meeting the criteria in mathematics or physics, for example.

Table 10: University admissions requirements

		Belgium	Finland	Ireland	Italy	Portugal	Sweden
General admission requirements	School certificate exams	Yes	Yes	Yes	Yes	Yes	No
		and/or	and/or	-	-	and/or	-
	On-going performance at second-level	Yes	Yes	No	No	Yes	Yes
		-	and/or	-	-	and/or	-
	Entrance exams (Managed by institution)	No	Yes	No	No	No	No
		-	-	-	-	and/or	and
	Other	n/a	n/a	n/a	n/a	Yes†	Yes‡
Additional admission requirements for Engineering courses	Maths	No	Yes*	Yes – 55% +	No	Yes¥	Yes
	Physics	No	Yes*	Approx. 10% of courses require one additional science subject	No	Yes¥	Yes
	Chemistry	No	Yes*		No	Yes¥	Yes
	Biology	No	No		No	No	Required in certain courses
% of students who meet STEM requirements		n/a	Advanced mathematics: 42% Physics/ Chemistry: 17%	12%	n/a	38%	11%

Table notes:

* These requirements refer to entrance exams which must be taken in these subjects
¥ These exams require the student to score a minimum of 50% for admission
† Additional pre-requisites may be required by certain courses, as decided by the institution
‡ Language requirement: proficiency in both Swedish and English

An important consideration in this discussion therefore is what we may call the effectiveness or purpose served by these entry barriers. We can define this effectiveness in terms of how well these barriers serve to provide an intake of students that is both qualified and committed, while not being overly restrictive or exclusive

This can be demonstrated by examining the case of IST. In order to gain a place to study engineering at IST, a student must have achieved certain grades in maths and in physics or chemistry. The grades required by IST have consistently been higher than those demanded by similar institutions in Portugal, and therefore may appear quite restrictive by comparison. However, research conducted at IST has demonstrated that students who have grades lower than those now required have significant difficulty in successfully completing the program.

This is particularly relevant in the case of the most common entry requirement shared by the ATTRACT countries, that of mathematics. In the countries where there is greatest flexibility in terms of entry to university, such as Finland, it is possible for some students to enter without the requisite qualifications in mathematics. However, evidence from Ireland demonstrates a strong correlation between achievement in mathematics and students' likelihood of passing first year exams at university, suggesting that admitting students who don't meet the stated criteria in mathematics may contribute to higher failure rates among that group (see Section 3, below).

International literature supports this connection between prior educational attainment and successful progression at higher education. Discussing the Spanish situation, Lassibille and Gomez have argued that reducing entry standards in order to increase the supply of entrants would have adverse effects. They instead make the counter-argument that tighter selection at the point of entry to higher education may be required.[49]

The Italian system provides a useful insight into an alternative structure. Under this system, no subject-specific entry requirements are imposed for most programs, and any student with a high school diploma will be admitted. The first year itself then operates as a kind of selection process, and only a much smaller number of students will be admitted to the second year to pursue their degrees. As a result, there is no way for universities to select the most competent and motivated students prior to entry, and consequently attrition rates in the first year are high.

Despite this, Politecnico di Torino (PoliTo) has established internal mechanisms for evaluating new entrant students which have proven to be highly effective predictors of student achievement. All new incoming students must sit an aptitude test in the core subjects of mathematics, logic and comprehension. The test is for information purposes only and has no influence on admission, but the results show a clear link between scores attained and credits gained during the first year at university. Students who score highly on the test gain a significantly higher number of credits during their first year, while those with low test scores obtain very few credits [see Section 3, below].

In addition to subject and grade requirements, evidence from Finland suggests that the mechanism of entry can also be significant. The progress of students at Aalto University has been followed since 2005, and the results of this study demonstrate that a student's entry route has an impact on his/her progression. The admissions system in Finland is such that a student may enter university based on the results of their terminal high school (or matriculation) examinations, or by taking university entrance examinations, or by using a combination of their results from both of these options.

The research at Aalto shows that students entering on the basis of their matriculation exam results alone gain on average the most credits in the first three years of study, whereas students who enter based on entrance examination results alone gain the least credits. However, there are differences between degree programs.

These findings can be attributed, at least in part, to the fact that students admitted via their high school certificate exams have already achieved high grades in mathematics and sciences in high school. This is particularly significant since in many degree programs the first year is comprised mainly of mathematics and physics, so prior achievement in these areas is an advantage. However, the above results do not take into account factors such as a student's background, motivation, financial circumstances, or quality of learning, all of which can impact on progression.

[49] Lassibille, G. and Gomez, L. N. (2008). "Why do higher education students drop out? Evidence from Spain" in Education Economics, Vol. 16, No. 1, March 2008, 89–105.

Table 11: Student entry route and progress of studies in the schools of technology at Aalto University in 2005–2010 -Source: Pakarinen, 2010

	Average Credits in Year 1 (ECTS)	Average Credits in Year 2 (ECTS)	Average Credits in Year 3 (ECTS)
Admission based on matriculation exams	50.0	57.7	53.0
Admission based on combined results of matriculation exams and entrance exams	43.7	48.0	46.8
Admission based on entrance examination results	35.4	42.1	41.1

According to a recent Finnish study conducted in the University of Oulu[50] interesting results regarding the study paths of engineering students have been observed as follows:

- Good performance during the first year at university correlates with good performance at later stages and vice versa
- The best predictors of good performance in university are (1) belief in one's own capabilities and (2) performance motivation (Robbins, et al. 2004)
- Prior performance in upper secondary school does not correlate with performance in university.

Indeed Honkanen found that "students with satisfactory learning results in upper secondary school did better than expected in their university studies, whereas students with better success in upper secondary school underachieved in their university studies. Furthermore, students whose success was better than average during the first academic year were also better in the following years."

In order to truly consider broadening access to engineering programs it becomes essential to examine the prospect of expanding the current system of admission in order to accept students who don't meet some of the presently used criteria, such as grades in mathematics or physics, but who could, according to determined criteria, be reasonably expected to succeed in their studies and become 'good' engineers. Obviously such a practice would necessitate that any opening up of entry procedures be balanced by complementary measures to ensure academic standards are preserved. One possible solution that could ensure this balance would be to define a set level of achievement of competency in the relevant subjects, but allow this level to be attained either prior to entry, as is presently the case in most partner countries, or during the first year of university studies. Such a change would create the potential for a much broader range of applicants to be admitted, while still safeguarding any academic measures deemed to be essential to building a successful engineer.[51]

Inevitably there would be some impact on the resources required by universities to operate such a system, as its success would require an increased level of academic support to be provided to some students. However any selection procedures used to admit this new group of students could be structured around admitting a cohort with a high level of motivation and commitment to engineering, factors which are at present not measured. If successful, higher rates of student progression could be seen, the financial and other benefits of which are documented in the report of WP8 of this project.

Though undeniably a significant change from the practices currently operating in many of the partner countries, this is not without precedent elsewhere. Such a system is already in operation to a certain extent in Aalto University. There applicants who have studied only the basic (not advanced) level in mathematics, physics or chemistry may still be admitted and required to complete the secondary-level advanced modules in these subjects during the first year at university. However at present only 1 – 2% of applicants fall into this category.

[50] Honkanen, S. (2011) Modelling of study paths leading to graduation of engineering students – based on study success in secondary school and early phases of studies. University of Oulu, Faculty of Technology, Department of Process and Environmental Engineering. Acta Univ. Oul. C 376 (in Finnish). Available: http://herkules.oulu.fi/isbn9789514293320/isbn9789514293320.pdf

[51] Hyland (2011) suggests a similar practice, whereby the initial phase of university be devoted to building the generic skills and foundational knowledge required by students to succeed in the programme in which they are enrolled.

Alternative entry paths

For students who, for a variety of reasons, may not be eligible for entry into university engineering courses under the standard criteria, there are alternative routes through which they may gain access under certain circumstances. These alternative pathways can improve equity of access to higher education, and are frequently made use of by students from lower socio-economic status (SES) backgrounds.

One common such mechanism is the recognition of competencies and experience gained in the work force, which can allow adults a route back in to education if they did not go to university directly from school.

These alternative mechanisms can undercut the division of students into vocational and academic streams at second-level [see Section 2.1, above], a process which may in the past have presupposed that those in the vocational stream would not go on to higher education, and can instead mean that they are afforded a 'second chance' to do so. As has been discussed above, this philosophy underpins the Finnish education system, which is built around legislation which ensures that any student is eligible to apply for any type of further education, regardless of whether he/she attended academic or vocational upper-secondary education.

The next graph depicts the percentage of the student population that enters university through the main categories of alternative route. In the case of Italy, this figure is zero since the direct or traditional route to third level education is the only one in operation.[52] It should be noted that these figures refer to students entering further education as a whole, not just the university system, and include all fields, not just engineering. If the figures were limited to only those entering universities, and further still to those entering university engineering programs, it is likely that the proportions would be significantly lower.[53]

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[52] Orr, D.; Gwosc, C. & Netz, N. (2011) Social and Economic Conditions of Student Life in Europe. Synopsis of indicators. Final report. Eurostudent IV 2008–2011. Bielefeld: W. Bertelsmann Verlag.

[53] See Table 5, below, for an illustration of this tendency in the case of Trinity College.

Table 12: Alternative entry paths to tertiary level

		Belgium	Finland	Ireland	Italy	Portugal	Sweden
Alternative routes of entry to university	Prior experience/ Qualifications (Mature Student Entry)	Yes (for over 21s)	Yes	Yes (for over 23s)	n/a	Yes (for over 23s)	Yes
	Access or Foundation program	n/a	Yes	Yes	n/a	n/a	Yes
	Aptitude tests	n/a	n/a	n/a	n/a	n/a	Yes
	Other	n/a	n/a	n/a	None	Yes [ii]	n/a
% of students who enter engineering via alternative routes [iii]		n/a	~ 5%	8%	n/a	~7% over all universities	Prior experience: 7.5%. Science Foundation Year: 10% Aptitude test: 33.3%

The figure 8 depicts the percentage of the student population that enters university through the main categories of alternative route. In the case of Italy, this figure is zero since the direct or traditional route to third level education is the only one in operation.[54] It should be noted that these figures refer to students entering further education as a whole, not just the university system, and include all fields, not just engineering. If the figures were limited to only those entering universities, and further still to those entering university engineering programs, it is likely that the proportions would be significantly lower.[55]

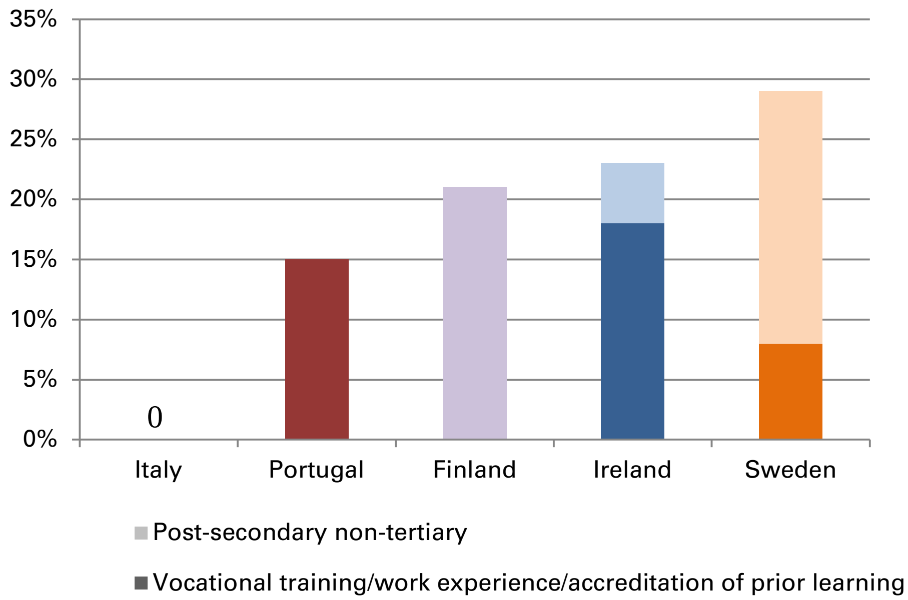
These figures are particularly important in the context of improving access to higher education for students from lower socio-economic backgrounds. The situation concerning equity of access is discussed in more detail in Section 1.3, below, but should also be highlighted in relation to this topic. Data from EUROSTUDENT IV demonstrates that in almost all countries where alternative routes operate, it is students from lower socio-economic background who benefit most from them. Specifically, the report points out that in "Finland, Ireland and Sweden more than one in 3 students from a low social background have utilised an alternative route to enter higher education, so these measures appear to be meeting their targets."

Ultimately, despite the range of practices in place for admitting students to higher education, meeting all of the entry requirements does not mean that a given student will obtain a place under most national higher education systems. Rather, the awarding of university places tends to operate on a supply and demand basis, with the most in-demand fields of study or universities being the most restrictive.

[54] Orr, D.; Gwosc, C. & Netz, N. (2011) Social and Economic Conditions of Student Life in Europe. Synopsis of indicators. Final report. Eurostudent IV 2008–2011. Bielefeld: W. Bertelsmann Verlag.

[55] See Table 5, below, for an illustration of this tendency in the case of Trinity College.

Figure 35: Students entering higher education through alternative routes, by type of route - Source: Orr, et al.



An initiative practiced in Sweden provides a good practice example for overcoming the problem posed by low numbers of students meeting the subject specific entry requirements set by engineering programs. As shown above, only 11% of Swedish high school students, and 12% of those in Ireland, meet the entry requirements in mathematics and/or physics and chemistry. To tackle this issue, many HEIs in Sweden offer a 'Science Foundation Year'. This year-long program consists of intensive study of science-related subjects and enables students to gain the required level in mathematics, physics, chemistry and/or biology. For students who did not choose to take the scientific branch of study in high school, this is a way of becoming eligible for engineering programs at university. Successful completion of the Science Foundation Year generally guarantees the student a place on an engineering degree program in the same university.

The number of students undertaking a Science foundation Year has remained reasonably consistent (approx. 3,500 per academic year), until the last two years when a significant increase can be seen. The number of such students rose to 4,200 in the 2008/9 academic year and 5,600 in 2009/10. (To put these numbers in perspective, during the fall semester of 2010, 369,000 people studied at Bachelor or Masters Level in Swedish HEIs.) Of these, most go on to enrol in degrees programs. Approximately two thirds of the Science Foundation Year students in 2008/09 had continued to academic studies in 2009/10. However, despite having thus qualified for entry into engineering and related programs, not all continuing students choose these fields, although a majority do. For the 2008/9 Science Foundation Year cohort, 68% of continuing male students entered academic programs in technology or natural sciences, while 53% of continuing female students did so. Overall the gender breakdown of those enrolling in the Science Foundation Year in 2009/10 was 59% male and 41% female. This figure represents an increase in the proportion of male students compared to previous years.[56]

Although the percentages are small when compared with the overall student population, this program nonetheless provides a mechanism for a significant number of students who would not otherwise be eligible to access engineering higher education programs.

[56] Swedish National Agency for Higher Education (2011). "Universitet & högskolor – Högskoleverkets årsrapport 2011" kapitel "Utbildning på grundnivå och avancerad nivå". Rapport 2011:8 R (in Swedish).

Table 13: Description of main alternative entry routes to third level

Post-secondary non-tertiary	**Adult or Further Education** This option is mostly made use of by early school leavers who can go back and complete their final secondary school qualifications, normally outside of the usual school setting.
Vocational training/work experience/accreditation of prior learning	**Mature Student Entry** This option exists in both Ireland and Portugal. Special provision is made for applicants to university-level education who are over 23 years of age. Their eligibility can be determined based on alternative criteria, including work experience, and they made receive additional financial assistance. **Vocational Training** In Ireland, the National Framework of Qualifications provides a system for equating vocational qualifications with other standard qualifications, which can allow a student coming from the vocational route to have their qualification recognised for entry into a non-vocational course. **Assessment of Prior Competencies** In Sweden, the Real Skills evaluation assesses the actual knowledge and competencies that an applicant has, independently of how these have been acquired, and accredits them.

Socio-economic factors

Section 1.1 explored how the structure of the school system can contribute to determining the direction a student takes when leaving secondary education. However, in addition to this, it has also been demonstrated that these structural elements often combine with societal factors to create further barriers for some students. The most recent EUROSTUDENT report asserts that, "[i]n many countries, evidence shows that secondary education systems have a tendency to reinforce social, cultural and economic differences between pupils, which might impair equal access to higher education."[54]

Additionally, engineering programs at university level in many countries appear to be rather less accessible than other programs to students from lower socio-economic backgrounds. EUROSTUDENT IV reports that "[i]n many countries Bachelor courses in humanities and arts appear more supportive of social mobility than in engineering, manufacturing and construction subjects."

This finding can be demonstrated by data from Sweden. Among the new entrant university population in Sweden who are under 35, 34% had parents with at least three years of post-secondary education, and 58% had parents with some kind of post-secondary education. By comparison, the same figures for the population as a whole in the 19 – 34 age group showed that 23% had parents with at least three years post-secondary education, and 42% had parents with some kind of post-secondary education. However, the tendency for new university students to have parents with a higher educational background is even more pronounced in the case of engineering. For students commencing Masters programs in Engineering in 2009/10, 54% had parents who had three or more years of post-secondary education. Perhaps most significantly, the level of overrepresentation of students with highly-educated parents has increased in engineering over the last ten years, whereas the overall figure for Sweden has remained roughly unchanged.[57]

The situation is even more pronounced in Italy, where the share of Bachelor students in engineering, manufacturing and technology is 25% lower for students from low social background than for students from high social background.[54]

Looking at the Irish situation, the proportion of students from the 'socio-economically disadvantaged' category entering Trinity College is significantly lower in the Faculty of Engineering, Maths and Science than it is for programs in the health sciences or arts and humanities. In fact, looking at new entrants according to key access criteria including socio-economic background, numbers of mature students, and students with disabilities, we see that the proportion of students under each of these headings is lower in the Faculty of Engineering, Maths and Science.

A possible explanation for this trend may be found in the data on PISA scores. In the Irish data, students with high socio-economic status (SES) scores significantly outperformed students with medium or low scores when it came to mathematics.

It stands to reason that this should subsequently impact on the numbers of students who go on to study subjects that require significant prior achievement in mathematics, such as engineering.

[57] Statistics Sweden. (2010) Higher Education. Level of parental education among university entrants 2009/10 and first time students at third circle studies 2008/09.

Table 14: Profile of undergraduate new entrants by key access criteria per faculty 2010/11

Category of Student	Arts, Humanities and Social Sciences	Engineering, Mathematics and Science	Health Sciences
Total CAO Entrants	951	735	639
Socio-economically disadvantaged	52	19	40
Mature students	68	20	93
Students with a disability	52	21	32
Totals	172	60	165
Total as a % of Faculty new entrants - CAO	18.1%	8.2%	25.8%

(TCD, 2010)[58]

Table 15: Mean combined mathematics scores of students in Ireland, by socioeconomic group

SES Level	Percentage of students	Mean mathematics score
High	31.1	535.7
Medium	33.6	506.1
Low	31.0	473.5
No response	4.3	452.0
All available cases	95.7	505.1

(Shiel, et al., 2007)[59]

[58] TCD (2010). Senior Lecturer's Report 2009/10. Online at: http://www.tcd.ie/vpcao/council/assets/pdf/SeniorLecturersAnnualReport0910.pdfAccessed 6th February 2012.
[59] Shiel, G., Perkins, R., Close, S. and Oldham, E. (2007) *PISA Mathematics: A Teacher's Guide*. Dublin: Department of Education and Science.

Analysis of impact of entry requirements

In order to be able to draw any conclusions about the validity of the formal barriers our national education systems impose, it is important first to be able to ascertain what attributes or factors make a student more or less likely to progress successfully under the current system. This provides a basis not only for drawing conclusions about the performance of the present system, but also for making any recommendations for alternatives structures or practices.

The aim is to use data analysis to identify the group of students most likely to progress successfully, and then to compare this group with that which is selected through the current university selection procedures. This provides a means of testing the effectiveness of the selection procedures employed by our universities.

Analysis is presented in this chapter for three of the project countries: Ireland, Portugal and Italy. The data was unavailable for the remaining partner countries and it was not within the scope of this project to conduct the same analysis for each one due to difficulties in accessing data and time constraints. As it stands, the information presented for both Ireland and Portugal attempts to analyse which factors related to student circumstances and prior educational attainment can be shown to influence progression. The data reported for Italy examines specifically the correlation between achievement in aptitude tests taken by new entrant students at the university, and the credits gained during the first year.

This chapter provides a summary of the main findings of this research. In Chapter 3, the detailed results of the study conducted in Trinity College are presented in full as a case study to demonstrate how this kind of research may be used to inform policy and practices around the admission of students.

Ireland: Data analysis for Trinity College Dublin

A study was carried out as part of the work of WP6 to test what correlation could be found, if any, between achievement in the subjects commonly set as barriers for entry to engineering programs, along with other factors for comparison purposes, and subsequent success in first year engineering at Trinity College. This was measured by modelling the probability of a student successfully completing the first year end-of-year examinations, with the examined factors as input variables.

The subject of the study is 1,835 engineering students at Trinity College Dublin over ten years (2000 – 2009 inclusive). Data was also obtained for students entering other programs in the university during the same period, giving a total sample size of approximately 21,000. However, only the analysis of the engineering student data is presented here, unless otherwise specified.

Key points

- Prior achievement in Higher-Level Mathematics is the single most significant positive factor when it comes to predicting performance in the first-year university exams.
- Having taken Higher-Level Mathematics for Leaving Certificate substantially increases a student's likelihood of passing the first year university exams, and the higher the grade achieved the greater this increased likelihood is.
- Physics and Chemistry are also shown to be significant, provided achievement in these subjects is above a certain level (65% and 55% respectively). This is perhaps unsurprising as these subjects are highly relevant to engineering.
- Accounting and Economics can confer an increased likelihood of passing, but only for students who score very highly in these subjects (>85%).
- The models used demonstrated increased accuracy in terms of identifying students most likely to succeed at university level when compared with the current selection mechanism used, that of CAO points only[60].
- Male and female engineering students are as likely as each other to pass or fail. This contrasts sharply with the findings for the university-wide cohort, where female students were found to be significantly more likely than males to pass their exams. Overall, the cohort is 62% female compared to only 21% in engineering.
- Regarding the subjects which were found to correlate with successful progression through the engineering program, the majority can be said to be more difficult than average (according to the levels of achievement recorded in these subjects compared to others).
- A further notable observation relating to the previous point is that uptake of these subjects at high-school level is significantly higher among male students than female students, and that Leaving Certificate exam scores attained in them are higher among male students (with the exception of Accounting where no gender difference is observed). This finding is contrary to more general trends which have shown female students achieving more highly overall than males at Leaving Certificate over the past number of years.

[60] CAO points refers to the combined score a student receives from results in their best six subjects in the Leaving Certificate, the end of high school State examination in Ireland.

Portugal: Data analysis for Instituto Superior Técnico (IST)

Several studies have been conducted in IST regarding the relationship between student success in engineering programs and their academic background.

In the most recently developed study, the results of which are consistent with previous results, a six dimensional axis of analysis about the students was used: academic background, socioeconomic status and family income, motivations/expectations, and contextual factors.

Key points

- The variables of parental education level and stage of admission were not significant.

- The variables regarding the academic background all proved significant, in particular the impact of the results obtained in secondary education on subsequent academic achievement (40% performance improvement for every 10 points) and the fact of having studied Physics in secondary school (72% increase in the probability of success, compared to those who had not taken the subject).

- Under the socio-economic status and family income heading, gender and household income level were significant. Female students were shown to have a higher probability of success than male students (+10%). Additionally, students whose level of household income was below the national average were found to demonstrate an increase of 8% in academic performance.

- Regarding the motivations and expectations, it was found that if a student has not achieved his/her first choice of program (-16%) and if he/she did not expect to engage in all subjects and attain a good average (-9%) there is a negative impact on academic achievement. Having made the course choice early (i.e. prior to the year of admission) had a positive impact on the success rate (+22%).

- Contextually it was observed that the fact that a student is away from his/her usual residence exerts a negative effect on their academic performance (there is a 17% decrease in academic performance demonstrated by students who are away from the family residence) and that lengthy travel time is also a negative factor (a student who takes more than 1h to travel to IST faces a 10% decrease 10% in academic performance).

Since the prediction models of academic achievement do not go beyond the explanatory power of 30%, it appears that there are some fixed effects which are not being considered in the model because they are not known *a priori* or because they are not measurable. There is also the possibility of other untested data correlation sources, like the type of program (which can vary according to workload, structure of the curriculum of the 1st year, the population size of the program, etc.).

Italy: Data analysis for Politecnico di Torino

Analysis undertaken at PoliTo has demonstrated a strong link between the results achieved by students in the aptitude tests and the number of credits gained during the first year at university. As has been discussed above, all new incoming students to PoliTo must sit entrance tests in each of the core subjects of mathematics, logic and comprehension. The tests are for information purposes only, and are not used to select students for admission. However, they have proven to be highly effective when it comes to predicting student achievement during the first year. Students who score highly on the test gain a significantly higher number of credits during their first year, while those with low test scores obtain very few credits. The following two graphs illustrate the scope of this correlation for students during the academic year 2010/11.

Figure 36: Credits obtained during first year by students with the lowest aptitude test scores

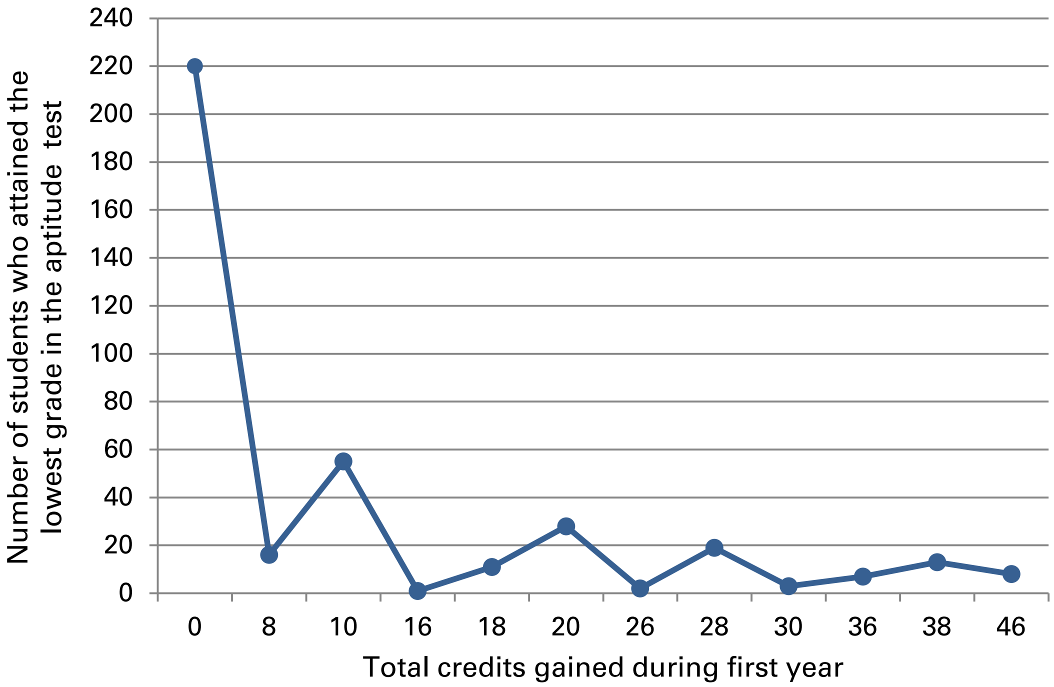
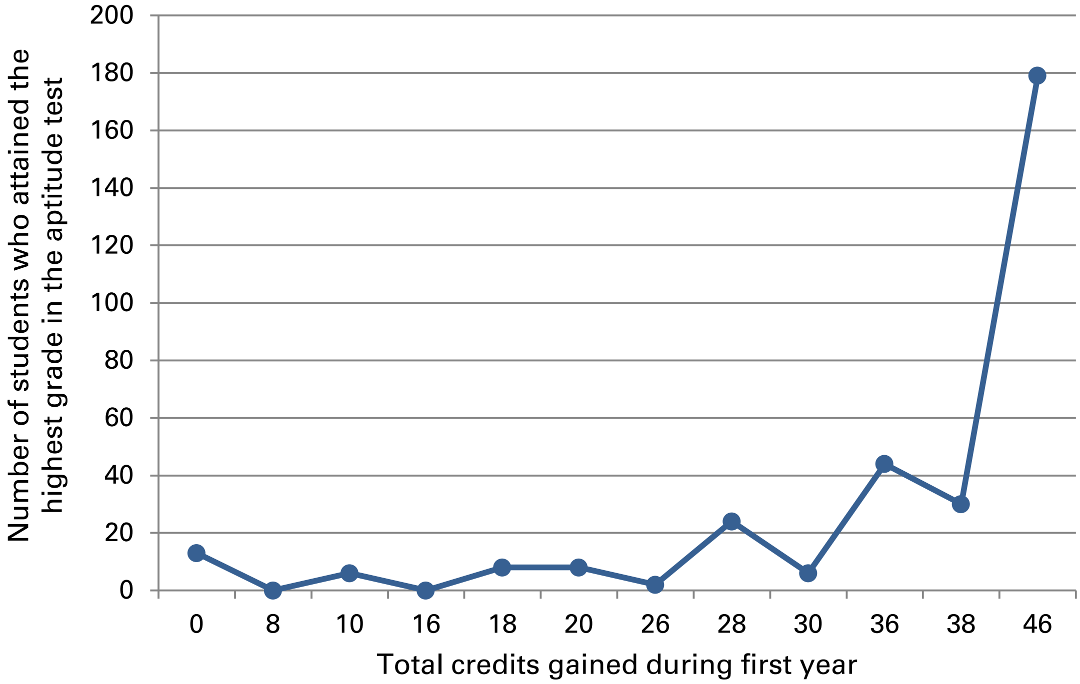


Figure 37: Credits obtained during first year by students with the highest aptitude test scores



Figures 9 and 10 indicate a direct correlation between scores in the entrance tests and credits gained during the first year. The vast majority of students with the highest scores gain the maximum number of credits, while a similarly large majority of those with the lowest score achieve no credits at all.

Analysis of student data at Trinity College: A case study

Previous research in Ireland has repeatedly linked high school performance in the areas of both English and Mathematics to an increased likelihood of successful progression at higher education (Mathews and Mulkeen, 2002; HEA, 2010). Mathematics in particular has been shown to be significant, and this impact can be seen across all subject disciplines, not just those that rely directly on mathematical competency. Prior analyses, however, have not examined the interaction between multiple contributing factors.

Under the auspices of WP6 a multivariate analysis was carried out to test several of the factors commonly set as barriers for entry to engineering courses, along with other factors for comparison purposes, and to assess whether or not these can be deemed to be effective as indicators of student performance. Since the purpose of such barriers should be to select a student population that is qualified and likely to successfully complete their degree, this analysis set out to provide some insight into the degree to which they are successful in this regard. This was measured by modelling the probability of students successfully completing the first year summer examinations, with the examined factors as input variables.

The subject of the study is 1,835 engineering students at Trinity College Dublin over ten years (2000 – 2009). Data was also obtained for students entering other programs at the university during the same period giving a total sample size of approximately 21,000. However, only the analysis of the engineering student data is presented here unless otherwise specified. The factors analysed are as follows:

Inputs

- Fact of having taken a given subject in high school or not (binary)
- Mark achieved in each subject (range: 0 – 100)
- Degree program chosen (binary; 1 of 2 programs available)
- Gender (binary)
- Year (1 – 10; to monitor changes, if any, over ten year period)
- CAO points[61] (0 – 600)
- Residential status; whether student lives in family home or not (binary)

Outputs

- Student had to take supplemental exam session (binary)
- Student progressed to second year of program

The key questions that the analysis aimed to answer were whether, using this model, it is possible to identify those entrants who are less likely to progress, and, if so, how accurately. To put it another way, what is the balance between correctly identifying those who will have difficulties and mistakenly selecting others who would in fact not go on to experience difficulties.

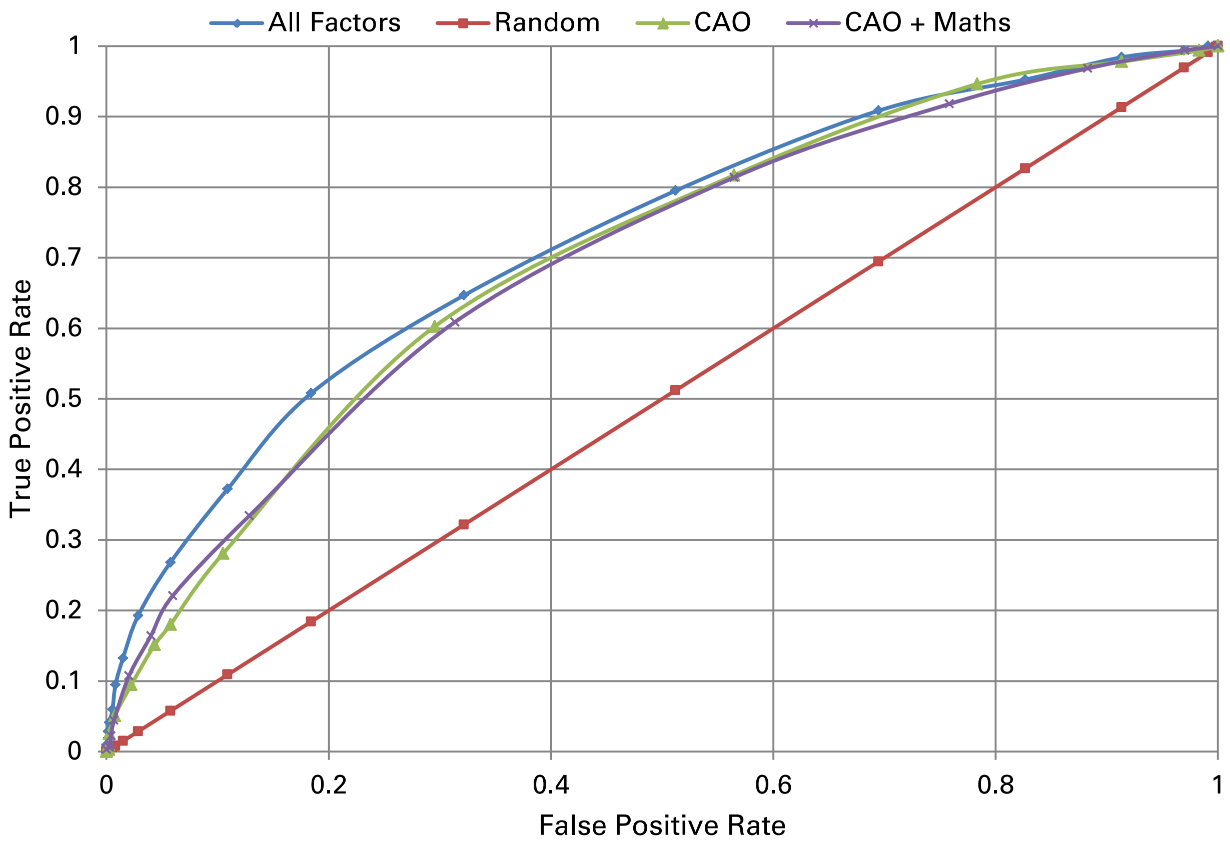
The below graph (Fig. 11) illustrates this balance. The graph displays the false-alarm rate (i.e. the number of those who passed but had been incorrectly predicted not to do so, as a proportion of the total number of failures) versus the true positive rate (i.e. the percentage of students predicted to fail as a proportion of the total number of actual failures).

Three models are compared. The green line depicts the result given when taking CAO score alone into account. The purple line refers to CAO score taken in combination with the grade attained in the Mathematics exam. The blue line illustrates the results achieved through use of the full model set out above. For comparison the ‘no discrimination’ line equivalent to random guessing is also shown in red.

A perfectly discriminating system would be a vertical line at the origin. A system that performs worse than random guessing would be below the diagonal. Most systems will lie above the diagonal, and the performance may be ‘tuned’. A more sensitive system will by definition detect more, but will consequently also result in increased false alarms.

[61] CAO points refers to the combined score a student receives from results in their best six subjects in the Leaving Certificate, the end of high school State examination in Ireland.

Figure 38: Receiver Operating Characteristic - Progression

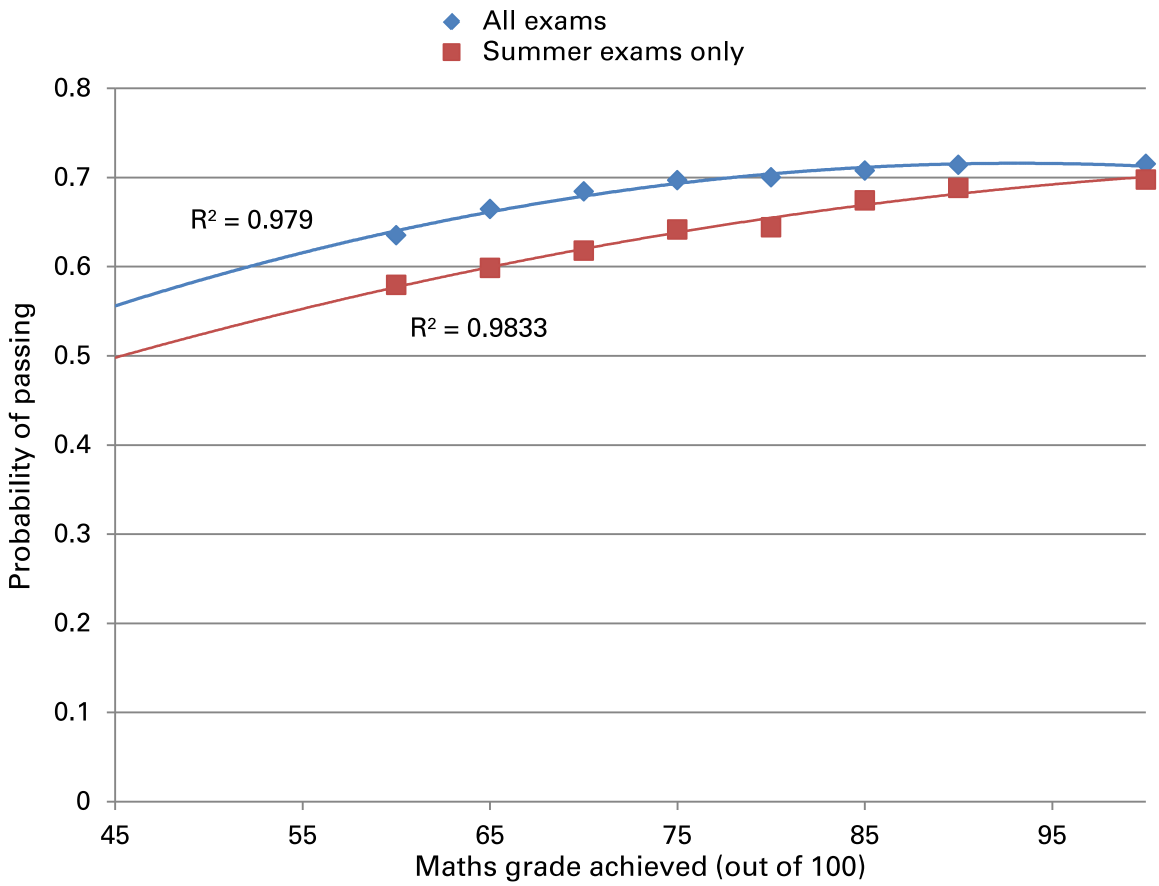


Relationship between mathematics grade and progression

The single greatest barrier to entry to engineering programs in Ireland is the mathematics requirement. For the vast majority of engineering programs in this country, a minimum grade of 55% or above in the Higher-level (or Advanced) Mathematics Leaving Certificate exam is required for admission. The effect this has on eligibility is extremely restrictive, as only 12% of students nationwide attain this grade (see Section 1.2 for discussion of this).

In order to ascertain whether or not this restriction was justified, an analysis was carried out into the progression probability for students according to their grades in Mathematics.

Figure 39: Relationship between Mathematics grade and Probability of passing first-year exams



The Irish system requires students to successfully complete all modules at the end of an academic year before progressing to the next stage of their degree. Students who fail to pass these examinations may take a 'supplemental' examination before the start of the new academic. Those passing this examination are allowed to proceed, while those failing it are required to repeat the entire year (all modules) – with a limit on the number of attempts allowed to repeat a year, after exceeding which students are forcibly excluded from the university (i.e. involuntary dropout).

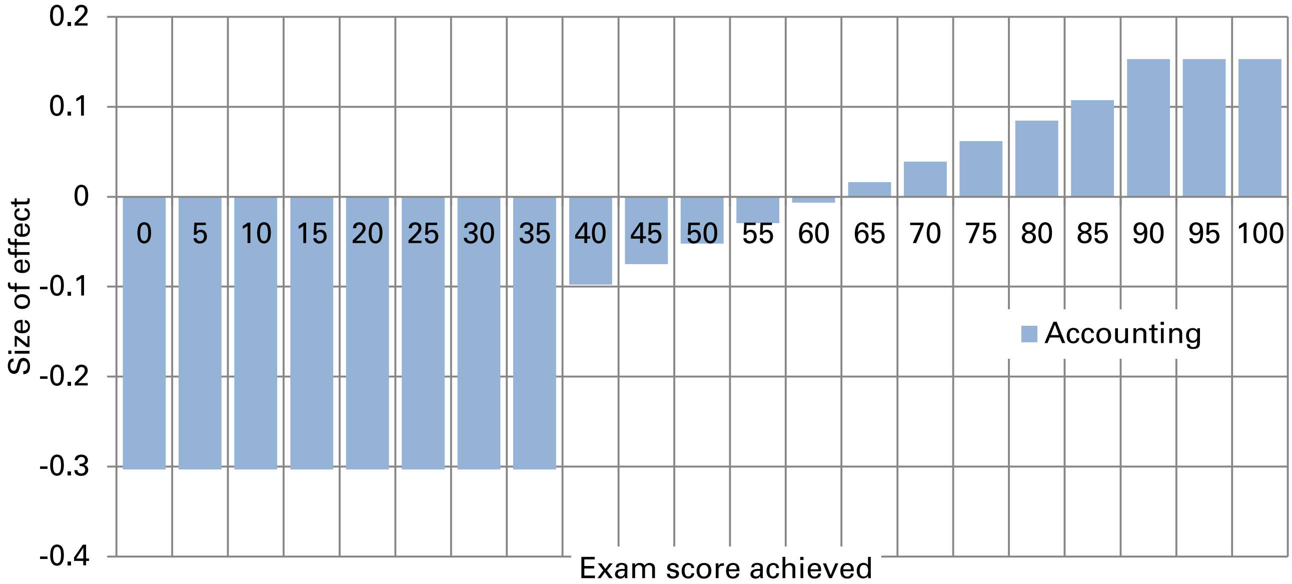
The red line on the above graph relates to the initial sitting of the end-of-year exams. Students passing this sitting progress to the next year, while any students who fail must then sit the supplemental exams before progressing. . Therefore the blue line depicts the combined results observed for both the initial and subsequent exam sittings.

Figure 12 demonstrates that the difference in probability of successfully completing the exams between a student who has achieved the required grade (55%) and one who scores slightly slower is relatively small. This suggests that if other support measures were put in place, students with lower (but still passing) grades in Mathematics could be admitted and could reasonably be expected to succeed.

Impact of specific subjects

In order to delve more deeply into the individual impact that particular subjects, and achievement in those, could have on progression, further analysis was conducted to determine which high school subjects were found to be statistically significant in terms of their impact on progression for students in engineering programs at the university. By examining these, it was possible to see not only what subjects were associated with a greater or lesser probability of passing the end-of-year exams, but more specifically what the impact was depending on the precise grade a student had previously achieved in that subject. Figure 13, below, demonstrates this for the subject of Accounting.

Figure 40: Variation of effect size according to exam score

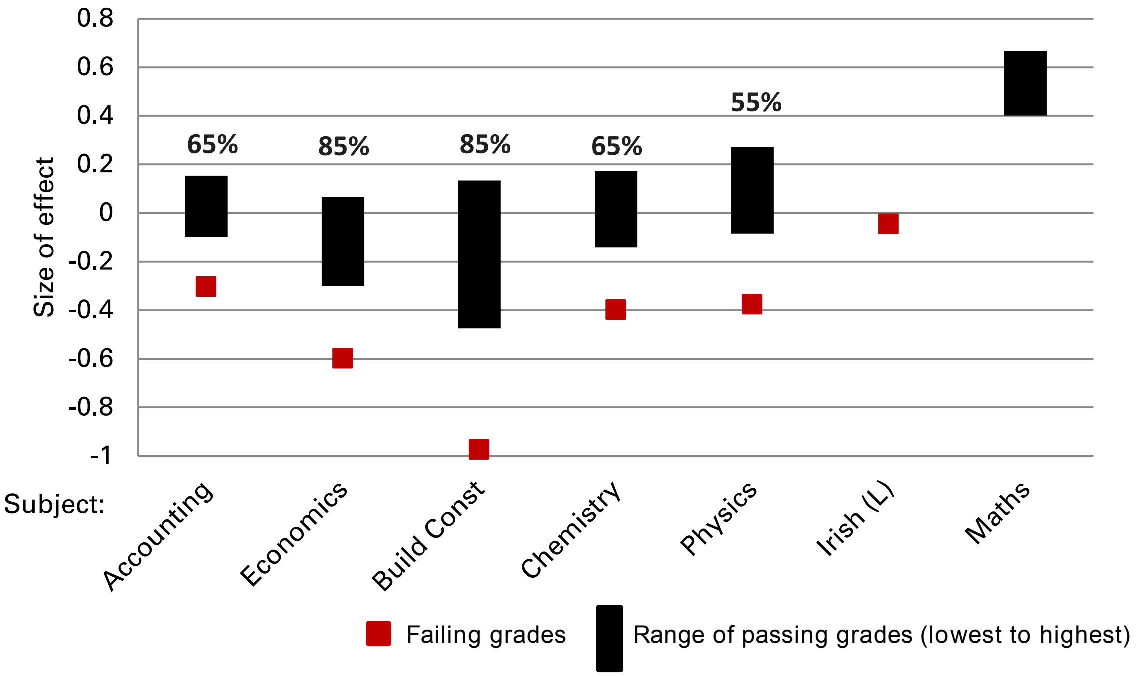


On the above graph all green bars above the line at zero indicate a positive effect on the likelihood of progression, while those below the line illustrate a negative effect. That is to say, the graphs shows that any student with a CAO score of 65% or higher in Accounting becomes more likely to progress successfully through first year at university, while a student scoring 60% or less is more likely to fail, and this likelihood increases significantly if they have scored between 0 – 35%.

Using this method, it is possible to determine a 'critical mark' for a subject; i.e. a mark above which a student becomes more likely to progress through their first year exams, while a student scoring below this mark is more likely to fail. In relation to Accounting, therefore, the 'critical mark' would be 65%.

In order to determine which subjects have the most significance when it comes to predicting achievement or ability in engineering it is useful to compare the effect size of different subjects. This is done in Figure 14, below.

Figure 41: Effect size per subject



The black bar indicates the range of passing grades achieved. Since the 'critical mark' for Accounting, for example, is 65%, students who have passed but received grades below this mark are therefore less likely to progress than students who have not taken Accounting at all.

The Fig. 14 graph shows only those subjects that were statistically significant for engineering students. It reveals the following key points:

- Of all the subjects depicted, Higher-level Maths confers by far the most significant positive impact in terms of progression. The very fact of having taking Higher-level/Advanced Maths means a student is more likely to progress, and the higher the grade they attain they greater this increased likelihood is.

- Achievement in both Physics and Chemistry in the high-school certificate exams also provides an increased probability of passing, provided the student has achieved grades in these subjects above 65% and 55%, respectively. This is perhaps unsurprising as these subjects are highly relevant to engineering. In the context of ATTRACT this finding is interesting given that most other partner universities require one or both of these subjects for entry to engineering programs.

- Accounting and Economics can likewise confer an increased likelihood of passing, although in the case of Economics this benefit is only gained by students who score very highly (>85%).

- Of the high school subjects examined, Building Construction demonstrates the greatest magnitude in terms of its effect on subsequent performance. However, this effect is largely negative. Unless a student taking this subject scores at the very top end of the spectrum (i.e. >85%), he/she is shown to be less likely to pass the first year university exams than a classmate who has not taken this subject previously. However, only 2% of students take this subject so the actual effect on overall progression rates is extremely small.

Similar results to the above points were observed when examining the remaining university-wide cohort (i.e. students in programs other than engineering) for the same ten-year period, although unsurprisingly the range of subjects found to be significant was somewhat different. However the following considerable differences were observed:

- A far wider range of subjects had significance as predictors
- Living in the family home while at university was a significant (positive) influence on progression likelihood
- Being female was a significantly positive influence (the overall cohort is 62% female, compared to 21% in engineering)

[See Appendix for further detail on the subjects influencing progression for students in all faculties at the university.]

A further notable point is that of the subjects that were found to be important predictors of progression in engineering, the following characteristics are observable:

- They each exhibit significantly higher uptake at high-school level among male students than female students
- With the exception of Building Construction (taken by only approximately 2% of students), the subjects can all be said to be more difficult than average (when considering the performance of individual students in these subjects compared to others).
- Furthermore, male students score more highly than female students in each of these subjects at Leaving Certificate, with the exception of accounting where there is no significant gender difference. This finding is contrary to more general trends which have shown female students achieving more highly overall than males at Leaving Certificate over the past number of years. [See Appendix for further discussion of gender and relative subject difficulty]

Conclusions on Barriers

At every point during the conduct of the work undertaken for this report, the necessity has been to draw together the seemingly disparate theories, practices and contexts which frame the widely varying realities in each of the ATTRACT countries.

This degree of difference extends to the very fundamental challenges facing each of the partner countries, as can best be illustrated by the fact that for most participating universities, the overarching aim of the project is to find ways to attract more students into engineering programs at our universities, while in Italy the problem is of too many students, not too few. Here again, though, there are commonalities to be found even in the points of divergence. The core issue is that each country wants to increase its intake of committed, motivated and capable students, and this is the case across the board.

With this in mind, the goal of this work package has been to examine how best to make engineering education as open and accessible as possible to those who may wish to pursue it, without unfairly exposing unequipped students.

By examining available literature, policy documents, national and international research, and conducting new surveys and analyses for the project, the participants have attempted to convey a comprehensive picture of the factors influencing access to engineering education. Section 1 of the report employs this research to document and examine the formal barriers that operate in each of the participating countries. The in-depth data analysis in Sections 2 and 3 offers insight into the correlation between some of these barriers and the selection and progression of new students, and provides a strong basis for the proposal of changes, where required, to present systems. In some cases, existing barriers have been validated, while in others alternatives have been suggested.

Section 4 discussed the difficulty in making general recommendations to fit very different education systems, but despite this there are certain factors which are common to most of the participating countries. The main broad types of change proposed are summarised below. The complete set of recommendations organized by country can be found within the appendix.

Recommendations (a): Changes to admission requirements

- Mathematics
- Physics and/or Chemistry

Data analysis in Ireland and Portugal shows a clear link between achievement in these subjects at high school, and subsequent achievement in university engineering. This reinforces the practice operating in many ATTRACT countries of requiring these subjects for entry to engineering programs. Where they are not (or not all) required, recommendations have been made to ensure students have the required prior achievement in these areas, through the weighting of results in the most relevant subjects.

Recommendations (b): Structural changes to education system

- Higher level of preparation in STEM
- Later ‘streaming’ of students into specialised branches of education (including mechanisms to prevent students effectively self-excluding by not taking any science subjects, for example, as they can in Ireland)
- Higher core STEM content for all students

The particulars of the high school systems vary from country to country, but in all students have some degree of choice over what they study. This can force them to choose quite specialised pathways early on or remain in more broad ones, but even so it is possible in most cases for some students to focus significantly on STEM subjects while others undertake only minimal study of them. An approach whereby all students receive a core level of education in a broad range of subjects, or at least delay the specialisation point until later in their high school career, would ensure that a greater number of students would be eligible to pursue engineering should they wish to instead of being effectively excluded by not possessing the required subjects.

Recommendations (c): Socio-economic and cultural issues

- Need to show relevance of STEM to real life
- Encourage more girls
- Increase participation from marginal socio-economic groups

While the issue of how best to widen access to tertiary education is the subject of much debate across Europe, it should be of particular concern to engineering departments. As has been illustrated above, in many ATTRACT countries engineering undergraduates are drawn from a particularly narrow sector of the available population. Male students significantly outnumber females in the uptake of engineering places, and students from lower socio-economic backgrounds are disproportionately under-represented among engineering students, even by comparison with other disciplines. Merely on the basis of equality this imbalance should not be allowed to continue, but targeting students from these groups also presents an opportunity that should not be ignored for attracting greater numbers of potential students to our engineering programs.

Student Retention

Working Package 8

Student retention as a phenomenon

A significant proportion of engineering and technology students fail to graduate. Student retention is an increasing concern in many institutions of higher education. High non-completion rates are undesirable for several reasons. Retention not only has an impact on individual students and their families, but also produces a ripple effect on the postsecondary institutions, the workforce and the economy. Or as Levitz et al. (1999) have elegantly put it "as budgets tighten, competition for students increases, resources shrink and regents, legislatures, taxpayers, and prospective students and their families take up the cry for institutional accountability, institutions that put students first will succeed, even excel, just as their students will".

Student retention is a topic that has involved considerable research interest especially in the UK and USA but also increasingly in Europe. Differences in assumptions and contexts, however, mean that findings applicable in one part of the world may be more or less irrelevant in other parts. There are differences between countries, educational sectors and even areas of study in terms of retention. This report aspires, therefore, to be of practical value and a contribution to the discussion addressing student retention in Europe, and especially in higher engineering education.

This chapter gives an overview of the phenomenon and discusses some of the most used terms and definitions related to student retention based on literature review. We also recommend the reader to have a look at the Glossary provided at the end of this report. References are made to glossary, literature review and especially the OECD's annual Education at a Glance.

Concepts and definitions

There is currently much interest not only in access to higher education but also in student success. Not surprisingly, concern about high dropout rates in higher education has also increased over the years, since "although participation in higher education has expanded significantly in recent years, the proportional figure for dropout has remained relatively stable" at least in the UK (Thomas 2002). There is also a large body of international research and theory exploring the impact of various individual, social and organizational factors on student retention in higher education (Tinto 1975, 1993; Benn 1982; Astin 1984; Johnes 1990; Pascarella and Terenzini 1991; Moortgat 1997; Berger and Braxton 1998; Ozga and Sukhnandan 1998; and Thomas 2002).

In the 1960's John Summerskill (1962) showed that within each type of institution, institutional retention rates vary between 18% and 88%. Summerskill also suggested developing a standard formula for measuring student retention so that the reported rates could be accurately compared. Almost five decades later, however, such a formula does not yet exist but the concept of retention and its appropriate measurement tools still remain ambiguous (Hagedorn, 2006). The following elaborates some of the most used definitions related to student retention.

The difficulty with international comparison often lies in the differences between national systems, concepts and performance indicators. This is also the case with student retention – a complex, confusing and context dependent concept – which is not only difficult to define in universal terms but also rather challenging to measure and control. It has, however, been suggested that withdrawal from university can arise either from voluntary withdrawal or from forced withdrawal (academic dismissal). While voluntary withdrawal is based on students' own dropout decisions, forced withdrawal usually arises from insufficient levels of academic performance or from the breaking of established rules concerning proper social and academic behaviour. (Tinto 1993) A student who enrols in university and remains enrolled until degree completion is usually referred to as a university persister. A student who leaves the university without earning a degree and never returns, in turn, is a non-persister or dropout. While these definitions are rather simple and easy to understand, student paths are rarely this direct or straightforward (Hagedorn 2006).

Retention and dropout are also widely used concepts and typically defined as two sides of the same coin. Simplistically, retention is staying in university until completion of a degree and dropping out is leaving university prematurely (Hagedorn 2006). The concept of retention, however, is far more complicated due to the prevalence of student enrolment in several different institutions throughout their educational career (Astin 1971). Former dropouts may also return and transform into "non-dropouts" either in the same institution where they previously dropped out or in another institution (Hagedorn 2006).

It has also been pointed out that "many who leave university do not see themselves as failures, but rather see their time in post-secondary education as a positive process of self-discovery that has resulted in individual, social and intellectual maturation" (Tinto,1987). Thus, student retention should be further complicated to consider students' educational goals.

Persistence and retention (attainment) are terms often used interchangeably. The American National Centre for Education Statistics (NCES), however, has differentiated the terms by using retention as an institutional measure and persistence as a student measure. In other words, "institutions retain and students persist". Another term commonly used with retention is attrition which is the process of students leaving their education, primarily due to institutional structures and processes. Finally, two important terms are also graduate and graduation. A graduate is usually considered as a former student who has achieved an academic degree. So he/she has persisted. However, not all persisters graduate. A graduate can, therefore, claim only one institution regardless of enrolment at other universities. (Hagedorn 2006)

In addition, at least four basic types of retention – institutional, system, in the major (discipline) and in a particular course – have been distinguished (Hagedorn,2006):

- Institutional retention is the most basic and easy to understand. In essence, it is the measure of the proportion of students who remain at the same institution from year to year.
- System retention, in turn, focuses on the student. Using system persistence as a measure, a student who leaves one institution to attend another one is not considered as a non-persister but a persister.
- Retention within a major or discipline takes a more limited view of the topic by viewing retention within a major area of study, discipline or a specific department.
- The smallest unit of analysis is retention within a particular course which measures retention by course completion.

It is also worth noting that depending on the terminology used, the phenomenon of retention may have quite a different connotation: while in the USA researchers often use the word "persistence" to indicate students who persist in pursuing their degree and not dropping out, in Europe many researchers prefer to use the term "retention" which implies that it is the universities that need to retain their students (Van Stolk et al. 2007). This also shows that the phenomenon can be viewed from very different perspectives. Also in the ATTRACT project we have used the word "retention" to describe the overall phenomenon. However, besides retention the project has also dealt with issues such as progression, dropout and graduation.

Retention indicators

As can be seen from a wide variety of statistics, there is no single formula for measuring student retention. According to various sources, however, there seems to be six dominant measurement practices – namely retention rates, dropout rates, attrition rates, completion rates, survival rates, and graduation rates – that are the most commonly accepted and widely used. Definitions and formulas both at national and at institutional level, however, tend to vary (see table 1). Some terms may also be used interchangeably.

Sometimes the performance indicators or data-monitoring systems that are in place do not necessarily allow for the tracking of students in a way that would meet the national or institutional definitions, and vice versa. For example in the Irish context, where student withdrawal is defined in terms of non-presence, students who remain recorded as present within a given program are deemed to be retained, while those recorded as non-present are withdrawn. Within these parameters any student who repeats a given year or who changes program within their original institution is classified as present and thus retained. The current data-monitoring system, however, does not allow for the tracking of students across different institutions, and as a result an undergraduate who transfers from one institution to another is classified as not having progressed (HEA 2010).

It is also worth noting that single measures of student retention usually do not tell the whole story. The existing concepts and indicators seldom cover all students and as such may provide inaccurate measures of student retention. Generally, the formulas tend to exclude for example part-time students, returning students, and transfers (Hagedorn 2006). In one of the ATTRACT WP8 trials (Footprint) we also tested in practice how comparable the different indicators used by different universities are.

Table 1: Measuring student retention – definitions and examples of formulas.

Measure	Definition	Examples of common formulas (among the ATTRACT partners)
Attrition rate	The percentage of students who leave education within a specified period of time	
Completion rate	The percentage of students who graduate	• **Finnish Ministry of Education and Culture:** the remainder of 100 % - dropout rate, where the dropout rate is the ratio of dropouts to dropouts and graduates in total • **OECD/Portuguese Ministry for Science and Education:** the ratio of the number of students who graduate from an initial degree during the reference year to the number of new entrants in this degree n years before, with n being the number of years of full-time study required to complete the degree
Dropout rate	The proportion of students who leave the specified level in the educational system without obtaining a first qualification (The OECD Glossary)	• **Finnish Ministry of Education and Culture:** the ratio of dropouts to dropouts and graduates in total • **Statistics Finland:** the ratio of dropouts to all students • **IST:** the ratio of dropouts year n / n+1 to enrollments year n-1 / n (= dropout rate in year n/ n+1)
Graduation rate	The estimated percentage of an age cohort that has completed certain type of education (**net graduation rate**) or the number of graduates, regardless of their age, divided by the population at the typical graduation age (**gross graduation rate**) (The OECD Glossary)[62]	
Retention rate	The percentage of a defined group of students who remain in education for some defined time	
Survival rate	The proportion of new entrants to the specified level of education who successfully complete a first qualification (The OECD Glossary)	

[62] In some countries the graduation rate corresponds more to the completion rate indicator described above. In the Swedish context for example, graduation rates are usually specified as the proportion of graduates within a certain number of years subsequent to the start of an education. Also national throughput measurements include the graduation rate indicator which is measured by carrying out follow-up of beginner students after three, five, seven and eleven years to find out what percentage of those has graduated.

Statistical review of the retention phenomenon

In order to get a better picture of the phenomenon, let us have a closer look at some of the educational statistics provided mainly by the Organization for Economic Cooperation and Development (OECD). These statistics also give us a good starting point for international comparison.

Tertiary graduation rates indicate a country's capacity to produce workers with advanced, specialized knowledge and skills. In OECD countries, there are strong incentives to obtain a tertiary qualification, including higher salaries and better employment prospects. Tertiary education varies widely in structure and scope among countries, and graduation rates are influenced by both the degree of access to these programs and the demand for higher skills in the labor market (OECD 2011).

In 2009, graduation rates for tertiary-type A programs [63] averaged 39 % among the 27 OECD countries with comparable data. The proportion ranges from around 20 % in Mexico and Turkey to 50 % or more in Iceland, New Zealand, Poland and the Slovak Republic. Disparities in graduation rates are even greater between women and men. The gender gap in favor of women is especially wide in Iceland, Poland and the Slovak Republic (more than 25 percentage points), while in Germany, Mexico and Switzerland, there is practically no gender gap. In contrast, in Japan and Turkey, more men than women graduate from tertiary-type A education (OECD 2011).

Furthermore, an average of 10 % of today's young adults in the OECD countries complete tertiary-type B education [64]. Only in Canada, Ireland, Japan, New Zealand and Slovenia more than 20 % of students graduate from these types of programs. International students make a significant contribution to tertiary graduation rates in a number of countries. For countries with a high proportion of international students, such as Australia, New Zealand and the United Kingdom, graduation rates are artificially inflated. This is because all international graduates are, by definition, first-time graduates, regardless of their previous education in other countries (OECD 2011). The first-time graduation rates from tertiary-type A and B programs are presented in figure 1.

In every country for which comparable data are available, tertiary-type A graduation rates increased between 1995 and 2009. The increase was particularly steep between 1995 and 2000, then leveled off. On average among the OECD countries with available data, tertiary-type A graduation rates have risen by 19 percentage points over the past 14 years while rates for tertiary-type B programs have been stable. In comparison, while doctorates represent a minor proportion of tertiary programs, the number of doctoral graduates has been growing at an annual rate of 5 % since 2000 (OECD 2011).

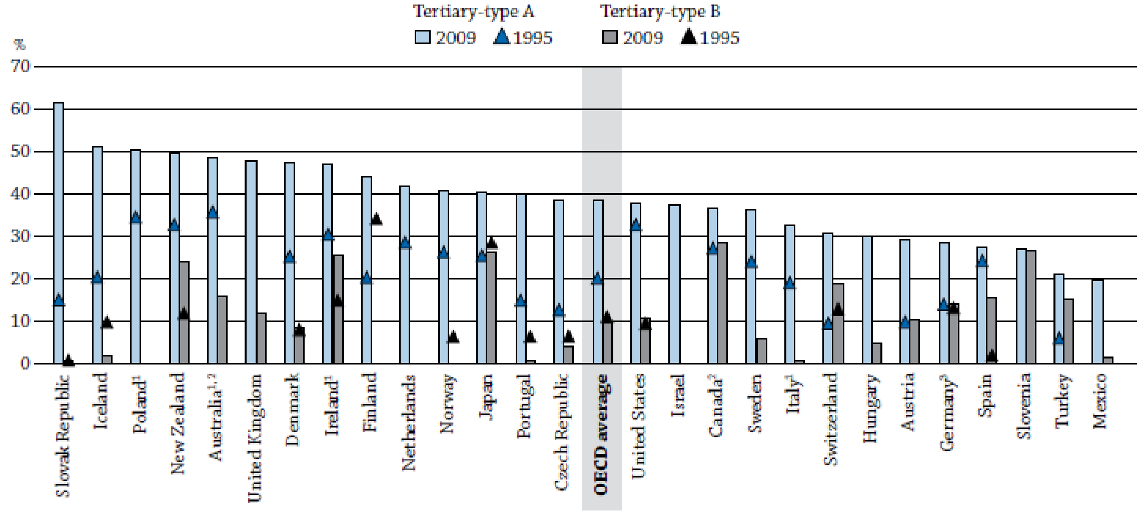
Based on current patterns of graduation, it is estimated that an average of 46 % of today's women and 31 % of today's men in the OECD countries will complete tertiary-type A education (largely theory-based) over their lifetimes. Only 39 % of women and 25 % of men will do so before the age of 30. In some countries, it is common for students older than 30 to graduate from tertiary-type A programs. More than 30 % of women in Iceland and Sweden who graduate from these programs, and more than 30 % of men in Iceland and Israel who do so, are over 30 (OECD 2011). The tertiary-type A graduation rates are presented by gender in figure 2.

A first-time graduate is considered as a student who has graduated for the first time from a type A or type B program in the reference period. So, if a student has graduated multiple times over the years, he or she is counted as a graduate each year, but as a first-time graduate only once. The graduation rates are calculated as net graduation rates (i.e. as the sum of age-specific graduation rates). Gross graduation rates are presented for countries that are unable to provide such detailed data. In order to calculate gross graduation rates, countries identify the age at which graduation typically occurs. The number of graduates, regardless of their age, is divided by the population at the typical graduation age. In many countries defining a typical age of graduation is difficult, because graduates are dispersed over a wide range of ages (OECD 2011).

[63] Tertiary-type A programs are largely theory-based and are designed to provide qualifications for entry into advanced research programs and professions with high requirements in knowledge and skills. The institutional framework may be universities or other institutions, and the duration of the programs ranges from three years (e.g. the honors bachelor's degree in many colleges in Ireland and the United Kingdom, and the licence in France) to five or more years (e.g. the Diplom in Germany). (OECD 2011)

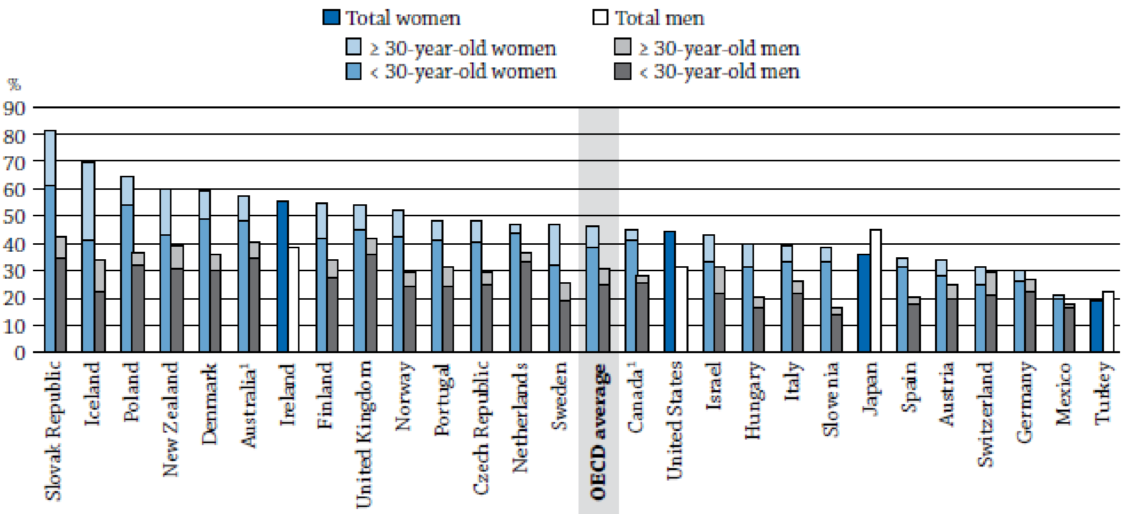
[64] Tertiary-type B programs are classified at the same level of competence as those more theory-based programs, but are often of shorter duration (usually two to three years) and vocationally-oriented. Generally, they are not intended to lead to university-level degrees, but rather to lead directly to the labor market. (OECD 2011)

Figure 1: First-time graduation rates for tertiary-type A and B programs (1995 and 2009) Source: Education at a Glance 2009, table A3.2



1. Year of reference 2000 instead of 1995.
2. Year of reference 2008 instead of 2009.
3. Break in the series between 2008 and 2009 due to a partial reallocation of vocational programmes into ISCED 2 and ISCED 5B.
Countries are ranked in descending order of first-time graduation rates for tertiary-type A education in 2009.
Source: OECD. Table A3.2. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).
StatLink http://dx.doi.org/10.1787/888932460040

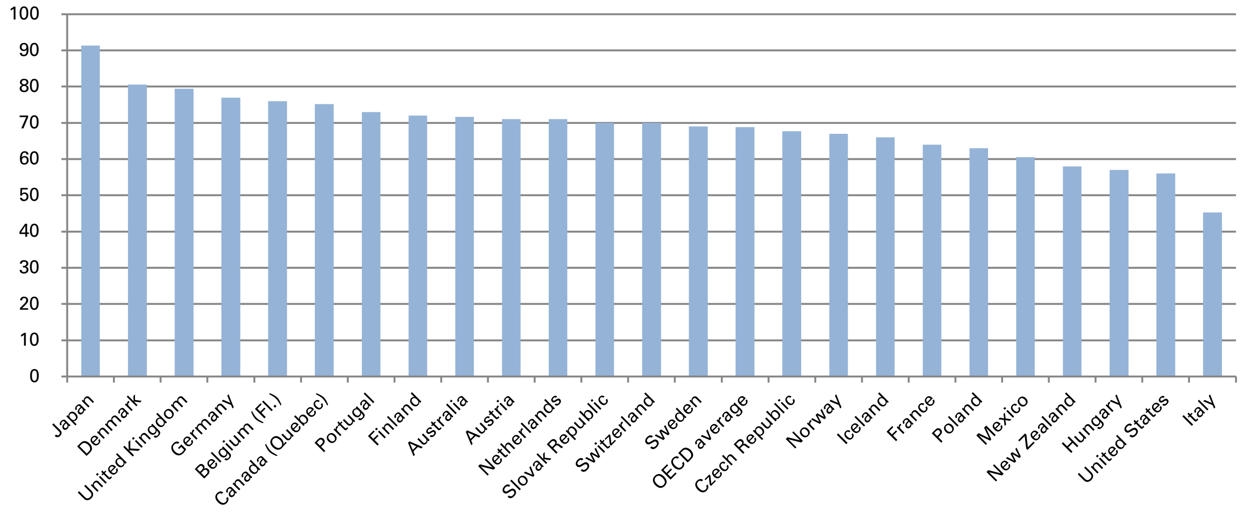
Figure 2: Tertiary-type A graduation rates in 2009, by gender (first-time graduates) Source: Education at a Glance 2009, table A3.1



1. Year of reference 2008.
Countries are ranked in descending order of women's graduation rates from tertiary-type A education in 2009.

The OECD indicator A3.4 "How many students finish tertiary education? Completion rates in tertiary education" has changed between the 2009 edition and the 2011 edition. That is to say that the OECD no longer reports completion rates (i.e. the number of graduates from certain programs divided by the number of new entrants to these programs in the typical year of entrance). This information, however, would have been relevant for the ATTRACT work, and therefore, we pick up this information from the 2009 edition, showing data of year 2005 (see figure 3). On average among the 24 OECD countries for which data are available, some 31 % of tertiary-type A students fail to successfully complete the program they enter. However completion rates differ widely among the countries. In Hungary, Italy, New Zealand and the United States, less than 60 % of those who enter tertiary-type A programs go on to successfully complete their program, in contrast to their counterparts in Denmark and the United Kingdom where the completion rates are around 80 %, and in Japan where it is 91 % (OECD 2011).

Figure 3: Tertiary-type A completion rates in 2005 (first-time graduation) Source: Education at a Glance 2009, table A3.4

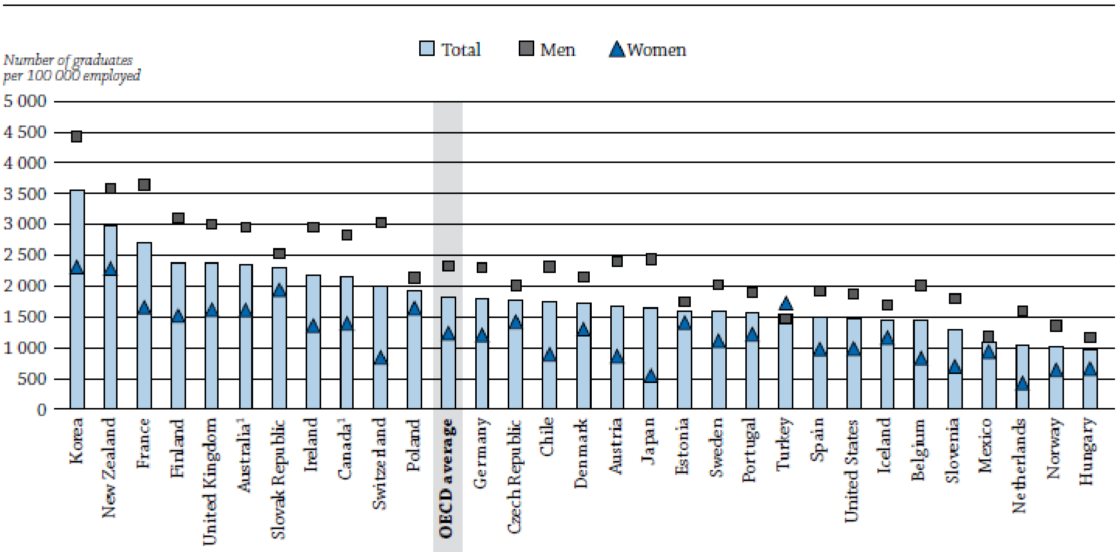


What comes to statistics available for science and engineering, examining the number of graduates in science-related fields (science and engineering, manufacturing and construction) per 100,000 25–34 year-olds in employment, might also be of interest to the ATTRACT work. The number of science graduates (all tertiary levels) per 100,000 employed persons ranges from below 1,000 in Hungary to above 2,500 in France, Korea and New Zealand (see figure 4). On the other hand, it is also worth noting that this indicator does not provide information on the number of graduates actually employed in scientific fields or, more generally, the number of those using their degree-related skills and knowledge at work.

On the other hand, as the figures above show, in terms of different variables (e.g. entry, graduation and completion rates) two countries may have similar graduation rates but significant differences in the other two variables. Thus, we have to be careful when analyzing these figures. As aforementioned, tertiary education also varies widely in structure and scope among countries, and thus graduation rates for instance are influenced by both the degree of access to these programs and the demand for higher skills in the labor market (OECD 2011).

Also employment before and after graduation matters. Kivinen and Nurmi (2011) for instance have added yet another dimension to the issue, namely labor market relevance. As figure 5 shows, in countries like Finland where study times are typically long, the university graduates are able to find employment in positions corresponding to their educational background faster than in some other countries, where study times are perhaps not as long. This is partly believed to result from the combination of work and study at earlier stages (Kivinen and Nurmi 2011, Aho et al. 2012).

Figure 4: Tertiary graduates in science-related fields among 25–34 year-olds in employment, by gender (2009) Source: Education at a Glance 2009, table A3.6

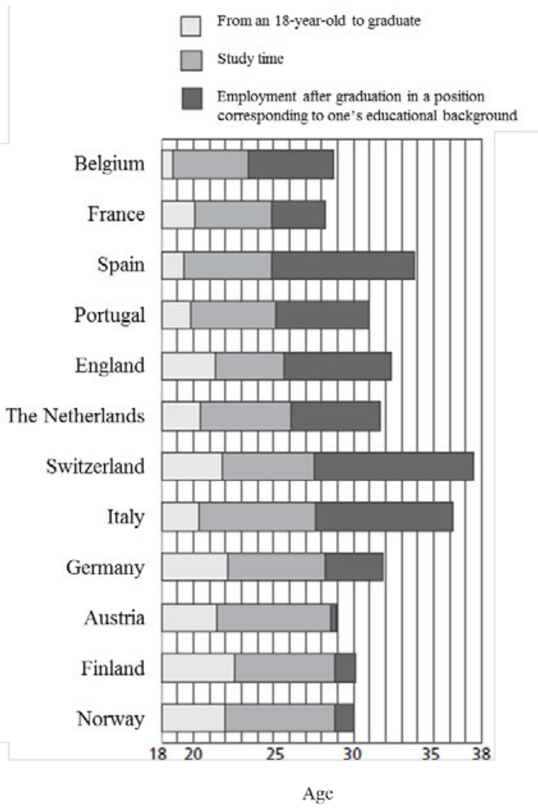


Note: Science-related fields include life sciences; physical sciences, mathematics and statistics, computing; engineering and engineering trades, manufacturing and processing, architecture and building.

1. Year of reference 2008 for the number of graduates.

Countries are ranked in descending order of the percentage of tertiary science-related graduates in tertiary-type A programmes per 100 000 employed 25-34 year-olds.

Figure 5. University students' careers in 12 European countries (Kivinen and Nurmi 2011)



Why is student retention an issue in science and technology?

Student retention has already for long been among the most widely researched areas in higher education. The generalizability of research in this field, however, is problematic due to cultural and structural differences between countries, universities and even programs where research is done. In recent years, much effort has been put in attracting young people to engineering. However, once the students are in universities, there is another challenge: how to retain them? In Sweden for instance, where the number of new entrants to engineering programs has grown by 50 % in the last 15 years, the graduation rates have simultaneously declined significantly. This illustrates a common problem; the students apply for engineering degrees, but the universities fail to retain them (Forsman, 2011).

Van den Bogaard (2011) has also pointed out that engineering students tend to drop out of university more often and they take a longer time to graduate than their peers in non-engineering programs. For example in Sweden, around 7,000 students register in Master's programs in engineering each year. A national survey (HSV 2009), however, shows that around 2,200 of them drop out of this type of engineering education. The same survey also shows that only about 37 % of the students graduate within the nominal study time (in 2005/2006 and 2006/2007), whereas the typical study time tends to be the nominal study time + one year for approximately 70 % of the graduates and the nominal study time + 2 years for approximately 86 % of the graduates.

Another interesting example comes from the Netherlands where at Delft University of Technology (DUT) for instance around 35–50 % of the students leave without a diploma, and the students who graduate take 7.2 years on average for a 5-year program (Van den Bogaard 2011). Furthermore, in Finland at Aalto University, approximately 85 % of all the applicants actually enroll in the university, and some 26 % of those aiming for a Master's degree drop out. These figures cover all students in the field of engineering, economics and art. The de facto percentage of dropouts – when the study time has been at least 12 years – is approximately 32 %. The number of dropouts is the highest among engineering students (Nivaro 2012).

On the other hand, in Belgium the situation is somewhat different. Compared to the global data of all KU Leuven programs, the Faculty of Engineering has slightly better scores: engineering students persist better than others. A possible explanation for this could be the fact that engineering education is often a "well-considered" choice. Engineering is considered difficult so the students want to be sure about their choice of study. Consequently, students who succeed in their first year really want to persist in their effort. In terms of progression, however, the Faculty of Engineering at KU Leuven is not that different: approximately 50 % of the starting bachelor students obtain their degree in three years and an extra 15–20 % in four years. The dropout rate has also increased from 25 % in 2005 to 30 % in 2007. In general, student progression for university students in Flanders is 77 %, which means that students obtain 77% of the credits they could despite the length of their educational program.

Nevertheless, student retention is an increasing concern in many institutions of higher education. High dropout rates are undesirable for several reasons. Hagedorn (2006) for example has expressed that "retention not only has an impact on the individual and his/her family but also produces a ripple effect on the postsecondary institutions, the work force and the economy". Indeed, retention is one of the most common ways students, parents and stakeholders evaluate the effectiveness of institutions of higher education. A positive reputation increases the university's attractiveness. Furthermore, when a student drops out from a university, the institutional resources are not spent wisely (Hagedorn 2006) Retention also has a significant workforce effect, when the non-persisting students do not have the university education and credentials to enter the professional workforce (Andrade et al. 2002).

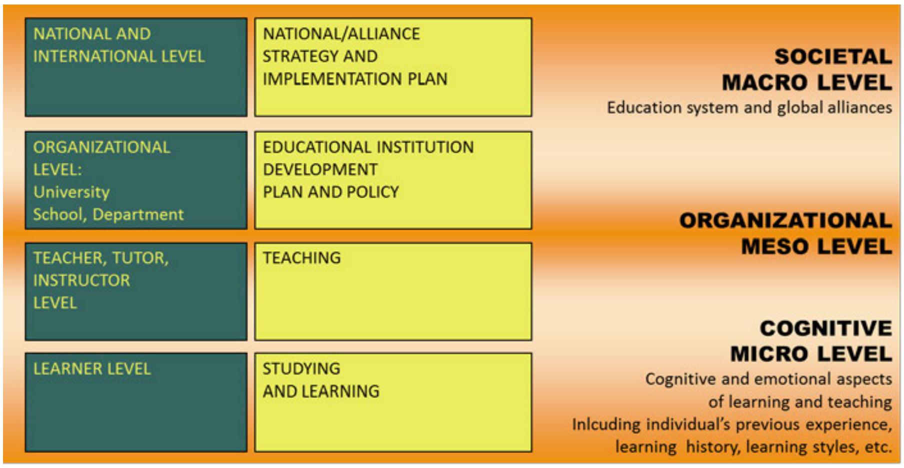
Modeling student retention

This chapter explores some of the most influential theories behind student departure. In this section, we will also reflect upon the question of differences between general and engineering universities in terms of student retention. References are made to literature review, country reports and comparison framework.

Different approaches to student retention

As aforementioned, the issue of retention may be approached from a wide variety of perspectives. Also the experiences and challenges related to student retention may vary depending on the perspective or actor in question; (inter)national policy makers, higher education institutions, teachers, tutors, instructors and learners all have different views of the phenomenon (see figure 6). Generally, we can divide different actors into three major strands, which represent the different approaches of perspectives. Macro level represents ideology, social context and policy-making, meso level institutional conditions, and micro level classroom and peer interactions. The levels of motivation, activities and goals may also vary.

Figure 6: Different levels of motivation, activities and goals (Becher 1994).



As Becher (1994) has demonstrated, comparative studies in higher education tend to focus on macro-level contrasts between the structures of one system and another. However, this leaves some important issues unexplored, as the approach overlooks the significant internal distinctions of different disciplines. Furthermore, there is the tendency for the administrators to lay down uniform specifications to be observed across the whole range of programs. Yet different programs are also influenced by the ecosystem of the industrial field they educate their students to. For example the attractiveness of e.g. civil engineering and also the willingness of students to complete their civil engineering studies are above all influenced by the economic situation in the construction industry. This represents the organizational meso level. Enquiries at micro level would appear less prone to this limitation Becher (1994) reminds us that within each level there are sub-systems that need to be taken into consideration. Forsman (2011) for instance has identified four nested systems that can be described as (1) university support issues, (2) institutional quality and reputation issues, (3) students' social issues, and (4) students' degree program issues.

It is also worth noting that education cannot be seen as separate from its context: values that are prevalent in a society are reflected in the way education is organized and who has access to education (McLean 1995, Wiegersma 1989). A striking example of this is the selection process. Even within Europe there are significant differences between countries. The education systems may be based on similar values, but education is organized in many different ways (see also the ATTRACT WP6 final report). This observation of differences is of high importance, because the differences in systems imply that seemingly similar phenomena like failure or dropout are understood in different ways within systems and carry a different weight. In other words, failure has different implications for different students depending on the context. (Van den Bogaard 2011)

Synthesis of various theories

Over the years several theories have been developed to explain the dropout phenomenon. Psychological models of educational persistence such as those by Summerskill (1962), Marks (1967), Rossmann and Kirk (1970), Waterman and Waterman (1972), and Ethington (1990) all emphasize the impact of individual abilities and dispositions upon student departure, and try to distinguish stayers and leavers in terms of attributes of personality. These models also see that retention and departure are primarily the reflection of individual actions and therefore are largely due to the ability or willingness of the individual to successfully complete the task associated with university attendance. Moreover, these models invariably see student departure as reflecting some sort of shortcoming or weakness in the individual (Tinto, 1993).

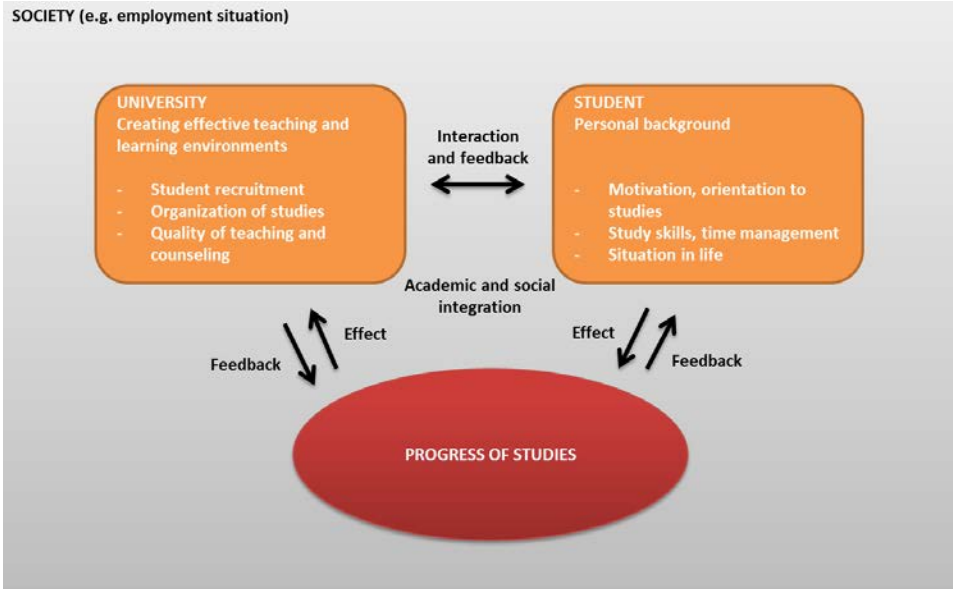
The 'psychological view of student departure', however, is only a partial truth. According to Cope and Hannah (1975), there is no one "departure-prone" personality, which is uniformly associated with student departure. Sharp and Chason (1978), in turn, have argued that individual behavior is as much a function of personality as well as of the environment where the individual finds themself. The psychological theories, hence, tend to ignore the forces that represent the impact that institutions have upon their students' behavior. They also suggest that student attrition could be substantially reduced either by improving students' skills, or by selecting the individuals who possess the personality traits most appropriate for university work. However, there is no widespread evidence to support this argument (Tinto 1993).

The 'environmental theories of student departure' such as those by Kamens (1971), Pincus (1980), Iwai and Churchill (1982), Stampen and Cabrera (1986, 1988), and Braxton and Brier (1989) are at the other end of the spectrum. They emphasize the impact of wider social, economic and organizational forces on the behavior of students within institutions. These may include for example students' social status and race (social), economic hardships (economic), and faculty-student ratios (organizational). These theories, however, focusing on the external forces in the process of student persistence, are seldom able to explain the different forms of student departure that arise within institutions. In addition, many of these factors tend to be of just secondary importance to other conditions as well as short-term in character. Therefore, they cannot explain the continuing long-term patterns of student departure (Tinto 1993).

Over the years, other theories and models have been suggested, several of them trying to explain the complex phenomenon of student retention as well as to understand and inform the various institutional interventions aiming to diminish student dropout. One of the most dominant theories is Tinto's 'Student Integration Model', according to which the processes of interaction between the individual and the institution lead to differing individuals to drop out from institutions of higher education. Thus, Tinto's model emphasizes the importance of academic and social integration of students in the prediction of student retention (Tinto 1987, 1993). Another rather influential theory has been the 'Student Attrition Model' presented by Bean, which builds upon process models of organizational turnover (March and Simon 1958) and models of attitude-behavior interactions (Bentler and Speckart 1979, 1981). Bean has indeed argued that student attrition is analogous to turnover in work organizations and stresses the importance of behavioral intentions as predictors of persistence behavior. The Student Attrition Model also recognizes that factors external to the institution can play a major role in affecting students' attitudes and decisions (Bean 1980).

Continued work in the area suggests that both these models have a predictive value and that educational persistence (see figure 7) is a product of a complex set of interactions among personal (e.g. explanations that relate to the students themselves, such as background, motivation and study approaches), institutional (e.g. explanations directly associated with the education, such as objectives, content, teaching, institutional climate, guidance and counseling) and external (e.g. statements that relate to the student's ambient surroundings, such as financial situation, housing, work and leisure time) factors where a successful match between the student and the institution is particularly important (Cabrera et al. 1992, Hede and Wikander 1990). Indeed, the most important actors in the nexus of issues related to student retention are arguably the students and university staff (Tinto 1997).

Figure 7: Factors contributing to student progression and completion (adapted from Ruutu 2010).



Furthermore, many researchers who have looked into student success in engineering education have also included a great number of variables in their work and come up with a range of variables that is very similar to the one found in general education. Therefore, researchers like Van den Bogaard (2011) for instance have also concluded that the variables that work in general education also apply to engineering education, although conditions in the latter are somewhat different. On the other hand, there are also researchers like Veenstra et al. 2009 who have argued that engineering education should be considered uniquely different from education in other disciplines, especially during the first year. The first-year experience is discussed more in detail in the following chapter.

First-year experience

Various theories of dropout usually consider two points in time: the point of entry, and some later time when dropout or persistence is determined (Simpson et al. 1980). It is believed that the forces that lead to dropout in the early stages of academic career can be quite different from those that influence dropout later. These may also differ for different types of students (Tinto 1982). Factors that frequently appear as significant predictors of student retention may not appear significant to graduation. One must, therefore, be careful in defining success in various longitudinal studies, as variables which appear significant in the short run – that is before graduation – may not, in fact, be significant in the longer run (Zhang et al. 2004). Research has, however, shown that the first two years at university are crucial for student retention. For example Mallinckrodt and Sedlacek (1987) have argued that the freshman attrition rates are typically greater than any other academic year and are commonly as high as 20–30 %. Tinto (1993) and Tinto et al. (1994), in turn, have stated that 25 % of university students drop out after their first year. Among all dropouts, 75 % leave university in the first two years (Tinto 1987, 1988).

The first-year experience is highly significant not only in terms of predicting students' ongoing success in tertiary education, but also as it is the time when students are most vulnerable in terms of academic failure, as well as most likely to experience social, emotional, and financial problems (McInnis 2001). Furthermore, it has been established that the first few weeks at university have important implications for students' long-term engagement and persistence (Macdonald 1995, Erskine 2000). Beder (1997) for instance has pointed out that it is during the course of the first year when most students develop their appropriate identity and become socially integrated in the university, as well as attain their learning skills and other general qualities.

Tinto (2010) has also shown that students who find themselves in settings that hold high expectations for their success, provide academic and social support, and frequent feedback about their performance, and finally that actively involve their students in learning are more likely to succeed and continue within the institution. The importance of support and feedback, involvement and relevant learning are especially important during the first year, in which students acquire new skills, qualities, and norms needed to learn and grow throughout their educational career (Beder 1997, Tinto 2002). Unfortunately, however, the first year at university is often somewhat isolated and uninvolving as far as learning is concerned (Tinto 2002).

The process of entering university has been compared to the process of moving from one community to another (Tinto 1988). It is a process where students must leave the familiar and begin again in an unfamiliar environment. Tinto (1988) has proposed that the process of beginning university studies consists of three distinct stages (see table 2) where student integration is fundamental in making the transition process successful (for example Terenzini and Pascarella 1977, Tinto 1988, Beder 1997, Huon and Sankey 2002, Wilcox et al. 2005).

Table 2: Stages in the process of entering university (Tinto 1988).

1) Separation	In this stage, the students disassociate themselves from their membership in prior communities (largely school and home environments). This is a process which is stressful for virtually all students.
2) Transition	In this stage, students interact with others (faculty, staff and students) in the new environment and begin to make connections. This is a period where students have not quite separated themselves from the past, and not quite acquired the norms of academic and social interaction with the new context in which they are operating. The stressfulness of this stage largely depends on the degree to which the new environment relates to the old environment in which students have previously been operating. For some students, the process of transition may be minor and relatively seamless, while for others the transition may take considerable time and effort. In terms of withdrawing from study, it is during the first two stages that first-year students are seen to be at greatest risk (Hillman 2005).
3) Incorporation	In this stage, students "face the problem of finding and adopting norms appropriate to the new setting and establishing competent memberships in the social and intellectual communities". One key element in achieving the stage of incorporation is the students' integration in the academic and social domains of the university (Tinto 1975, 1988, 1993).

As aforementioned, the first year is an important time for all students. However, the pressures on students are numerous and many do not succeed, especially in the engineering area of studies. where a combination of factors (including difficulty of the subject and mismatching of student and academic expectations), seems to have resulted in higher dropout rates than for many other subjects (HESA 2006). Some researchers (for example Veenstra et al. 2009) have indeed argued that engineering education should be considered uniquely different from education in other disciplines. They have also found that general models of dropout such as those by Tinto (1975, 1993) do not adequately address engineering student retention. This happens for a number of reasons.

1) A major in engineering (and in other pre-professional and professional programs) tends to prepare a student for a specific career, whereas majors in liberal arts or sciences are less focused on a career.
2) Focus of the freshman engineering curriculum is often on developing strong analytical skills and problem-solving using technology, something which appears quite demanding freshman in math and science courses.
3) Secondary education provides more "university-prep courses" for majors in liberal arts and sciences than for engineering (in some countries).
4) Studies (for example Astin 1993) show that engineering students generally achieve less academic success (lower grades) in the first semester than other students.

National approaches to the phenomenon and related studies

As we have already seen, the issue of student retention is of relevance at many different levels and, apart from being very complex, a rather context-bound in nature. This is also the reason why it is so important to look at the issue from national perspectives. Student retention is an important question not only from the institutional perspective, but also at governmental level, particularly for agencies of education. Governmental initiatives to explore retention as well as to improve it can be found in many countries. There are also many examples at university level of exploration projects and redemptive programs. We have also found some examples of research initiatives to explore student retention. These commonly draw on theories, such as the Student Integration Model (Tinto 1975, 1993), but also some other models argue that success in higher education is largely dependent on a positive interaction between the individual and the university/educational program. This chapter gives an overview of some of the most interesting studies carried out in some of the partner countries and universities. References are made to country reports and comparison framework.

Belgium

In Belgium education is a regional authority: the Ministry of Education belongs to the Flemish (or Walloon) government. Therefore, the situation explained below concerns only the Flemish part of the country, where KU Leuven is situated. It is also worth noting that at KU Leuven a bachelor student who does not start his/her master's program is considered as a dropout – also from the viewpoint of employers.

Since dropout rates are considered to be rather low in Flanders (see chapter 0), there has been no urge to conduct thorough research concerning retention. In general, however, it has been discovered that engineering students persist slightly better than others and that most dropouts occur between the first and the second year. Reasons for withdrawal are as diverse as the number of withdrawals, but the overall opinion has been that some starters seem to fail in assessing themselves concerning their knowledge and skills for academic or engineering education.

Before 2003 engineering students in Flanders had to pass an entrance examination before entering the university. The abolition of this exam did not result in a spectacular rise in student numbers, but the students entered the engineering programs less prepared. Consequently, the professors had difficulties in coping with the contrast between expected and real level of prior knowledge. In other words the starting cohort was much more heterogeneous from 2003 onwards.

At KU Leuven this challenge is remediated before entry with online tests, summer courses for secondary school students in their final year, and starting from 2012 with the so-called mathematics calibration test. After the test, the participants receive feedback about their position regarding the group and eventually about how to prepare for entry in the engineering program. The calibration test is also believed to have predictive value for the success rates of the students and to allow for an estimation of the mathematical skills of the group considered useful for counselling.

A possible and desirable side effect is also to influence teachers in secondary schools prepare their students for the test. Moreover, the (academic) staff cooperates with teachers in order to improve the preparation of youngsters for higher education, not only in the calibration test but also in various projects and working groups. At entry level the students are also coached by "monitors" (in English: tutors) – professors or assistants – who explain difficult topics to the students, make exercises with them in smaller groups, and give advice before and during the examination period. Students can also make an appeal to the Study Advice Team for counseling.

As a conclusion, once the students have entered the program and succeeded in their first year, they also tend to persist until graduation. Hence, the focus at the Faculty of Engineering Science at KU Leuven is on orienting incoming students and helping them to make the right choice of study. The discussion on how to proceed is on-going: the mathematics calibration test is considered to be an interesting pilot, which could also become of high importance in this discussion.

Finland

In international comparison the dropout phenomenon seems less significant in Finland. However, problems caused by long study times are not. An international comparison shows that Finnish university graduates enter the labor market later than their European counterparts. In addition, Finnish youth tend to start their academic studies relatively late compared to many other nationalities (Davies et al. 2009).

On the other hand, other studies (e.g. Kivinen and Nurmi 2011, Aho et al. 2012) have also shown that Finnish university graduates are able to find employment faster than some of their European counterparts despite the long study times. Also the students emphasize the importance of internships / relevant work experience during education (TEK 2012). Indeed, there seems to be three main elements under discussion in Finland; (1) entry of students to the system (including admission and access), (2) progression and completion (including flexibility, course architecture and support), and (3) labor market outcomes. (Ministry of Education 2007, 2010; OECD 2009)

In technical universities and faculties the progress of bachelor-level studies in the new two-tier study structure has been followed in a national monitoring project "Monitoring, evaluating and developing study processes on the branch of technology" in 2005–2009 and afterwards. The premise for the study was the reform of the university curriculum and degrees implemented in year 2005 in accordance with the Bologna Declaration (Erkkilä 2010a). Flexibility in studying, work load, financial support, effectiveness of teaching arrangements, interplay between work and study as well as student counseling and support were issues often raised in the project.

Furthermore, the study showed that students entering on the basis of their matriculation examination results gained on average the most credits in the first three years of studies, whereas students who entered based on their entrance examination results gained the least credits. These findings can be attributed, at least in part, to the fact that students admitted based on their matriculation examination results have already achieved high grades in mathematics and sciences in upper secondary school. This is particularly significant since in many degree programs the first year is comprised mainly of mathematics and physics, so prior achievement in these areas is an advantage (Pakarinen 2010). The study also showed that student progression was the slowest among those students who had not been able to complete their compulsory mathematics courses during the first three years of study – the nominal study time for completing a Bachelor's degree (Rantanen and Liski 2009). On the other hand, the above results do not take into account factors such as a student's background, motivation, financial circumstances, or quality of learning, all of which can also affect progression (Pakarinen 2010).

Also other initiatives have been taken at Aalto University to study student retention, particularly in engineering programs Rintala (2012). for instance has studied the impact of academic and social integration on first-year students' expectations and commitment in the degree program of Bioproduct technology at Aalto University. She has found that the positive evolution of expectations and sense of commitment during the first year are evidently interlinked, but that the role of interaction between the student and the university is also rather complex. Rintala has also discovered significant differences between individual students. Ruutu (2010) emphasized the role of academic and social integration in student progression in her study on "Progressing and Promoting Freshman Studies in Communications Engineering – Integrating Students to The Scientific Community" at Aalto University.

Another rather recent study conducted at the University of Oulu also shows some rather interesting results about engineering students and their study paths; "Students with satisfactory learning results in upper secondary school do better than expected in their university studies, whereas students with better success in upper secondary school underachieve in their university studies. Furthermore, students whose success is better than average during the first academic year are also better in the following years." In other words, prior performance in upper secondary school does not correlate with performance in university. However, good performance during the first year evidently correlates with good performance at later stages and vice versa (Honkanen 2011).

The awareness of universities on student retention has raisen over last years. There are manifold actions already taken and to be taken by them. One of the major changes taking place in Aalto is the bachelor's degree program reform. As a result of the reform, first-year studies will place particular emphasis on providing personal study guidance, encouraging students to study full-time and monitoring student progression more systematically. The new programs will be launched at the beginning of the 2013/2014 academic year.

Ireland

In Ireland feeling that the students have made the "wrong choice of program" has been identified as the most significant factor contributing to dropout among higher education students (e.g. Baird 2002, Mathews and Mulkeen 2002). On the other hand, program choice is also demonstrated to become a less significant factor as students proceed further with their studies. (Baird 2002) The fact that the majority of students are withdrawing from programs, which they initially ranked among their top three preferences, also indicates a disparity between students' expectations of a program before entering third level, and their experiences of it upon arrival.

Several examinations of dropout in Ireland have also attempted to ascertain whether or not there is a correlation between the number of points a student achieves in the Leaving Certificate examinations, and subsequent withdrawal from third level. The findings demonstrate somewhat various results. The relationship between Leaving Certificate points awarded and performance at third level seem to vary, among other things, according to the field of study. (Lynch et al. 1999) Some researchers (e.g. Mathews and Mulkeen 2002), however, have found a correlation between mathematics achievement at Leaving Certificate and student progression at third level.

Research carried out for the Irish Higher Education Authority (HEA) adds a further dimension to the issue. The research has looked at data from all seven universities in Ireland and found a relationship between completion rates and the points required at entry (the minimum point requirement for entry into a given program which a student must either meet or exceed). The results demonstrate the following; "in programs with high entry points, 81.7 % of students graduate on time and only 9.2 % fail to complete the program for which they first enrolled. In the case of programs with medium entry points, 72 % graduate on time and 15.2 % do not complete their programs. In programs with low entry points and programs with restricted entry, less than two-thirds of the students graduate on time and a fifth does not complete the program." (Morgan et al. 2001). Finally, other research in Ireland also highlights the fact that most withdrawing students return to third-level study within a year of their initial departure, either at the same university or elsewhere (IUA). Mathews and Mulkeen (2002), in turn, have stated that only a very small percentage of students leave third-level education entirely.

Portugal

In Portugal the Ministry of Science, Technology and Higher Education (2007) developed a measure comprising the release of innovative pedagogical pilot projects and research/diagnosis projects aiming to reduce the dropout rate in higher education by half. The measure was accomplished with the release of a special program entitled "School achievement, and combat against dropout and underachievement in H.E.", in which 23 intervention projects and 5 research projects were selected. As an example, one of the projects included a case study, conducted in the Engineering Faculty of Oporto University, in which the representation of school success and failure concerning management bodies, student support offices, teachers and students was analysed. The study discovered that for the students, dropout means above all incapacity of adaptation to higher education and failure of the student support offices and of the management strategy. The student support offices in turn perceived it as a vocational problem, while teachers blamed the management for unawareness of the problem, high number of students per class, the obligation to attend the classes, and the low motivation of students to attend the classes. The management also identified the last two items as being a problem, in addition to vocational issues and course preference.

In terms of school success, the students identified some best practices that could promote school success. These included for example the introduction of more motivating pedagogical practices and the presentation of explanations on the impact of class subjects on professional life. The student support offices in turn mentioned the introduction of more flexible pedagogical practices, the creation of socialization areas versus traditional higher education in the classroom, and the communication between all higher education agents as practices to be promoted. Furthermore, the teachers found that they should invest more time in teaching rather than in research. They also advocated the introduction of pedagogical practice seminars and the submission of pedagogical surveys as potential best practices. Finally, the management bodies mentioned the need to identify students' learning profiles as they enter university, the implementation of learning evaluation diagnosis instruments, the early course unit planning (identifying the required volume of working hours), the creation of student support offices, and a better communication between all management structures within the institution in order to increase academic success.

Another project studying the academic success and strategies in science and engineering programs concluded that the absence of pedagogical activity support units in Portugal implies difficulties in the implementation of intervention strategies. In the project, students identified the teachers' motivation and interest showed in them, the proposal of extra class assignments, the encouragement of autonomous work with teacher feedback, the teachers' guidance during school activities and a good relationship between students and teachers as pedagogically positive aspects. On the other hand, they also identified low encouragement to do autonomous work, low feedback to the students' work, and low incentive to group work as pedagogically negative aspects. Measures that were found to have a positive impact on students' academic success in turn included for example the diversity of evaluation methods, the correlation between old subjects and new subjects, more exercises, more interactive and dynamic classes with students' participation. The students also found that teachers could give more feedback and promote group work, be more in touch with the students, as well as be more available and motivated. The teachers responsible for the classes with lower grades in turn explained that students' underachievement was mainly due to their approach to the class, lack of study strategies, low commitment and endeavor, low autonomy and prejudice related to the class.

Some Portuguese researchers question an evaluation of academic success considering uniquely retention or persistence rates, and consider academic success an inclusive concept, where cognitive and metacognitive skills, as well as behavioural and communication skills should be considered, since they're of paramount importance for the student, the HEI's, and for the employers of HE students (Tavares & Huet Silva, 2001).

Sweden

The Swedish National Agency for Higher Education, sometimes in collaboration with Statistics Sweden and different government agencies, has measured and explored student retention since the mid 1960's. This has resulted in a number of different reports and recommendations. "Strengthened support for studies" (2009) evaluated and provided proposals on how the new regulations for student grants could stimulate higher throughput. "Studies – Career – Health" (2007) evaluated the university colleges' and universities' work with educational guidance, career counseling and student health. Another national report on "Good examples of how universities and university colleges work with educational guidance, career counseling and student health care" (2007) also provided suggestions on a number of practical steps that can be of benefit and applied in practice. The need for a good grounding prior to university studies and how this grounding affects study results at university has also been evaluated in "The Link between grades in upper-secondary school and achievements at university" (2007) and in "Beginner students and mathematics; mathematics teaching during the first years of technical and scientific education" (2005). Of particular interest has been the report "Reasons for study departure" (2010) which explores reasons for study departure given by students leaving vocational programs before achieving a degree.

A number of universities and university colleges in Sweden have also conducted studies regarding student retention. An early work in the field was Hede and Wikander's (1990) study on "Interruptions and study delays in legal educations; a follow-up of the admissions round fall term 1983 at Uppsala University". In the study, the authors created a model that assumes three main reasons for student departure. Many studies have also provided suggestions on how to prevent students from dropping out of university, by for example offering individual, academic and social support measures and by providing feedback that can serve as an early warning system. The measures outlined include systematic monitoring of academic performance, student counseling, career guidance, strengthening the student's professional image and relations with employers, various forms of mentoring programs, measures to strengthen the contact and affinity between teachers and students, and teaching efforts.

Among technical universities and university colleges, Linköping University has conducted studies involving technology students' views on life as a student as well as proposals for and evaluations of interventions designed to prevent students from dropping out. The project "Young Engineer" has also reported about the problems and difficulties in various engineering courses and the need for better grounding especially in mathematics. Wikberg-Nilsson at Luleå University (LTU) in turn has evaluated the situation, provided suggestions and studied measures to support increased throughput in the report on "Mentoring for Students" (2008). Other studies and proposals for action include for example "the LTU model for increased throughput and dropping out of program courses" 2006–2007 at Luleå University. Finally, Stockholm Academic Forum has published a study entitled “Hope or drop out?” (2007) which deals with those students who decide to persist. A lot of research emanating from both universities and other interested parties has also touched upon the study of psychosocial aspects and student life. Mental health problems, stress and even burnout are highlighted as a concern in most of the studies.

Furthermore, the research group in Physics Education Research at Uppsala University has explored student retention and related issues in physics and engineering programs since 2005. The studies have underlined the importance of students' experiences of the disciplinary and educational discourse (Johannsen 2007). The gender perspectives of the educational experience have also been investigated (Danielsson 2009). Andersson and Linder (2010) for example have studied the relations between motives, academic achievement and retention in the first year in the degree program of Engineering Physics at Uppsala University. In their study four different discourse models of how students explain their reasoning for enrolling in the program were identified. These models included “program student”, “engineer to be”, “cosmic explorer” and “convenience student”. The group using the program student model showed the highest fraction of successful students, whereas a majority of the students using the engineer to be model were unsuccessful or left the program. Students using the convenience student model in turn had the largest fraction of unsuccessful and leaving students. On the other hand, even more recent studies at Uppsala University have also shown that the different student profiles as well as their impact on student success can also vary over the years.

Recently initiatives at the Physics Education Research group have also produced materials for research-based initiatives to improve student retention (Andersson, Chronholm and Andersson 2011). Recent work of the group has explored the complexity of issues behind student retention (Forsman 2011, Forsman, Linder, Moll, Fraser, and Andersson 2012), Forsman (2011) has done research on students' networked interaction and how it can provide researchers with (1) a deeper understanding of how students' network interaction is dependent on, but not determined by, the social and academic systems of the university (Tinto, 1987, 1993, 1997), and (2) show indicators for academic success.

In “Young Engineer” project 72 Master of Science in Engineering programs were compared related to the size of the program and success of studies. This study shows no evidence for correlation. Program size as such obviously does not give better study environment for the students in Sweden. Another finding of the same project was that number of credits after nominal study time correlates with the number of credits after one year in these 72 programs. Therefore, good results in year one could be a predictor for good results further on in the program.

Gothenburg University made 2007 a national statistical investigation concerning what subjects in upper secondary school had the greatest impact on number of taken credits in the first year of higher education. The investigation clearly expresses the correlation between higher grades in math and physics and better results during the first year of higher education for engineering programs and for studies of economy. Studies made in KTH confirm the conclusions of the Gothenburg study.

In Sweden incorrect choice, dissatisfaction with education, poor academic performance, and lack of social contacts have been identified as the most significant factors contributing to dropout. In the Swedish project “Young Engineer” in turn an interview survey indicated that the students who stay and intend to graduate usually give two reasons: first, they say that the main factor for study success is to get study mates and form a study group early, preferably in the first semester. Second, they argue that those who drop out “where not meant to be engineers” since they did not socialize with the study culture.

National and institutional contexts

In this chapter we will have a closer look at the WP8 comparison framework, its purpose and results. We will provide an overview of the national/institutional degree structures, progression rules, student selection mechanism and numbers, funding and monitoring systems as well as explore the retention phenomenon in figures. Besides the comparison framework, references are made mainly to the country reports.

International comparison framework

The purpose of the comparison framework was to gather comparative information on student retention and parameters effecting student retention. In other words, the framework provides an overview of the national and institutional retention and progression strategies, monitoring systems, statistics and good practices in the ATTRACT partner countries and universities. The framework parameters (see table 3) were chosen by the working group on the basis of the literature review, country reports and experiences of partners. The data was collected mainly in 2011.

The parameters of comparison as well as the results by country and institution are described more in detail in the comparison framework. In what follows we will, however, elaborate some topics a little further: funding regimes, student selection and numbers; degree structures, rules of progression and policies behind; and student monitoring systems.

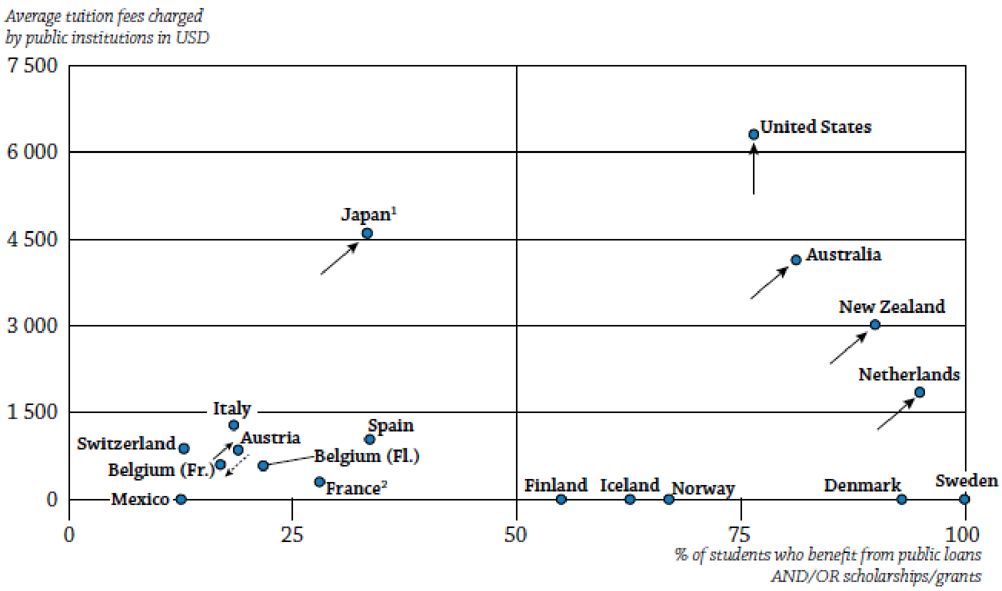
Table 3: The parameters of the comparison framework.

Topic	Feature
Background information	Funding system
	Selection mechanism(s)
	Student numbers
Retention policies and strategies	National
	Institutional
Progression rules	National
	Institutional
Student progression monitoring systems	Centralized (monitoring progression of groups, individuals)
	Decentralized (monitoring progression of groups, individuals)
Statistics	Prior to studies
	The first 1–2 years
	During education
	Graduation
Activities, good practices and their impact	Prior to studies
	The first 1–2 years
	During education
	Before graduation
Student association role	Roles and activities in academic integration

Funding regimes, student selection and numbers

In all countries the core funding sources include government, student fees and other sources. Only in Finland and in Sweden higher education students do not need to pay any tuition fees (see figure 12). Tuition fees charged by educational institutions affect both the cost of education to students and the resources available to institutions. Subsidies to students and their families also serve as a way for governments to encourage participation in education – particularly among low-income students– by covering part of the cost of education and related expenses. (OECD 2011).

Figure 12: Relationships between average tuition fees charged by public institutions and proportion of students who benefit from public loans and/or scholarships/grants in tertiary-type A education (academic year 2008/2009). (For full-time national students, in USD converted using PPPs). Source: Education at a glance 2011, chart B5.1



1. Tuition fees refer to public institutions but more than two-thirds of students are enrolled in private institutions.
2. Average tuition fees from USD 190 to 1 309 for university programmes dependent on the Ministry of Education.

In countries with tuition fees, the amount varies depending on e.g. the program taken and the institution being attended. In some countries there seems to be also a relation between the share of public funding and institutional retention figures. For example in Finland, majority of the basic funding from the Ministry of Education and Culture is based on the quality, extent and impact of operation where the funding criteria include, in addition to those related to research, also e.g. the number of completed Bachelor's and Master's degrees, the number of Bachelor's and Master's students who have completed at least 45 ECTS credits per academic year[65], and the number of students who have started their studies in year n and completed their degree seven years later.

The main reasons behind current entry requirements in turn are the need to determine whether applicants are motivated, have the relevant aptitude and hold the requisite knowledge. With the exception of Belgium and Italy, where all students with an upper-secondary school diploma are eligible for entry to university education, achievement in mathematics and often also in other subjects, such as physics and/or chemistry, is a requirement in all the rest. In other words, the selection is based on national or entrance examination results which mainly focus on determining whether the applicants hold the requisite knowledge for a specific program. Student motivation or aptitude is seldom measured. Motivation, however, is of relevance. Robbins et al. (2004) for example have argued that the best

[65] The Finnish Ministry of Education and Culture is currently re-evaluating its funding criteria, and starting 1.1.2013 one of the leading funding criteria will be the number of students who have completed at least 55 ECTS per academic year.

predictors of good performance in university are not students' prior achievements but (1) their belief in their own capabilities and (2) performance motivation.

Furthermore, in Italy where generalized aptitude tests are currently used for information gathering only, it has been discovered that the aptitude test results correlate highly with student performance; students with high test results are less likely to drop out after the first year than those with low test results. Also results from the calibration mathematics test used by KU Leuven seem quite promising in terms of predicting success rates and offering the academic staff an estimation of the students' mathematical skills.

Student numbers in the partner universities are quite different; while some universities have less than 1 000 engineering students in total, others reach more than 10 000 students. Over the last decade also the number of applicants and new entrants to engineering programs has steadily increased at least in Aalto, IST, Polito and TCD. Also more men than women have opted for engineering. Most partners reported that the share of female students in their engineering programs is somewhere around 20–30 %. In terms of student retention, there is no evidence that student numbers as such would directly correlate with student retention or progression.

Degree structures, rules on progression and policies

It is true that both the structure and the duration of studies differ to some extent from country to country (see table 4), but it is the European Credit Transfer and Accumulation System (ECTS) where one academic year consists of 60 ECTS credits that is used in all of the countries. In terms of student retention, however, there is no clear evidence that the degree structure as such would correlate with student retention or progression.

Table 4: Structure and duration of studies in different countries.

Country	Degree	Credits (ECTS)	Length (years of full-time study)
Belgium, Finland, France, Germany, Italy, Portugal	Bachelor Master	180 120	3 2
Sweden	Bachelor Master	180 120 (or 60)	3 2 (or 1)
Ireland[66]	Bachelor	240	4

[66] Currently, the target time for completing a Bachelor's degree in Ireland is 4 years (240 ECTS). However, starting from the beginning of the 2012–2013 academic year also Trinity College will increase the duration of its engineering degrees from the current 4-year Bachelor's degree to a 5-year Master's degree (300 ECTS).

While student retention is a major concern in most countries, it is also something that is seldom dealt at national level but more at institutional level. Also the strategies and action plans dealing with student retention and degree completion tend to vary from one institution to another, and in fact only a few universities reported having a separate retention strategy or numerical goals for their student retention and progression. These were usually covered indirectly in some other strategies or action plans in the form of e.g. tutoring, guidance and counseling, quality of teaching, or student-teacher ratios.

The conditions for progress that individual universities have set for their students and the way how these conditions are being followed also vary to some extent. For example, at TCD there are two annual exam sessions – one at the end of the academic year and a supplemental set for those students who fail to pass the first. Failure of these supplemental exams results in repetition of the academic year, requiring the student to pay full tuition fees for the year being repeated (about 6,000 €). However, this is not the case at Aalto, where students are entitled to fail an exam three times, after which they should only negotiate with the course responsible how to complete the course. Practices, however, vary depending on the course responsible and students often tend to have an unlimited number of exam resists. In addition, in Finland students are not required to pass each academic year as a whole.

At IST in turn, or in fact in the whole of Portugal, there is a separate law on the exclusion of students with low academic outcomes. In other words, if after a certain number of enrolments, a student has not completed enough credits, he/she will be excluded from the university for one academic year. Also, in Sweden there are guidelines on how many credits the students must have completed to be able to proceed from one level to the next.

Student monitoring systems

Monitoring of student progression and success vary depending on a number of national and institutional factors, such as retention strategies, funding systems, progression rules, and size and structure of the programs. At national level the monitoring tends to be quite systematic, but mainly for statistical purposes. There are also differences in how the statistics are produced. National statistics for example often tend to provide data by calendar year, while universities in turn usually operate by academic year.

At institutional level, in turn, processes and methods vary even between individual programs. However, we have seen during the lifetime of the project that universities are seriously improving their monitoring systems. Generally, it seems that in smaller and more tutoring-oriented programs where the rules on progression are also tighter, the follow-up of and support for individual students is often more systematic than in larger programs allowing more academic freedom. In smaller programs and courses where the teachers know their students personally the monitoring of students is also rather easy, since missing students are so easily noticeable. Student who lack behind are contacted personally. In other words, proactive measures are taken to identify already potential students at risk.

An example of a relatively small (about 700 students) and more tutoring-oriented engineering department with tight rules on progression is TCD. At TCD the students are required to pass each academic year as a whole, and the follow-up of individual students and their study progress is covered through the university's very systematically organized Tutorial Service. Indeed, the existence of the Tutorial Service is generally perceived within the university as something that is integral to the TCD experience and in part this may be due to the fact that it is unlike anything offered in the neighboring universities. The importance of human factors in the monitoring of student progression is nevertheless significant, since TCD has one of the lowest dropout rates among all ATTRACT partners.

In some countries, such as Finland and Sweden, the follow-up of individual students is in turn mainly carried out through the student financial aid system. In other words, students who do not make satisfactory progress do not receive their financial aid. In order to qualify for student financial aid in Finland for example, one must have gained admission to HE studies, make satisfactory progress (min. 5 ECTS per study month) and be in need of financial assistance. Students who do not make satisfactory progress, may lose their financial aid. On the other hand, students also get to decide for themselves how many months each academic year they plan to study and apply financial aid for. In other words a student, who has completed for example 15 ECTS within the academic year and has received financial aid for only 3 study months, is entitled for his/her study grant. Thus, the student financial aid system is not an absolute progress monitoring system. For example, University of Oulu Faculty of Technology took in use a specific tool so that all the teachers, and study affairs staff members can easily follow monthly results of students' performance.

In Sweden the student financial aid system is slightly different. One must apply for a study grant one year at a time. In order to receive a study grant, the student must be able to manage a sufficient number of courses and acquire enough university credits to be eligible for further study grants. In addition, the student grant may be demanded back if the student is not registered on a sufficient number of courses based on the application submitted.

Different dimensions of student departure

While in some partner universities and even countries student numbers in technology and engineering education have slightly increased over the years, dropout on the other hand has decreased. Generally, women have also been more likely to graduate on time and complete their studies than men. On the other hand, there are also differences between programs and years. As aforementioned, student retention and degree completion are rather complicated phenomena influenced by a variety of factors, and some of these indicators can indeed be quite volatile. We should, therefore, focus more on analyzing trends in different programs over time instead of just momentary snapshots. At the same time, in some universities the beginning of the Bologna Process has also had the effect that the statistical follow-up and comparison of results over time has become almost impossible, since comparable long-term data simply does not exist anymore.

In terms of student withdrawals the first two years of studies are the most critical, especially the first year. In some countries problems exist also at later stages, often just before graduation. In Finland for example, most dropout decisions are done after the first 1–1.5 years at the university, even if the actual dropout might take place only later. In other words, students register as absent several times before officially dropping out (Erkkilä 2010b). Especially in Finland and in Sweden, (temporary) dropout also occurs among those students who are already in the final stages of their academic career – that is they only need to finish their thesis and/or to complete a few often so-called bottleneck courses to graduate – and who enter the working life just before graduation. For example in Finland – in a country of about 5.5 million inhabitants – there were about 15 000 university students whose graduation depended only on their thesis in 2007. (Finnish Ministry of Education 2007) In other countries, for example Ireland, only a small number of students withdraw after the first two years of studies. At TCD this equates to approximately 1.2 % of students, while for the first year the non-completion rate is 10.5 % and for the second year 3.6 %.

Results of the activities taken by the project

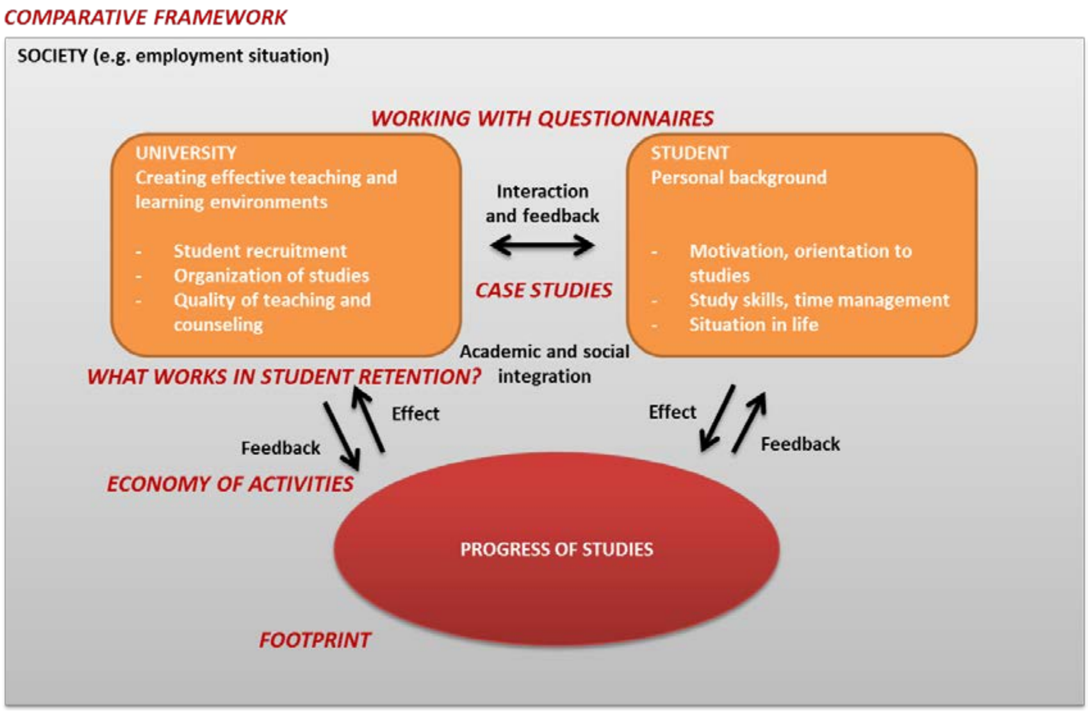
In this chapter we will have a closer look at the results of the activities taken by the ATTRACT WP8 working group by simulating the costs of student retention and related initiatives, the outcomes and conclusions of the "What works in student retention?" survey and the different field trials, namely "Footprint", "Working with questionnaires" and "Tutoring, mentoring and academic integration". References are made to the relevant sub-reports.

As aforementioned, building upon theories such as those by Tinto (1987, 1993) and Bean (1980), it can be argued that educational persistence is a product of complex set of interactions among personal, institutional and external factors where a successful match between the student and the institution is of particular importance. In the ATTRACT WP8 we were able to take a closer look at some of these elements in the rather rich and complex system. In figure 13 the different activities carried out by the partner universities are mapped against this theoretical framework.

Calculating the costs of student retention and related initiatives

The economy of dropout and student retention is in the interest of societies and institutions. Calculating the costs of dropout or economical effectiveness of various actions to support student retention is a complex issue. In what follows we will not go into detail about macroeconomics but refer to the OECD's annual Education at a Glance.

Figure 13: ATTRACT activities mapped against the theoretical framework.



Investigating the various "what-if" scenarios

A tool developed within the ATTRACT project at TCD aimed to investigate various "what-if" scenarios with regard to retention initiatives, their effectiveness, their cost, and the net benefit. In what follows we demonstrate the tool with some illustrative information.

The first part of the tool "ROC" is for the receiver operating characteristic (see figure 14). The ROC indicates what level of discrimination an institution has – that is how well those likely to drop out can be identified. Varying levels of discrimination from perfect to zero can be modelled. See pages 106 to 107 for further discussion.

In comparison we can also use the information about expenditure per student to estimate the cost of student dropout. This may be reasonable, even though the fixed costs of institutions are only indirectly dependent on the number of active students. The expenditures of universities have been estimated by for example the OECD. Figure 15 shows the expenditure per student by educational institutions (tertiary level). In figure 16 this information is shown relative to GDP per capita in 2008. (OECD 2011)

Figure 14: The Receiver Operating Characteristic – ROC indicates how well those students likely to drop out can be identified by the institutions.

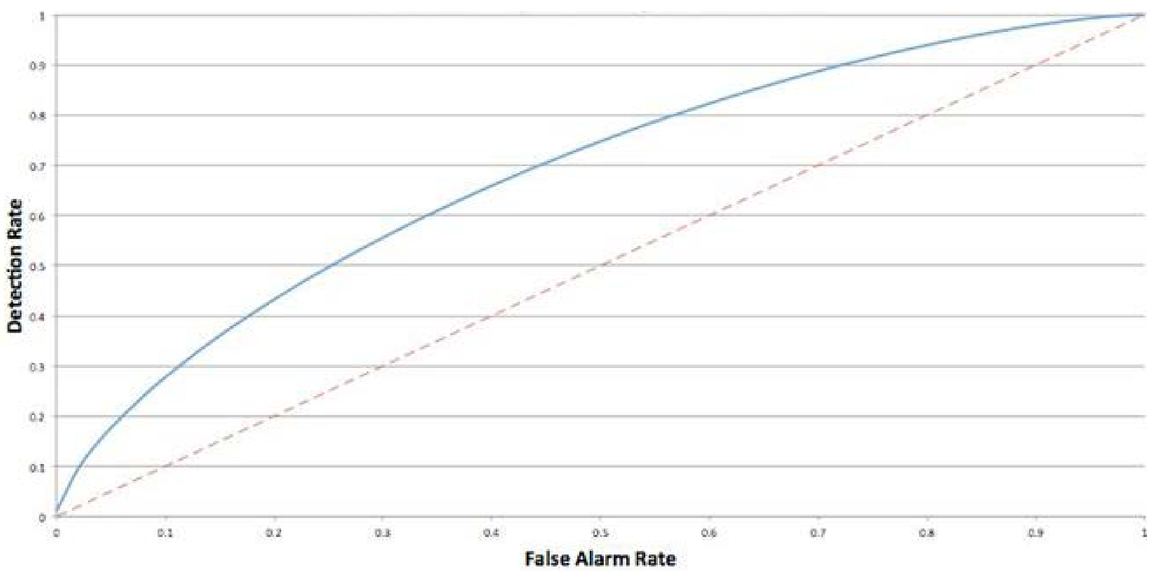
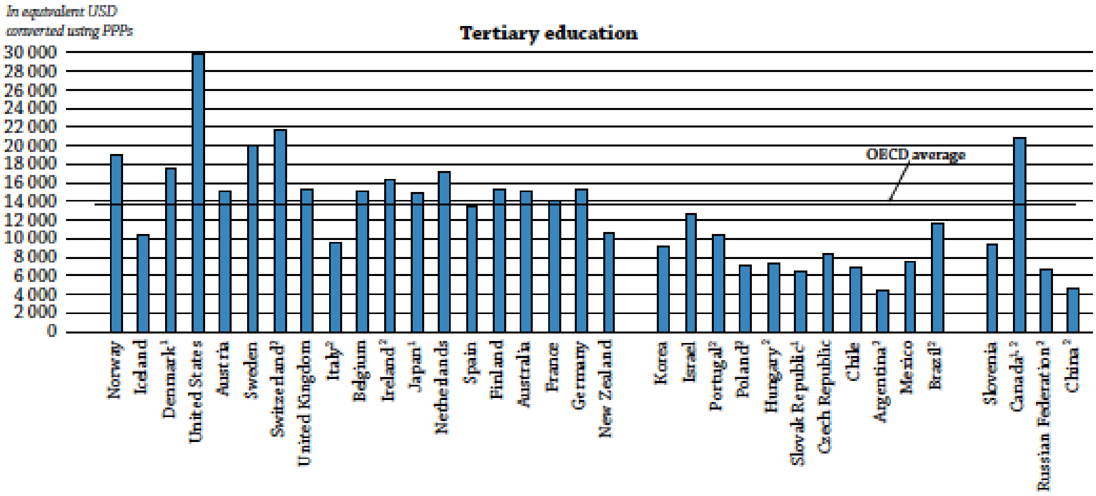
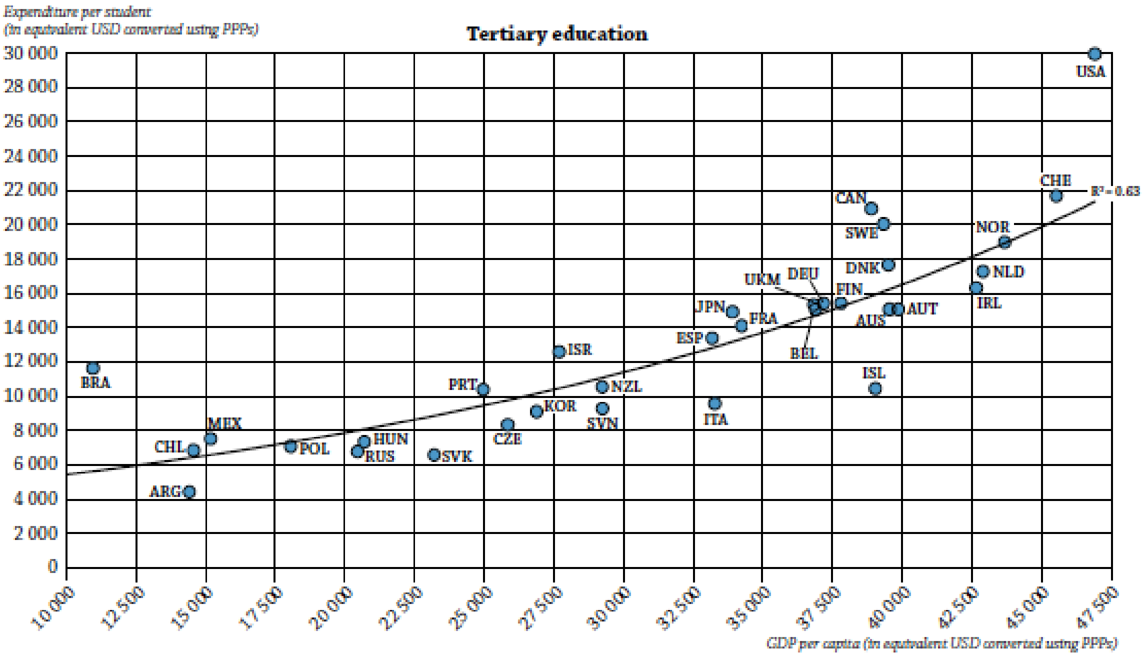


Figure 15: Annual expenditure per student by educational institutions (tertiary level) for all services (2008) (Education at a Glance 2011, chart B1.2).



1. Some levels of education are included with others. Refer to "x" code in Table B1.1a for details.
2. Public institutions only (for Canada, in tertiary education only; for Italy, except in tertiary education).
Countries are ranked in descending order of expenditure per student by educational institutions in primary education.
Source: OECD. Argentina, Indonesia: UNESCO Institute for Statistics (World Education Indicators Programme). China: China Educational Finance Statistics Yearbook 2009. Table B1.1a. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).
StatLink http://dx.doi.org/10.1787/888932460914

Figure 16: Annual expenditure per student by educational institutions (tertiary level) relative to GDP per capita (2008) (Education at a Glance 2011, chart B1.5).



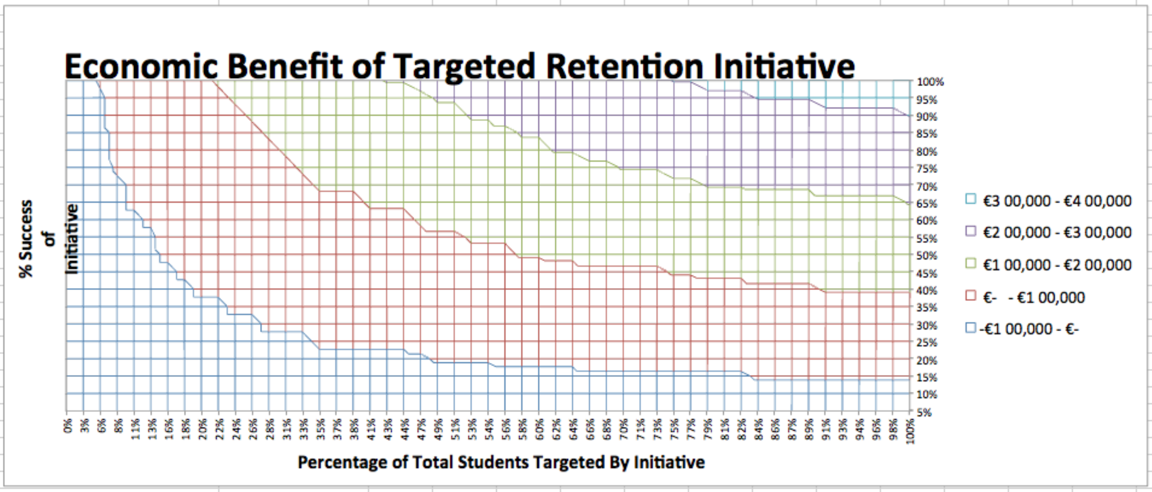
Note: Please refer to the Reader's Guide for the list of country codes used in this chart.
Source: OECD. Argentina: UNESCO Institute for Statistics (World Education Indicators Programme). Tables B1.1a, B1.4 and Annex 2. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).
StatLink http://dx.doi.org/10.1787/888932460971

The second part of the tool contains space for the user to enter specific information about his/her institution – that is dropout rates, class sizes, economics etc. (see figure 17). This is also where the user can examine the economic impact of any particular retention initiative he/she has in mind. Various costs/benefits are allowed to be included, including a cost (over and above the cost of running the initiative) of devoting resources to students who would not have dropped out (e.g. user of the tool may feel that "tagging" some students has a negative effect on morale, so he/she can assign some economic cost to this if he/she likes.).

The graph below shows the economic benefit for various success levels of a particular initiative given the cost information put in above. The "break-even" line is the line between red and blue areas. The line may seem a little "jagged" as we are dealing in discrete units (individual students). The x-axis is the percentage of the total cohort that the initiative targets, while the y-axis is the success (on those who would otherwise have dropped out) percentage.

Figure 17: The economic benefit of targeted retention initiatives.

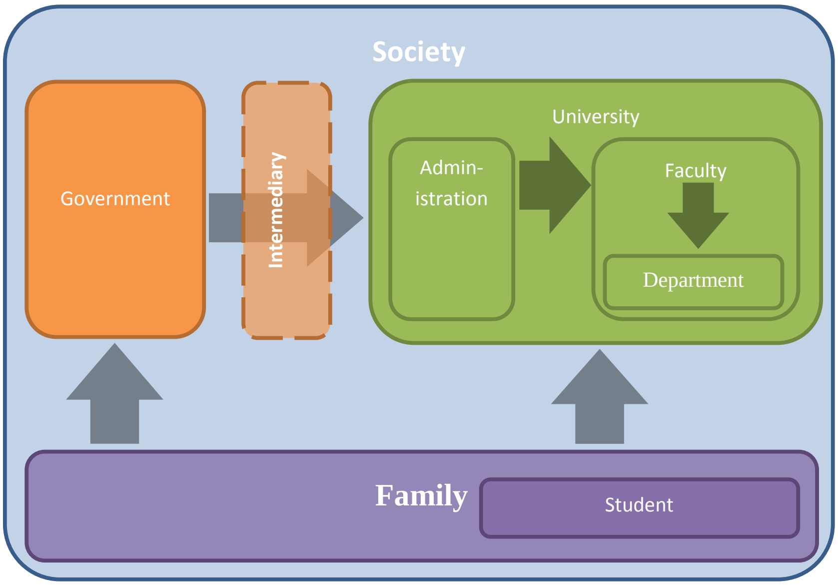
Metric	Value	Notes
Dropout/Failure rate	20%	Percentage of students dropping out or failing (depending on analysis required)
Number of Students	180	Total number of students under consideration
Cost Per Student dropout/failure	€ 11 000,00	Total cost of a student dropout (e.g. lost revenue over the remainder of their studies) or failure
Cost per incorrectly tagged student	€ -	Cost (excluding cost of initiative) of incorrectly tagging student as likely to fail
Est. Cost of Initiative	€ 50 000,00	Budget available
Approx Number targeted	20	Number of students who will partake/be affected by initiative
Total failing students	36	Number of students failing
Breakeven	5	How many students need to be 'saved' to break even, neglecting cost of incorrectly tagging
Gross Success Rate required	13,89%	What percentage of total dropouts need to be 'saved'
Net Success Rate required	25,00%	Percentage of targeted cohort who must be saved



Conclusions

The economic aspect of student retention is important, even if it is not the only factor (or even the primary factor) in decision making. Nonetheless, with generally perceived increasing pressures on universities to be more "business-like" in their management, it would seem timely to give the matter due consideration. There are many "actors" or stakeholders present, and analysis could take place from a range of perspectives – mirroring somewhat the macro, meso and micro paradigm referred to above. Figure 18 below gives a simplified schematic illustration with the arrows indicating flow of money on educational activities of universities.

Figure 18. Economic actors in university education (incl. student retention)



Let us have a closer look at the figure from the perspective of universities. Associated with each student there will be a marginal income/revenue. Depending on the structure of the education system the source of this income may be any or all of government (local or national) or student (or their family), or in some cases may be paid for by an employer. Similarly there will be a marginal cost associated with delivering education and ancillary services to each extra student. The majority of universities will not be set up as profit-maximizing enterprises, and thus it is to be expected that (certainly in the medium term) the balance between income and cost for the average (not the marginal) student will be equal – the revenue associated with each student will cover the associated cost.

The difference between the marginal and average costs is of course explained by the quantized nature of costs incurred by the universities – buildings have to be built, people must be employed, equipment must be purchased etc. – with such strategic decisions being based on estimated utilization. However, the income is typically denominated in terms of the average student – i.e. student fees, governmental support etc. Furthermore, resource planning is based largely on the assumption that a majority (if not all) students will progress successfully through the system. It may readily be seen therefore that "saving" a student who would otherwise have left before completing their studies will accrue a financial benefit to the university – in addition to the benefits to the student themselves.

Should the university seek to put in place new initiatives (or to increase funding to current initiatives) it needs to know that this investment can be economically justified. At the most basic level this would require that the cost of the initiative is matched by the marginal revenue from the extra students retained within the system. There may of course be other less quantifiable benefits which justify such investment when considered in addition to this simplified cost/benefit analysis.

What works in student retention?

A survey of institutional profiles on student retention was conducted in the partnership. The survey was based on an instrument called 'What Works in Student Retention?' owned by a company called ACT Company. Our interest was to test how the tool could help in for example finding common retention practices and other common factors among the partners, taking notice and being aware of the new and different retention practices (using, as a starting point, survey data on practices common in the USA and collected through ACT), and reflecting on how many of those practices could be implemented and with what outcomes in European Engineering Schools. The survey was implemented in spring 2011 among the partner universities. Altogether 10 universities answered to the survey. The topics of the survey included:

- Background information.
- Retention and degree-completion rates
- Factors affecting student attrition at your school (42 factors).
- On-campus retention practices (94 factors).
- Items that have the greatest positive impact on retention at your school.

The full report of the study is available for download on the ATTRACT website. Here we sum up the results briefly.

Summary of the results

The analysis of responses indicates some differences in retention rates. Generally, the northern and central European countries had higher retention and the southern countries lower retention rates between the 1st and 2nd year. The main reason might be the differing student selection criteria and progress rules of the universities. For further information please visit the comparison framework in the appendix. In terms of degree-completion rates, the realities are slightly different. Two of the respondents presented really high completion rates, but the remaining respondents had a completion rate of about 65 % on average. It seems that when it comes to completion the geographical factor loses significance.

The majority of the identified factors affecting student attrition in turn seem to be mainly intrinsic factors that the university cannot directly control: among the 10 identified factors, only 4 could be regimented by the universities. The factors that the respondents identified as having the smallest impact on attrition were all related to the social, cultural or material way of living in the university: loans, facilities, activities, security and transition support programs. The reflection of this result is that there are many factors which seem to be out of the direct influence of universities.

Furthermore, the most common on-campus retention practices mentioned by the partners were "faculty use of technology" and "faculty use of technology in communicating with students". The practices with the greatest positive impact on retention included "peer mentoring", "internships", "staff mentoring" and "vocational aptitude assessment". The practices with the highest mean within the most frequent chosen by the partners were in turn "peer mentoring", "mathematics centre/lab", and "remedial/developmental coursework".

For benchmarking purposes, it was also interesting to note that some of the on-campus retention practices that the partners had chosen were also identified as factors having a positive impact on retention. These included "supplemental instruction", "performance contracts for students in academic difficulty", "assessing student performance", "study skills course, program or centre", "tutoring" and "academic advising centre". For further information about these activities, please visit the case studies available in the appendix.

Finally, the question about the assessment of different practices was evidently interpreted differently by the respondents. Some general trends, however, were also discovered. The three factors the majority of partners reported to assess were "student employment opportunities", "level of job demands on students" and "availability of academic advisors". Also factors such as "level of student motivation to succeed", "commitment to earning a degree", "quality of interaction between staff and students and between faculty and students", "student study skills", "student personal coping skills", and "level of student preparation for college-level work" were reported by some of the partners. Consequently, the obvious need for improving assessment in these areas led to the organization of a workshop called "Knowing our students – Working with questionnaires" (Uppsala, May, 9–10, 2012).

Comparison with the North American submission results

In what follows we sum up the main similarities and differences between the ATTRACT results and the "What Works in Student Retention?" North American submissions (2010). The comparison is made with the public sector of 4-year college/university programs. Please note that the samples have a distinct dimension; the North American example is a national survey, whereas we only cover 10 European universities.

Majority of the partner universities had no specific person responsible for the coordination of retention programs, whereas in the USA only 31 % of the colleges/universities in the public sector reported not having such a person in their college/university. Furthermore, only two of the universities reported offering online instruction, about 5 % of their total credit hours, whereas in the USA even 39 % of the public schools mentioned that they offered at least 5 % of their total credit hours in online instruction.

Regarding retention rates (for the partner universities which provided an answer to the question on retention) between the 1st and 2nd years, an estimated mean value of 66 % for the partner universities was calculated which was lower than in the USA where the equivalent figure was about 74 %. The degree-completion rates, on the other hand, were higher among the ATTRACT partners, approximately 70 %, whereas in the USA the equivalent figure was about 50 %. Furthermore, about 20 % of the ATTRACT partners and about 23 % of the US public schools claimed to have a specific goal for their degree completion rate.

When comparing the top 10 attrition factors with the highest mean among the ATTRACT partners and the US public schools, it can be concluded that the "level of student preparation for college-level work", "student study skills", "level of student motivation to succeed", "level of student commitment to earning a degree", "level of job demands on students" and "student personal coping skills" were identified as the main attrition factors in both samples. The main difference between the partner universities and the USA was the level of importance that the North American schools attached to financial, social and economic factors.

Interestingly when comparing the practices with the highest occurrence, we could observe that only five of them were shared by both groups of respondents. These were "faculty use of technology in teaching", "individual career counselling", "faculty use of technology in communicating with students", "instructional (teaching) techniques" and "interdisciplinary courses". When comparing the most frequent practices with the highest mean in turn, we could observe that only four of them were shared by both groups: "mathematics centre/lab", "tutoring", "advising interventions with selected student populations" and "study skills course, program or centre". In the North American context, there were also two common practices that could be beneficial when applied to a European context, namely the "freshman seminar/university 101 (credit)" and the "integration of academic advising with first-year transition programs".

Reflection on the usability of the tool

The study shows that the originally North American tool has to be tailored to the European context. This includes also defining the academic terms used. The challenge is that definitions for different academic terms vary from country to country and are potentially lost in translation. However, there is also the need to find methods and tools to compare the practices of different universities and even more important, to learn from one another about what works in student retention. In order to benchmark one another's practices, systematically gathered background information is required. The USA based tool may be a good starting point to develop a more specialized method for European universities.

Footprints of programs

There has been a lot of discussion in the working group about "what works in student retention". To be able to discuss this indicators that measure and monitor student retention, progression and graduation are essential. Discussion over national and institutional boarders, however, requires that one can agree upon similar and comparable indicators or descriptions of retention and graduation rate. The field trial Retention Footprint tested the usability of a method for describing engineering education across different universities in this matter. The footprint was originally developed in a Swedish project called the "Young Engineer" (Ung Ingenjör).The full report of the field trial is available on the ATTRACT Project website.

Implementation

1 Creating the framework

The footprint used in the Young Engineer project aimed to visualize throughput in different programs, but as the focus was more on retention we decided to name it the Retention Footprint. Also as the systems for measuring and keeping figures and statistics, as well as the systems of running education differ quite significantly between countries, it was also decided that we should not try to find "19 indicators" as in the original footprint but test if a comparable footprint could be produced at each university, and as a result discuss the usefulness of this method.

2 Defining the indicators and areas of investigation

It was decided already in the beginning that Swedish definitions would be used as the basis for comparison. Then each university could try to identify or construct an indicator as similar as possible, and each university tried indeed to create and find similar data on their education. As KTH already had a computerized system for producing Retention Footprints it was decided that each country should choose a suitable engineering program for their analysis and that at least KTH should produce a footprint in the same engineering area for comparison. The type of program chosen was a Master of Science in Engineering, which in most of the partner universities, except for TCD, is a 5-year program. The different areas to choose from (based on Master's programs at KTH) included:

- Biotechnology
- Computer Science and Technology
- Design and Product Realization
- Electrical Engineering
- Vehicle Engineering
- Industrial Engineering and Management
- Information and Communication Technology
- Chemical Science and Engineering
- Mechanical Engineering
- Materials Design and Engineering
- Medical Engineering
- Media Technology
- Microelectronics
- Civil Engineering and Urban Management
- Engineering Physics

Creation of the footprints

As a result, each university delivered the data for creating footprints together with a description of how the footprints had been produced and if there were any limitations with comparability. Then KTH created the footprints for each program and displayed the footprints in groups of similar programs. Each university also got to compare their footprints with others'. However, as comparability of footprints was not guaranteed, it was decided that for a wider audience they would be presented anonymously.

Table 6: Footprint indicators.

Indicator	Purpose (Swedish definition)	Remarks
Number of applicants	To show students' interest in the program	Here it seems that all partners could produce a comparable figure. However, we must also take into account the differences in appliance, acceptance and registration for higher education. The volume of education in each country also differs quite significantly which means that the numbers are not directly comparable.
Number of active students	To identify a cohort to be followed through the program, not including new students or excluding drop outs or students leaving the program	Here not entirely comparable figures could be produced. However, the patterns of the different footprints are still somewhat comparable.
Credits after the first year, median	This is the first "retention indicator" and it is meant to indicate how the cohort has proceeded after the first year	All partners, except for TCD, could deliver comparable figures.
Percentage of students with more than 40 credits after the first year	An indicator that is supposed to show to what level the cohort is prepared to transfer to the second year	This indicator does not fit all countries as it is very much a Swedish indicator; in Sweden a student must take at least 40 ECTS credits to be eligible for further student financial aid. Some partners also reported that they might benefit more from an indicator showing how many students have completed for example 45 or 55 ECTS credits, instead of 40 ECTS credits, per year. Consequently, as the systems for progression and student financial aid for instance differ so much, this indicator should probably be abandoned.
Credits after 3 years, median	This is the second "retention indicator" and it is meant to indicate how the cohort has proceeded after 3 years – the nominal study time for completing a Bachelor's degree according to the Bologna principles	All partners, except for TCD, could deliver comparable figures. However, the definitions also differ which means that the method must be analyzed and discussed thoroughly before drawing any conclusions.
Credits after 5 years, median	This indicator is meant to indicate how close to graduation the cohort is; the higher the median value, the higher the possibility for graduation in the cohort	All partners, except for TCD, could deliver comparable figures. However, the definition of "active students" affects the comparability meaning that comparison of single values is less reliable.

Graduation rate from the starting program after nominal program length (5 years) + 1 year	This indicator is meant to indicate the rate at which students graduate one year after nominal program length	All universities were able to produce comparable indicators. However, the definition of "active students" affects the comparability meaning that comparison of single values is less reliable. Some partners also reported that they might benefit more from an indicator showing how many students have graduated after 5+2 years, instead of 5+1 years. The values given in the current footprints, however, show how dedicated the students are to graduate "on time".
Graduation rate from any program after nominal program length (5 years) + 1 year	This indicator is meant to indicate the rate at which students graduate one year after nominal program length; in comparison to the previous indicator, this indicator deals with institutional retention, not retention within a program	This indicator was less successful as only a few partners were able to produce such data.

Results

As aforementioned, the retention footprint aims at initiating discussions and further analysis. The graphic presentation in a polar diagram is meant for comparing, finding similarities over time and between programs as well as pronounced differences. As a result a number of retention footprints were produced in different areas of engineering. In figure 18 there is an example for a retention footprint for Mechanical Engineering in four different universities. As shown in the figure, the challenges universities face are also somewhat different – others experience more difficulties in the early stages, whereas others in the later stages.

Conclusions

The field trial shows that it is difficult to find comparable indicators due to differences in educational systems and ways of measuring and producing statistics, and the willingness of organizations to produce indicators others than the ones they normally use. Furthermore, it is essential to describe the purpose of the footprint as no university wants to appear as having bad retention or problems with graduation.

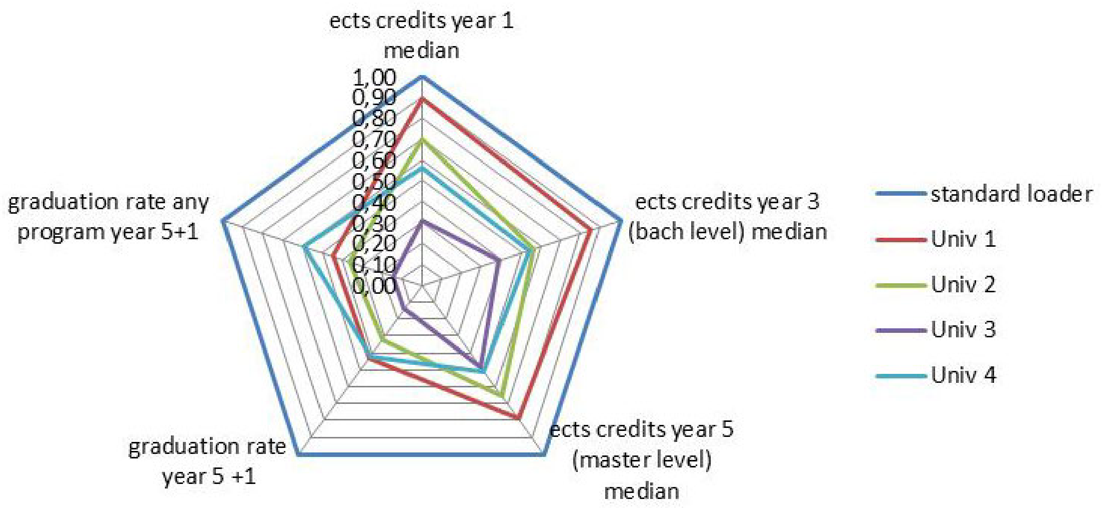
The effort taken by each partner, however, shows that it is possible to find comparable indicators for benchmarking. Also, the variation in footprint patterns within each university, and the variation between programs of different universities show that the footprint can catch differences and similarities in retention and graduation. To actually analyze the differences and similarities, is not possible only by discussing the footprint – each university must dig deeper in reasons and effects regarding retention.

The footprint is a historical picture of retention; it only shows what has already happened. This also means that one can take the results as less valuable. However, the footprint still shows us how defined cohorts proceed in their studies, and as such it gives us indications of how the universities have succeeded in building their educational programs. As a platform for further discussions, the footprint could surely be useful.

Benchmarking through figures and indicators tends to stop by discussing definitions and ways of measuring. With a graphical visualization, such as the retention footprint, comparison can be done by studying similarities and differences in the pattern. The footprints produced in this field trial gave each country a glimpse of how the programs appear together with similar European programs. The main use of the retention footprint in ATTRACT tended to be that the comparison inspired the participating universities to discuss and develop a systematic method for measuring and visualizing student retention and progression. Also participation in a European project where actual comparison (benchmarking) is done gives the universities legitimacy and mandate for working with and changing the matter locally.

However, to make the most out this tool the universities should probably produce several footprints over time to find out if the differences are just temporary. The footprints could indeed be used for analysing trends in different programs over time instead of just momentary snapshots to identify possible trends and even to predict future in a more reliable way.

Figure 18: Retention footprint – Mechanical Engineering.



Knowing our students

Questionnaires are an integral part of the quality work of universities. They provide information about practice and can support our educational development activities. Thus, questionnaires can play an important role when working to improve student retention and building an educational quality culture. Representatives from four ATTRACT partner universities met at a workshop in Uppsala on May 9–10, 2012 to report results, share ideas and discuss practice about student questionnaires. It was soon discovered that, despite the differences in contexts and structures, central issues are often quite the same. The full report of the field trial is available on the ATTRACT website.

Questionnaires as part of the institutional quality structure

- Quality structure

Student retention is seen as the ability of institutions to retain their students and to help them to reach their educational goals. During the workshop discussions often returned to the notion of a quality culture where all participants are responsible for creating and maintaining the environment. We found that these key features provide a good common framework for discussions and comparisons regarding institutional practice and development in different contexts. Quality culture relies on the involvement of its participants, and this part of quality culture is often rather personal and decentralized, whereas the other features are more structural. This led us to discuss quality structure as the more formal part of an educational environment. Formal documents, action plans, support agencies, questionnaire programs and educational leaders are some of the building blocks in this structure.

- Questionnaires and feedback loops

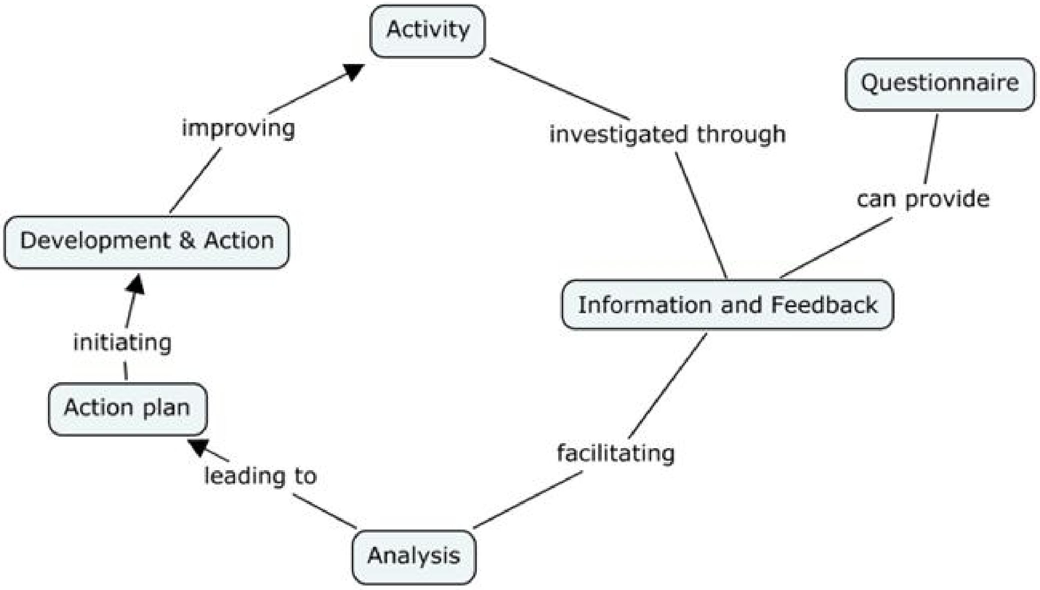
The different activities that build our educational practice are constantly evolving. This development can be enhanced significantly though relevant information and feedback (see figure 19). Institutions build different structures for this and questionnaires can play an important role in the systems. Indeed, questionnaires can have multiple purposes and aims. Two different structural purposes can be identified – that is feedback and feedforward.

The questionnaires can provide means for monitoring development or creation of new activities within the organization, thus, being part of the feedback system of the university. As an example, the course evaluation questionnaires which aim to provide feedback for further development of the courses. The questionnaires can also be used to create feedforward systems, thus, developing practice by identifying critical changes in student populations before the activity actually reaches the critical point. The development of an early warning system aiming to identify students at risk of failing provides a good example. Hence, activities can be created already before the students fail.

- Building the quality structure

The parallel between what Tinto (2010) has identified to be critical for enhancing student retention and what is needed to create a quality culture is apparent. The construction of a quality culture is dependent on active leadership that handles expectations of the institution, provides feedback and support for continuous development, and institution-wide involvement in the culture. One way to provide feedback and involvement of institutions is by using questionnaires not only to gather information from students but also from university staff.

Figure 19: The feedback loop.



Questionnaires in Practice

1 Purpose

Students, teachers and the surrounding society are continuously changing. To be able to talk to the students in their own language, to provide them with the support they need and to see if the students and the university share the same goals, information needs to be transferred from the students to the university and possibly the other way around. Questionnaires can also be used as a tool for starting discussions.

2 Plans and structure

Feedback is perhaps the most important part of a control system and in such a complex system as the university education it is needed at many levels and at many stages. Universities are often interested in what the prospective students want, expect and require from their future education. They want feedback from the present students to be able to take action and change the curriculum. Finally, they also want feedback from the graduates to be able to find out if the educational program has provided them with the appropriate employability. Feed-forward is also critical in monitoring such a complex system.

To ensure the quality of the surveys and that they are done at the right time avoiding too many overlaps with other activities, it is important that the universities have a plan for their questionnaires and that they are incorporated in the educational structure. Universities also need to make sure that questionnaires are not made redundant, and use their existing questionnaires to their fullest. This will certify a systematic approach and make it possible to see trends and effects of changes carried out in the curriculum.

3 Asking the questions

When composing a questionnaire it is important that the goals and objectives are well-defined. Consequently, the questions should be composed in a way that enables the easy compilation and analysis of results. The more relevant the questions feel to the target group, the higher the response rate tend to be and the better statistical conclusions can be made. Furthermore, if the number of questions is too high, also the response rate is likely to decrease. There are also technical aspects that affect the response rate. Questionnaires done and collected during lectures tend to have higher response rates than those performed at home via web for example.

To motivate the target groups to participate in the surveys it is important that they feel that their opinions matter. This requires that the process of how the results are used is transparent, starting from the purpose of the survey all the way to the actions taken as a result of the survey outcomes.

4 Getting the answers

A critical issue regarding questionnaires is the response rate which is of outmost importance in creating a basis for informed institutional decisions. When creating a quality culture, we need to make sure that the answers we get are useful and valid when the questionnaire results are presented. During the workshop, one university reported that their solution to improve the response rates was to link the questionnaires with the system that handled students' course choices. In other words, the students were prompted with relevant questionnaires before their choice of enrolment for the next courses. Also e-mail reminders were sent out to students who had not yet completed their questionnaires.

5 Using the results

Finally, the questionnaires should also be aimed at something that the institutions can actually change. So the use of results is highly dependent on the questions asked, purpose and aims. As an example, the results can be used as a discussion starter, basis for informed decisions, or as an indicator of student satisfaction. The use of the results, however, is critical in creating involvement in the quality culture and improving response rates for the questionnaires. There is also a need to make the whole process as transparent as possible. If the stakeholders are not aware of how their answers are used, they are less likely to provide the institution with the information it needs.

Conclusions

Questionnaires should be seen as one way out of many to get particular information. Furthermore, it has been made clear that it is not only the students that we need to get to know but also the universities. Creating a quality culture needs involvement from all the different groups at the university; students, teachers, and faculty.

Good practices within tutoring, mentoring and academic integration

Based on the findings of country reports, literature review and discussions in partner meetings, the WP8 working group decided to explore deeper the different practices in interaction, academic integration and tutoring carried out by the participating universities. This trial focused on the issue of interaction between students and staff with special emphasis on the interaction supporting academic integration of students and student progression, and the early identification of students at risk. The methodology was chosen to provide deep enough information on the activity itself but also the background information on the context for other universities to benchmark the activity. The full case studies are presented in the appendix.

Universities' activities to increase students retention can be divided into three major strands:

- Changes in the structure of studies
- Changes in progression rules
- Changes in human support – both academic and well-being

The case studies focused on the third strand; changes in human support. The institutional support services often operate at a number of different levels. In this context, the different levels of actions can be categorized as shown in figure 16. Provision of information is usually a one-sided activity building upon mainly fact-based information and the provision of it. Counselling and guidance are both two-sided. However, the difference is that in counselling the students usually get help or advice with their particular problems or questions, whereas in (personal) guidance the advice and support are often long-term and there may not even be particular problems or questions as such. Furthermore, the universities tend to offer their counselling and guidance services not only for individuals but also for groups. In various group activities, the significance of peer interactions and relationships becomes of high importance.

Figure 20: Institutional support services: different levels for interventions.

<table>
<tr>
<td rowspan="2">PROVISION OF INFORMATION
building upon fact-based information and the provision of it (e.g. websites, flyers, databases)
usually one-sided</td>
<td>COUNSELLING
helping and advising students with their problems; answering to their questions (e.g. face-to-face, email, telephone)
usually two-sided</td>
<td>PERSONAL GUIDANCE
providing long-term support and guidance to students
usually two-sided</td>
</tr>
<tr>
<td colspan="2">GROUP ACTIVITIES
tutoring/mentoring groups where one can discuss a wide range of questions from study skills to future career plans
peer interactions</td>
</tr>
</table>

Case study process

In this trial the methodology chosen was to collect narrative descriptions of good practices in different universities. The goal was to provide sufficient information on what really works and why in different contexts and to enable benchmarking between universities with similar activities. Each partner university was, therefore, asked to provide a minimum of 3 narrative case study descriptions which they wanted to present as good practices in the field. The criterion was to choose case studies which others can learn from and which may be unique. The case studies could also vary in scope: an entire program or a set of actions (e.g. tutoring program, integration of first-year students) or smaller activities within a program or project, or it could also be an organizational approach. Majority of the case studies focused on 1st and 2nd year actions.

The process for collecting the case studies consisted of two rounds. The first round was an open invitation to submit case studies. This generated altogether 21 case studies. The submitted proposals were then initially assessed, and the comments and suggestions for improvement passed on to the contributors for further editing and fine-tuning. The final case studies were also adjusted to follow e.g. the terminology of the glossary. Once the full case studies were finally submitted, the working group decided which case studies to actually publish. The structure of the case studies is described below.

Background information (including information on target groups, goals, actors and regularity) and narrative description, including information on:

- Relation to other activities
- Structure and organization
- Interaction mode(s) between different actors (e.g. staff and students, teachers and students,
- teachers and other staff)
- Student approach; how it facilitates the activity?
- Early warning systems to identify students at risk of dropping out; what kind of early warning systems, if any, are included?
- Evaluation of the activity, evidence of success
- Reflective conclusions
  - Strengths and weaknesses
  - What really worked?
  - Things to be taken into account when implementing such kind of activity (in another university)
  - Impact of the project (e.g. student satisfaction, impact on performance and well-being, happiness)

In the case study descriptions special emphasis was placed on the last item (reflective conclusions), since often one of the biggest challenges in carrying out different activities is in how to measure the evidence of impact of these activities. This is especially true when the phenomenon is as complex as student retention and the impact of different activities often indirect.

Conclusions

The case studies are a collection of actual practices implemented in the partner institutions in order to decrease non-completion rates among higher education students. Measuring (as much as possible) the impact of these activities has, however, proved to be a significant challenge. The first case study – scholarly attitude to the retention practice – reinforces precisely this need to systematically evaluate all initiatives aimed at reducing student retention. Furthermore, it is of high importance that the universities understand their own contexts. The generalizability of different activities is limited due to the context dependency. There seems to be plenty of similar activities (in terms of e.g. tutoring) across universities but dissimilar execution.

What? Why? When? Where? Who? – The Five W's in Student Retention

In this chapter we first sum up our findings on the retention phenomenon in general – under what we call the five W's in Student retention. The retention phenomenon and the actions taken by the universities are complex and rich, and strongly context related. Reasons behind dropout and unsatisfactory academic progress are many and usually difficult to identify with precision. It is also about human behavior and experience in this complex system, not always predictable, measurable or directly controllable. In this system the students are the masters of their own life, making choices of their own. Therefore, ATTRACT was able to take a closer look at only some of the elements or activities in this system. We are happy to share our findings with the wider audience.

The five W's in student retention as a phenomenon are What? – the phenomenon itself, Why? – the factors contributing to staying or leaving, When? – when the dropout tends to happen, Where? – does engineering differ from other fields of education somehow, and finally Who? – who are the actors influencing the phenomenon.

What? (Phenomenon)

- Retention refers to the ability of institutions to retain their students, whereas persistence deals with the desire and action of students to remain in higher education and complete their degree. Depending on the terminology used, the phenomenon may have quite a different connotation. Dropout, on the other hand, refers to the act of leaving university prematurely.
- Dropout may be permanent when the students leave university prematurely and never return or temporary when the students leave education temporarily but return later. Dropout may also occur at different levels (e.g. university, program, course).
- The process of retention is not the mirror image of the process of leaving; knowing why our students leave is not equivalent to knowing why they stay.
- Besides retention, completion and dropout, institutions of higher education should also pay attention to (1) entry of students to the system (including admission and access), (2) progression and completion within the nominal study time (including e.g. curriculum development and support) and (3) demand in labor market before and after graduation.

Why? (Factors contributing to staying/leaving)

- Student retention is a product of a complex set of interactions among personal, institutional and external factors where students are mainly influenced by the interaction with other students and staff.
- Leaving is seldom the result of a single overwhelming concern, but a upshot of a push and pull process over time. On the other hand, students are also individuals who react differently to the same situations; the so-called survivors have usually developed particular attitudes or coping strategies. Also serendipity plays a part in persistence.
- Most common factors contributing to dropout at the early stages:
  - Students prior knowledge of the institution and program; the (mis)match between students' expectations and their experiences
  - How stimulating the students feel their teaching to be
  - Poor academic performance
  - Lack of social contacts
- Factors contributing to dropout at later stages:
  - Students' entrance into working life
- Predictors of good performance and progression:
  - Good performance during the first year often correlates with good performance at later stages
  - Belief in one's own capabilities
  - Performance motivation

When? (Time)

- In terms of dropout, usually two points in time are identified: the point of entry and some later time – often near graduation. Reasons behind dropout also vary at different times. Factors that frequently appear as significant predictors of student retention may not appear significant to graduation.
- Majority of the students who drop out do so after their first year. The first-year experience is critical because it is the time when
    - students are most vulnerable in terms of academic failure and likely to experience social, emotional and financial problems
    - important implications for students' long-term engagement and persistence are created
    - most students develop their appropriate identity, become socially integrated in the institution and attain their learning and generic skills and qualities

Where? (Different fields of education)

- Does engineering education somehow differ from general education? Many of the variables that work in general education also apply to engineering education, although the conditions may vary. Generally, however, dropout rates in engineering education seem to be higher than in many other disciplines.
- Engineering education is considered uniquely different, especially during the first years, since
    - a major in engineering tends to prepare a student for a specific career, whereas majors in liberal arts or sciences are less focused on a career
    - focus of the freshman engineering curriculum is often on developing strong analytical skills and problem-solving using technology which appears in demanding freshman math and science course
    - secondary education provides more "prep-courses" for majors in liberal arts and sciences than in e.g. engineering

Who? (Different levels and actors)

- Three major strands, also representing the different approaches of perspectives, can be identified:
    - Macro level ideology, social context and policy-making (policy makers)
    - Meso level institutional conditions (institutions, staff)
    - Micro level classroom and peer interactions (students)
- Depending on the actor, also the levels of motivation, activities, goals and even perceptions may vary.

Conclusions on Retention and Quality Culture in Higher Education

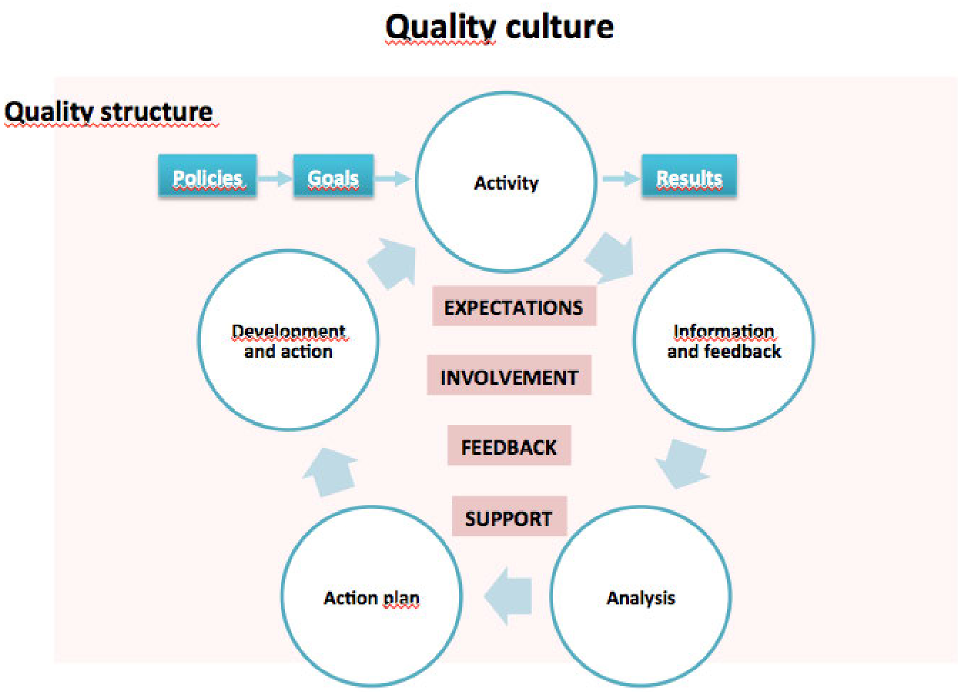
In this section we draw up conclusions based from the activities taken by the consortium. As described above, student retention is the ability of institutions to keep their students and help them to reach their educational goals. Student retention is therefore part of a greater context of a university – a constructive educational environment that facilitates student learning and success.

The educational environment of the university can be approached in many ways and from different angles, one of them being the four key features of a constructive educational environment inspired by Tinto (2010):

- Expectations
- Feedback
- Support
- Involvement

There is an apparent kinship with what is needed to create a quality culture, where all participants' involvement in creating the environment is central but also quite personal and decentralized. There are, however, other features that are more structural. Indeed the more formal part of the educational environment – policy documents, action plans, programs and educational leaders, support agencies, projects etc. – forms some of the building blocks of a quality structure which the quality culture relies on (see figure 21).

Figure 21: Quality culture in higher education.



In addition, based on the observations of the working group, universities' activities to increase students retention can be divided into three major strands:

- Changes in the structure of studies
- Changes in progression rules
- Changes in human support – both academic and well-being

This categorization overlaps with the key features of constructive environment described earlier, but not entirely. Therefore when making conclusions, we also take on-board this categorization.

Finally, how do we then measure student retention and progression of studies in a meaningful way to provide information on trends and patterns for retention? The challenge of output indicators is that they do not provide us with information about the factors influencing e.g. dropout or graduation times. Furthermore, if the universities take actions, how do we measure the economic benefits of these actions? These two issues were approached by implementing the trial called Retention Footprint and by developing a tool to be used for iteration of economic benefits of actions taken.

In what follows we provide some conclusions, based on the work done and categorize them under the themes inspired by what was described above:

- Expectations
- Feedback
- Support – academic and wellbeing
- Involvement
- Fostering quality culture by quality structure
- Structure of studies and progression rules
- Measuring retention and economic benefit of initiatives
- Getting to know your context
- Benchmarking and learning from other universities' actions

Expectations

In a constructive environment and quality culture the expectations of all involved should be high, but realistic. It is also very important that these expectations are clearly communicated to all parties and especially for the first-year students as early as possible.

Feedback

Feedback is essential for all parties to know how they live up to expectations. The different activities building our educational practice are constantly evolving. This development can be greatly enhanced through relevant information and feedback. Two different structural purposes can be identified – feedback system and feed forward system – the latter develops practice by identifying critical changes in student populations well before the phenomenon itself reaches the critical point. This helps the institutions to make foresights, with the help of early warning systems – at institutional, program and individual level. An example of this is the development of an early warning system which aims at identifying students at risk of failing, thus activities can be created already before the students fail. Effective foresight helps the universities to manage their own future.

Support

Support in different forms can greatly help participants reach their respective goals. The support can help clarifying expectations and providing feedback, but can also have many other forms as described in many of the case studies provided by ATTRACT. This support can be formal and organised, as well as quite informal. Human support must include both academic and well-being support.

Teaching can be seen as a support system for learning. Additional support for this statement comes from UU (Sweden), where colleagues found that "good teaching is the component with the smallest fraction of positive reported experiences".

Involvement

The involvement of the participants is vital for a productive educational culture. The culture must grow and it is important that participants see its value. It is important that the reasons behind different activities as well as their results are clearly presented to all involved – and a feedback loop exists. What are then the best ways of activating students and teachers alike in order to get the collaboration needed to find solutions for student retention in the partner universities? Should some of the proposed activities be made mandatory for students and teachers alike and on what grounds? With what consequences?

Fostering quality culture by quality structure

The construction of a quality culture is dependent on active leadership that handles expecttations of the institution, provides feedback for continuous development, and provides support for the institutions for continuous development and institution-wide involvement in this quality culture.

How to foster this with the help of formal organizational structures? Should different activities sharing the common goal of improving student retention in the same university be integrated in a single structure?

Would it also help to develop retention plans for each university, setting goals, strategies and action plans to ensure improvement of student retention indicators?

Also the common language shared by all stakeholders is crucial to support fruitful collaboration and shared development. There is a need of common definitions within institutions but also between the institutions cooperating – like the glossary provided by WP8.

Structure of studies and progression rules

We saw changes in the structure of studies and in progression rules in many participating universities during the lifetime of this project. They are central issue in the everyday decisions made by students, affecting their progress of studies, together with e.g. financial factors. The structure of studies and progression rules should obviously be a point of much interest in future studies.

Measuring retention and economic benefit of the initiatives

Retention is a complex phenomenon. There are difficulties in measuring it in a reliable manner (particularly in what concerns the measurement of the impact of these activities on retention data) and in identifying the "active ingredients" which, in each activity, are responsible for positive changes in retention data and also the economic benefit. This calls for use of advanced and visual tools such as the "retention footprint" that provide patterns of the phenomenon over a period of time to give also information on trends. Joining data from quantitative studies with data from more qualitative studies (e.g. interviews to participants, focus groups, content analysis of support materials) is essential in order to reach a more comprehensive view of change processes over time.

To fully understand an institution's rate of student success, multiple indicators should be calculated and reported. Besides graduation, completion and dropout, the universities should also pay attention to students' transfer from secondary education to tertiary education, target times for completing a university degree, and demand in labour market before and after graduation. Besides calculating and reporting, university officials should also take prompt and effective steps to investigate the reasons behind various results as well as to take proactive action to prevent individual students from dropping out.

Getting to know your context

Universities need to understand their own contexts – we hope that the ATTRACT reports provide some inspiration on what kind of aspects and parameters are worth looking at. In addition, one needs to be aware of the issue that no one theory can provide us with a definite understanding of the problem. Students are also individuals; there is no one "departure-prone" personality. Neither is there one magic solution for all.

Much of the research in recent years has mainly focused on events, often external to the institution. It is surely enlightening to know that students' previous experiences and family context correlate with retention. However, such knowledge is less useful to institutional officials because they often have little immediate control over students' prior experiences or private lives.

There is also the need of going deep enough in the analyses of different disciplines, and programs, this is also the case within science, technology and engineering. The patterns of student motivation and performance may vary dramatically across the fields of studies.

Benchmarking and learning from other universities' actions

The generalized use of the case study results and descriptions is obviously limited due to context dependency. The fact that all activities described e.g. in the case studies are very much dependent on institutional and also national contexts for higher education calls for a contextual analysis to be able to take into account the culture of organizations as a powerful determinant of what really works in student retention for each partner institution. Also similar activities (e.g. tutoring, first-year programs) are found across universities, but many times the execution is different as well as the intended impact upon retention. However, we can benchmark similar activities, learn from each other, and improve our practices. This learning process requires clearly a rather elaborated discussion to support what the other means of information gathering (like reports) can provide. Therefore, we hope that this report also acts as a starting point for shared discussions on these topics not only within those institutions that participated in the process but also in their countries and in other European forums.

A combination of “improved first year experience” with “monitoring of student results at key points in their academic life” and “early identification of individual and institutional challenges” with “human support” (especially for those experiencing difficulties) and eventually “changes in the structure of studies and in progression rules” seems to be the most promising path to follow from here onwards.

Stakeholder Recommendations

Stakeholder Recommendations

The scope of this final chapter is to provide recommendations from the point of view of the different stakeholders on the topics covered by the project and for each of 5 stages identified as the critical steps in Engineering Education.

The set of recommendations has been developed by collecting comments from stakeholders that attended the open sessions and who contributed to the online surveys rich with the findings and recommendations of different working groups of the project.

The final goal of the project was in fact to investigate the four main topics (perceptions, recruitment, barriers and retention) through surveys, collection of data, comparative studies and field trials in order to identify the critical issues and address concrete recommendations and good practice to the actors that are in the position of implementing these measures and correct therefore the trends and cover the gaps when and where needed.

In order to identify the relevant areas, EU priorities and national realities have been taken into account. In particular:

1 Target 4 of Europe 2020 – Education:

- Reducing higher education drop-out rates below 10%
- At least 40% of 30-34–year-olds completing third level education

2 Lisbon strategy on growth and jobs:

The Lisbon European Council emphasised the role of education and training in developing a competitive and dynamic knowledge based economy capable of sustainable economic growth with more and better jobs and greater social cohesion. To this end the Lisbon and subsequent European Councils called for concerted efforts in modernising education and training systems. In order to guide progress on achieving the objectives set for education and training systems, the Council adopted five benchmarks to be achieved by 2010.

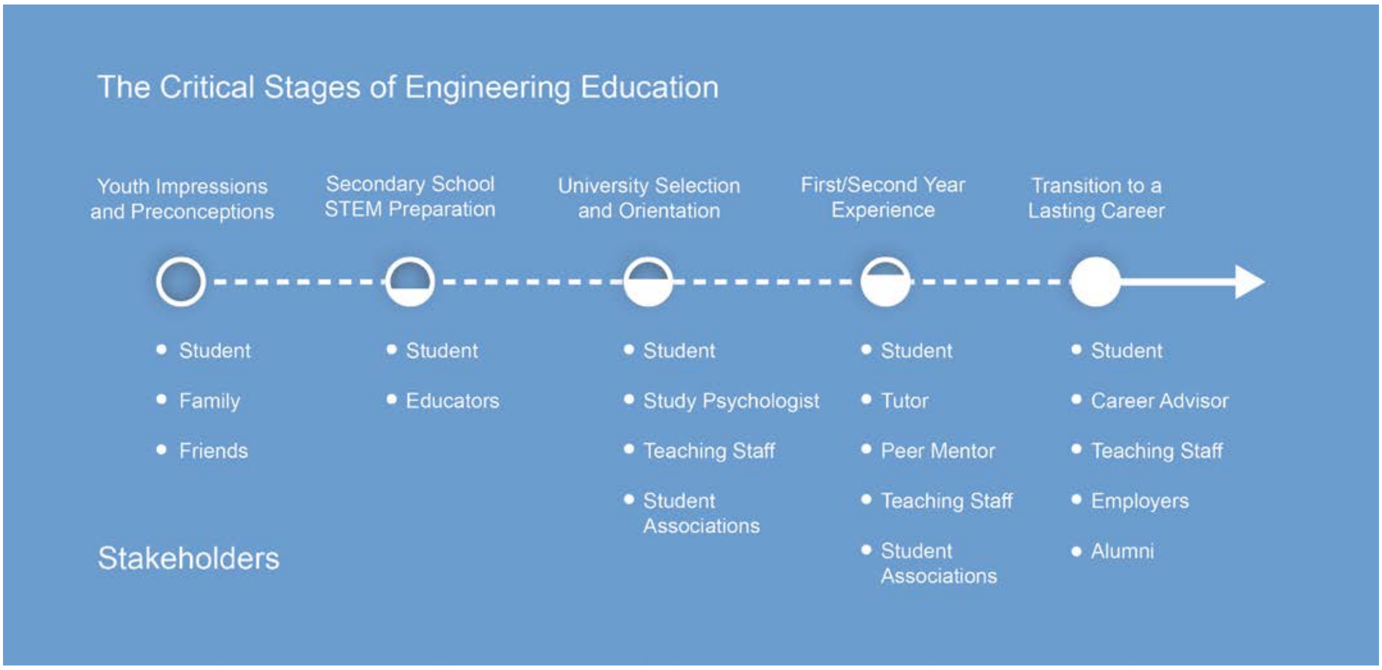
These communitarian targets have been explored in combination with the national concerns and progress and the project has focused not only on issues related to attraction and recruitment of students to engineering programs but also on the reasons why we need more engineers and how these individuals can be best identified.

The two questions we need to ask ourselves in order to obtain consistent conclusions are:

- Are the top performing students at upper secondary level interested in engineering? Why? Why not?
- Do students who are interested in engineering perform well enough? If not, how do we support and help students perform better?

The gender issue has been extensively addressed. Female students represent 57% of the overall student population and females represent around 50% of the world population, so why do we still have this gap between sexes in Science and Technology? Research shows that female students perform better than their male colleagues in higher education, which brings us to the conclusion that increasing the number of female students in Science and Technology would also result in an improvement in the overall quality and performance of the student population as a whole. It has been noted anyhow that the gender distribution in higher education is mirroring the gender equality of the country. These elements are tightly linked with the recurring observation that the image and the role of engineers in society are very different in northern and southern European counties. Also the role of salaries and the perception of the difficulties attached to the Engineering studies and profession are very different in different regions, which suggests that recommendations should take in due consideration this factor.

Finally, it has become clear that in order to recruit a higher number of better performing, more motivated students to Science and Technology programs we need to promote engineering as an education that opens numerous career opportunities. However this is not to say that Engineers can do “just anything” it remains necessary to direct potential students to the idea of competence flexibility in many of today’s rapidly evolving professional fields.



The Critical Stages of Engineering Education

In order to better illustrate the recommendations of the ATTRACT Project we have determined these five critical stages of a student's progression through engineering studies towards becoming a viable part of the workforce. This allows for an understanding of the essential concerns along with the acting stakeholders at each stage. This can be thought of as a linear timeline of experiences that define the successful progression and finally the resulting qualifications of the future engineer. In order to enhance the attractiveness of studies in science and engineering through specific recommendations it is best to start with the complete narrative of the student.

In order to successfully achieve continuous improvement in all of the stages described here, higher education must critically review the way data is collected and successful progression is benchmarked and assessed. Finally, it is important to find the opportunity for change that best fits the national and institutional context.

Youth Impressions and Preconceptions

One of the main objectives of the ATTRACT Project aims to improve overall understanding of gender equality. If you walk into many technology companies or university science departments, you will notice fewer women than men writing software code and teaching mathematics. The gender disparity in certain fields of science has long been a concern and the fact is that we simply don't have as many women as men going into the fields of engineering, physics, computer science and mathematics. This has the negative potential of creating and preserving gender bias stereotypes. This report does not – and cannot – necessarily explain why gender differences in STEM exist, it aims to provide data and insight that will enable more informed policymaking.

Attracting more students to studies in science and engineering so as to increase the qualified available workforce must begin at the genesis of student life. From a young age, students are assaulted with popularized multimedia with points of view that in turn shape their own outlook and consciousness. In order to make a long lasting positive impression at a young age, the student needs to have been given an encouraging view of the way things work. This starts with family, friends, and a commitment to boosting up imaginations. Positive and negative stereotypes can be mediated by parents focusing more on the process of asking questions and instilling inspiration.

For young students stereotypes make a big impression, even when not taking into account gender disparity, the preconceived stereotypes of a scientist or engineer do not always reflect the exciting aspects of the field. Thus it is imperative that the image of the 'nerd' engineer turn into something positive and sought after: engineers who solve the problems of mankind, not simply mathematical problems.

The concerns arise as early as primary school. Young girls in particular that are seldom encouraged to pursue math and science, will eventually be problematic considering that studies show a lack of belief in intellectual growth can actually inhibit it. We do see fewer women going into science and technology, engineering and mathematics; but once they're there they tend to excel at much higher rates than their male counterparts.

The stereotype threat phenomenon works by causing people worried about a stereotype to often act in ways that make the stereotype self-fulfilling. If you take the stereotype that girls are not as good as boys at math, and remind children about that stereotype then in effect girls will perform measurably worse on a math test.

This suggests that the gender disparity in science and technology may be a vicious psychological cycle. When women look at technology companies and math departments, they see few women. This simply activates the stereotype effectively making it harder for women to enter those fields. According to a recent 2011 U.S. Department of Commerce survey, women with a STEM degree are less likely than their male counterparts to work in a STEM occupation; they are more likely to work in education or healthcare. They further concluded that, there are many possible factors contributing to the discrepancy of women and men in STEM jobs, including: a lack of female role models, gender stereotyping, and less family-friendly flexibility in the STEM fields. Regardless of the causes, the findings of this report provide evidence of a need to encourage and support women in STEM.

We must see media coverage as effecting parents which in turn may influence student's choice on whether to pursue engineering. The media itself should focus attention more on objective facts in order to adjust any false perceptions that might exist. For example, if the focus is pointed towards high salary rates and low unemployment rates it would effectively inform parents. The picture of engineers in media is different in different parts of Europe but based on our results the overall picture on engineering in media is positive.

In Germany, Ireland and in Portugal engineering is often mentioned in a positive way in relation to the labour market since it has for long been put in relation to a good employment outlook and a high salary. In these countries engineers are also described in a positive way as experts and co-responsible for bringing forward the economy. In Sweden on the other hand, engineers are often considered, by non-engineers, as cold, insensitive technocrats, deeply specialized with highly repetitive work and with little or no social contact. This illustrates the differing presumptions that may well be unique to a country but may affect the attractiveness of studies in the field.

The engineers educated today will become the industrial workforce, secondary and upper secondary educators, researchers and innovators of the future. Preparing young students to think and develop analytic skills necessary for the success in the field rests heavily on early childhood experiences. This presents us with the opportunity and responsibility to sustain and expand the paths to learning and discovery that has become increasingly overshadowed by popular media.

Secondary School STEM Preparation

With the main objective of this project in mind, that is to attract students to STEM programs across Europe, the challenge is to facilitate broadly open access to engineering education while simultaneously maintaining standards of excellence and not unfairly exposing students who may be unequipped for such studies. The task of striking this balance falls to the university admissions mechanisms which operate in our countries. In the majority of European countries a limited number of places are available on most higher education programs. As a result, certain criteria must be applied to select the students to whom these places will be awarded. This report discussed the criteria which form the basis of the formal barriers to engineering education. The barriers are scrutinised to determine how effectively they serve their purpose; that is how well they serve to admit an engineering student population with the skills and commitment to succeed at university and as professional engineers. This question is explored through comparison of national systems, review of international literature, documentation of alternative practices, and in-depth data analysis.

Different approaches are adopted within each national education system, but common to many is the employment of entry requirements which set a stated level of achievement in engineering-relevant subjects that must be met by applicants. Typically this refers to mathematics, often along with physics and/or chemistry. The report puts forward evidence to suggest the validity of this approach by exploring the achievement of a student at university with reference to his/her previous attainment in these and other subjects at high school. However this necessarily shifts some of the focus to the secondary education system, as it performs the task of laying the foundations of STEM education among students.

The degree of preparation young people obtain in STEM education varies significantly from country to country, both with regard to structure and subjects taught. Insight into the differing national contexts is provided within the ATTRACT report, attempting to probe the advantages and disadvantages of a designated science and technology track within high school when contrasted with the broader, general education pursued in other partner countries. The effects of these contrasting approaches are significant. In countries such as Portugal and Sweden where specialised study is typical at upper-secondary level, students in the science track receive in-depth instruction in STEM subjects which should provide them with a solid foundation for engineering study. However, this practice has the corresponding effect of limiting eligibility for many engineering programs to those students who have followed this pathway. As the decision regarding specialisation is taken at an early age (typically 15 years), many students are thus precluded from studying engineering later on. Education systems which offer a balance between a degree of specialisation on the one hand, and greater flexibility regarding choice and progression on the other, may suggest a model which overcomes this difficulty.

The choices made by a student concerning subject selection at upper-secondary level ultimately have a significant impact on the programs available to him/her at university. Nonetheless, this choice is not made in isolation and many external factors are at play, not least of which may be a lack of awareness or understanding regarding the subjects required to pursue careers such as engineering. Furthermore, many STEM courses suffer from a perception that they are more difficult than other programs (see WP7 results). This impression has an impact at high school level also, for example in Ireland where the perceived difficulty of the advanced mathematics course at high school contributes to the very low numbers of students choosing to pursue it.

The image of STEM subjects is also a factor in the persistent gender divide of high-school students taking these courses. There is a general trend whereby girls are under-represented among those studying the most engineering-relevant subjects, such as advanced mathematics, physics, and technical graphics. It is unsurprising, therefore, that when it comes to university engineering, male students form the overwhelming majority in most programs.

The question of the image of engineering is central to attracting more young people to STEM subjects both at high-school level and beyond, and is explored in depth in the Work Package 5 report.

The provision of informative and balanced advice is essential to young high-school students who are faced with the task of making decisions about subject specialisation and possible future careers. In many of our countries there is a tendency for guidance counsellors to come from humanities, rather than scientific or technical backgrounds. Close relationships between university engineering departments and high schools can be of benefit, particularly with regard to educational outreach on the subject of engineering study. Activities such as university student ambassadors who visit schools to talk about engineering are common in many countries (see WP7).

Educators at university level have a particular role to play in relation to the issue of alternative admissions practices, or the admission of students who do not meet traditional entry requirements. Such practices are in operation in many partner countries and allow for students to gain university places on the basis of their other competencies or work experience. Many of these students have not completed the required levels of study in engineering-relevant subjects but can typically do so during the first year of university. As a result there are implications for university educators regarding the provision of additional support and tuition. These alternative pathways can improve equity of access to higher education, and are frequently made use of by students from lower socio-economic status (SES) backgrounds.

Recommendations:

- Examination of the factors which influence the decision-making process in relation to subject choice at high school and beyond
- Mechanism which allows for the later 'streaming' of students into designated tracks or branches of education
- Higher level of core STEM content for all students, regardless of area of specialisation
- Encourage more girls to pursue STEM subjects
- Increase participation in engineering among students from lower socio-economic groups
- Use of aptitude tests at university entry for information purposes, to evaluate students' strengths and potential areas of difficulty

University Selection and Orientation

A successful transition from upper secondary school into a university program is a crucial if not the most important step for the on-going success of the engineering student. The individual student experiences the challenge, uncertainties and resulting anxiety associated with the application and subsequent orientation to university program. By easing this transition, integrating students and incorporating relevant actions outlined in the ATTRACT section on student retention a university can successfully establish the foundation for enduring retention strategies throughout a student's academic career.

For the university this step marks the transition from the original profiling of a student applicant to ensuring their retention through a set of student support services. In this report we have clarified that teaching as a support system for learning, student support services and peer relationships are crucial for the social integration and academic success of a student. It is further important that the student takes ownership and academic responsibility in his/her own educational process. How well the student adapts into his/her role within the university experience ultimately determines their success.

It is initially important that the correct university program and subsequent courses are chosen that best progresses a student's interest and knowledge which can be determined by their performance in pre-requisite subjects taken during upper secondary education. The importance of secondary school subjects are elaborated upon in WP6 and decisively correlate performance during secondary education to the successful progression through a university program. Entrance testing that effectively calculates a student's aptitude has been shown to benefit the student and the university in harmonizing ability with a required course load. However this could potentially produce additional anxiety during the period of transition and requires close advising on the part of the university.

The entrant student will inevitably arrive with preconceived knowledge of the university and program of choice only so far as they have been made aware of by the university's public channels and friends. The job of the university is to construct this public channelling in a way that produces an enthusiastic and well informed entrant student. Much too often, found through ATTRACT's student outreach sessions, entrant students find themselves overwhelmed during the orientation period. Important information is skimmed over or lost in the stress of the situation they find themselves adjusting to.

The job of the university during this orientation to higher education is to make the entrant student aware of organizations and groups that produce this positive university life. The prospective student does not necessarily base choice upon the composition of teaching staff but rather on qualities determined by their individual perception of the program and university life. Thus the importance of integration as explained in WP8 and the positive peer to peer guidance from older students on younger entrant students can be seen as an integral part of the university system as a whole.

The student tutors should become the student's inside view of their education system. A successful tutor can effectively monitor and act as an early warning system if the student is displaying certain characteristic dropout indicators as defined in WP8. This can be seen as the key relationship between the student and the university program in which they are participating. There should be emphasis given to bridge the secondary and university experience of a student both academically and socially. This should be done as early as possible once a student plans to attend a university program and should allow the student time to reshape study habits that became well established in secondary school, and are not necessarily effective during their critical first year within the university system. Advising prior to university orientation would be particularly useful in preparing a student for challenges that they may face due to a lack of basic information.

Research on the benefits of student association membership suggests that actively involved students perform better academically, are more satisfied with their university experience and are more likely to graduate. Student organizations provide a medium for academic discourse, personal growth, leadership development, intercultural understanding, community service and lasting friendships. The challenge is to get students involved in these associations as early as possible and to retain substantial integration into the formal university decision making processes.

These organizations should be accessible to all students and allow for functioning membership in more than one. A university should understand the importance of involvement and encourage its students to find opportunities to meet and interact with each other in a variety of ways. Organizations should represent a variety of academic and interest areas.

During the beginning of higher education professors are expecting certain competencies to carry over from a student's secondary school in order to create a homogenized academic foundation for learning. Students entering a program less prepared forces professors cope with the contrast between expected and real level of prior knowledge. Therefore the development of an efficient system to identify and attract most of the potential students without cutting off other good ones is clearly required.

The relationship between the student and the professor and other teaching staff should be mutually beneficial. A student will work hard if they see a professor also work hard and act passionately towards what is being taught. The material promised during a particular course should directly reflect and build upon the expectations that were promised to the student upon admittance to the program. There should be an on-going elaboration on the significance and impact of a class subject on professional life, resulting in a more motivated student.

A university should challenge potential and admitted students to understand, embrace, and act in accordance with their responsibilities as members of a diverse, globalized European community.

Through the development of personal links and cooperation between upper secondary education and the prospective universities will effectively smooth this otherwise very uncertain and confusing time for an individual student.

Recommendations:

A successful transition would require that universities ensure that an entrant student;

- Have a comprehensive face to face academic advising session
- Gain more knowledge of student support services
- Reduce anxiety about the transition to university life
- Understand the necessity of taking ownership and academic responsibility in their educational process

First/Second Year Experience

Student retention strategies invariably last for the duration of a student's academic career however particular emphasis should be placed on the first two years of study, especially the first year. The first-year experience is highly significant not only in terms of predicting students' on-going success in tertiary education, but also as it is the time when students are most vulnerable in terms of academic failure, as well as most likely to experience social, emotional, and financial problems. Good performance during the first year often correlates with good performance at later stages.

Student departure is seen as a complicated phenomenon influenced by a variety of reasons therefore the tracking of student progression over an academic career and analysing long periods for cause and effect relationships is necessary if a university aims to raise their retention. The Footprint model defined 'Retention' reveals the comparison between programs although requires deeper benchmarking within their particular context. One must, therefore, be careful in defining success in various longitudinal studies, as variables which appear significant in the short run – that is before graduation – may not, in fact, be significant in the longer run. (Zhang et al. 2004)

Student success can also vary from year to year which makes it important to note that university actions can never account for all variables influencing a student's choice. Actions to motivate, incentivize, and monitor the student must be in place yet the student ultimately constructs their own decision making process.

Successful progression through a student's first two years relies on their ability to handle potential social sacrifices and recognize the need for careful time management. The university's student services can potentially play a role in assisting a student in the development of relevant life skills that are essential not only for the duration of the program but after graduation as well.

During a student's first year, motivation and heightened interest play an important role. Many of the ATTRACT partner universities utilize a number of presentations from professionals and professors as one of the methods of constructing a student's realistic perception of a successful engineer. However it is important to ensure a diverse selection of role models that are representative of both sexes and not necessarily PhD qualified individuals working in NASA or CERN. More important is to exhibit qualities and responsibilities that students can associate and envision themselves acquiring. The ability for an individual student to realize how they can affect society and contribute positively is an important and necessary dialogue to build within STEM programs.

The tutor's duty during this period is to effectively guide the student through issues that might arise within academic or social life and build a connection to the student based upon personal correspondence. It is important to realize that students themselves are many times not aware of problems they have until constructive feedback is given. During this correspondence the expectations should be re-communicated to ensure that a student becomes aware of what they are working towards and furthermore how they can effectively work to attain it. This should also seek to assist in particular courses with sink or swim philosophy when peer mentors are key to student success.

When there is an instance of "wrong choice of program" the tutor is the first to know and should be the bridge out of a university program as well as a way through a particular program.

Student services should invest in peer mentoring and tutoring designed to assist incoming first-year students with their adjustment to the university environment. First and second year students (mentees) should be paired with student leaders of a higher year who serve as mentors and role models. These leaders provide academic and developmental support through social connections, leadership development, support resources, direction and guidance directly associated with the program's advisory division. These mentors should be primarily allocated to underrepresented students so as to support those from disadvantaged backgrounds.

Tutor and peer mentoring programs encourage active participation from student across academic years. Incentives should be in place that offer part-time positions to potential mentors and offer training in enhanced study skills, time management and self-discipline. The mentors and tutors themselves gain significant opportunities to interact with various faculty and staff across campus on a more intimate level and are given heightened access to leadership and involvement opportunities within the university.

Student/Professor relationships during this period are established and rely upon a social contract founded through successful engagement from the university. It is important to identify the responsibilities a university has towards a student and how best to build upon this engagement. Good examples of professor/student relationships within a particular program should be identified and benchmarked in order to strive towards and improve retention. ATTRACT partner universities have found that they should invest more time in teaching.

Personal contact between the professor and student as they progress through a program becomes increasingly important compared to the standardized significance of study time. When a student knows what is expected of them, they are more likely to comply with the increased demands. It is furthermore the professor's duty to monitor their own students and continually identify what might be seen as issues hindering a student's ability of success.

By a student's second year they should be fully immersed in the social life of the university. Student associations as explained during the orientation phase should continue to act as catalyst in developing a student's life skills. Often relationships gained through different organizations aid in progression by promoting group study and other mutually beneficial opportunities for reaching common goals.

Communication between the different stakeholders within student support services is required in order for each to emit a positive effect. Support services should be able to gage the impact of retention initiatives and best analyse the important issues pertaining to a particular program. Student feedback has been identified as vital in sorting out detailed conditions within a program and identifying courses that might need direct assistance through extracurricular mentoring and guidance. Tutors during the first and second year are the main actor in successful student progression by keeping the many actors in communication with each other.

Recommendations:

- Maintain or increase student self-reports of having made meaningful connections with peers.
- Maintain or increase student involvement in university activities.
- Maintain or increase student self-reports of meaningful interactions with faculty and/or administrators.
- Maintain or increase student understanding of and compliance with the university's expectations of them.
- Increase the number and percentage of third year students who report satisfaction with their chosen major and perform successfully in that major.
- Increase the number and percentage of students who demonstrate progress toward the development of a preliminary life/career plan.
- Identify and report on activities/memberships that seem to correlate to academic performance changes as compared to appropriate comparison groups.
- Maintain or increase the percentage of first year students who are retained to their second year.
- Increase the percentage of second year students who are retained to their third year.

Transition to a Lasting Career

The final critical stage in any academic program is the transition to a lasting career. While aspects regarding career counselling and bridging services were not explored in depth it remains an important characteristic of attraction and the successful progression of a student. Knowing a certain career path builds motivation and self-determination which are factors that greatly affect performance during studies.

Through the education emphasis should be placed upon the final resulting skills set that can eventually turn over into a prospering career. This is done through cooperative learning, internships, and other methods of bridging education with professional life. Determining the right subjects to take during a student's duration in a program will effectively limit and direct their possibilities later in the job market. Thus it is important that the advising and networking complement the student's own individual life goals.

The value of the student in assessing their own education is unquestionable and the ability of student groups to act as a stakeholder during important structural decisions is good practice. Student groups such as BEST are organized around strong leadership and common goals throughout many European engineering programs. They aid in integrating students into university life and encouraging them to take action when aspects of their program of academic system is non-effective. This has proven to be an effective outlet for individual students to take part in university decisions.

A student needs to see the effects of progress through their studies and the transformation towards becoming an engineer. The ability to imagine and transfer their knowledge and experience from the classroom and apply them in work environments outside of the classroom generates a significant amount of motivation. Internships and cooperative learning provides opportunities related to a student's major and/or career interests. This experiential learning should be provided and to eventually become a standardized requirement for degree completion.

Professors play an important role in preparing students for a potential working environment however there should be actions taken to attract students to pursue academia. A respectable relationship is needed in order to build confidence and interest from a student to continue their academic interests. In WP8 section 8.2 we have outlined that heightened expectations, feedback, support and involvement are aspects that aim to build this enduring academic relationship.

The tutor is decisive in bringing students and employers together to facilitate an academic viable and mutually beneficial work experience. Students should be counselled one-on-one by the end of their second year to aid in determining effective career choices based on realistic self-appraisals and comprehension of applied engineering. Cooperative learning and internships provide this career-related, engaged learning experience which result in self-sufficient graduates who market their education, skills and experiences.

It is necessary for a successful, attractive engineering program to cultivate strong corporate business and industry partnerships with organizations willing to participate by investing in their future employees. These partnerships help to formulate opportunities for cooperative education and give employers the chance to observe the students for potential employment. The student equally obtains an increased understanding of human relations and business/industry operations in turn better preparing them for effective transition out of a university program into full-time employment.

By learning what engineering specialties are required in the ever-changing workplace, universities can bolster their plans with support from the outside. Industry can be drawn into a position of partnering with the engineering department when the department shows sensitivity to emerging markets.

While employment for engineers has been rising, more than ever before, employers look to hire engineering graduates with internship experience in their field. It is the task of the university to make sure students are prepared to enter the workforce and transfer from a program to employment as smoothly as possible. Part of this task involves appropriate advising for the student and providing them with opportunities to gain career-related experience in a variety of settings, while at the same time increasing the cooperation with private sector employers.

Institutionalizing Engineering Education Innovations

Implementing steps towards recommendations found within the ATTRACT project may prove to be a difficult task. In order to make lasting and permanent innovation there must be a series of steps taken to insure success within an upper secondary institution, engineering department and at government policy level. These suggestions for institutionalizing engineering education innovations will highlight best practice in a number of points.

The ATTRACT project itself provides a credible justification for change however more may need to be done in order to contextualize initiatives. It is important to emphasize the effects of failure to change and the idea that change is a requirement in order to stay up-to-date. This can be done by projecting the positive future impacts and involving all stakeholders at an early stage.

A step-by-step plan for implementing change should be formulated including identifying required resources. Data-based benchmarking, assessment, and evaluation should then be conducted independently. The plan needs to be flexible in order to overcome resistance and communicate continuously with all those concerned. This should include communication through all possible means including: web page, university catalogues, and other dissemination tools.

Strategies for institutionalization vary depending on the context. In some instances, implementing a recommendation is best done once at a time as part of a coordinated overall vision. Other times it is most effective to present the entire package all at once. The creation of a change-ready environment at the university is essential in order to have an atmosphere conducive to change.

Where to go from here

At the end of the project's formal lifetime (covered by the LLP funding), the partners will extensively disseminate the results of the study and undertake actions addressed to the national and local decision makers in order to implement the recommendations outlined in this section.

The CLUSTER consortium will also evaluate the work done and follow up with similar activities in the next future. All the 13 consortium members will be invited to implement the developed measures and keep informing the project consortium about similar initiatives each of them is developing at local level. Concerning the tools and good practices developed, partner universities have already expressed their intention of making regular use of them, in particular the field trial methodologies.

During the project lifetime several interactions have taken place between the consortium and SEFI, more in particular the newly created Working Group named "Attractiveness of Engineering Education". Synergies have been identified and it has been decided that ATTRACT will continue operating under this umbrella in the future in order to ensure sustainability to the carried out activities.

The consortium is investigating additional possibilities for extending and deepening the study. During the last phase of the project different approaches have been identified:

- Refine the overall picture of attractiveness and promotion of the profession through applied media studies.
- The development of tools comparable to but not limited to: data collection and management, examples and guidelines, assessment/evaluation methods, and cost/benefit intervention strategies.
- Deepening the study carried out by one or two (attractiveness + recruitment and/or barriers + retention) of the work packages in order to further investigate related themes.
- Widening the geographical coverage of the project by involving not represented EU countries.
- Extending the study to extra European regions in order to compare the trends and situations by taking into consideration also the cultural, historical and structural differences to uncover the role that these factors play.
- Expanding the study by covering more psychological and sociological aspects as well as deepening the study on the socio-economic barriers.
- Taking a curricular approach in order to investigate the impact of the curricula themselves on attractiveness, recruitment and retention.
- Directing the study's methodologies and results over different programs in order to acquire long term (3-5yr) applied case studies.

Given the fact that "social inclusion" is currently one of the EU highly prioritized policy areas, the consortium will investigate how to look into this issue and combine the EU target and priorities with the future projects' scope.

Funding available and the structure and priorities of the upcoming "Erasmus For All" program will surely have an impact on this decision as well as the reactions to the present report that the partners will collect. In particular, taking into account the relevance that the EU is currently giving to the ENPI (European Neighbourhood Policy) Countries in the field of education, MEDA and Eastern neighbourhood Countries will most likely be covered by the future comparative studies on the topic.

Glossary of Terms

This glossary gives an overview of some of the specific terms related to student retention in higher education. The glossary is not intended to be exhaustive, but to define a common set of concepts, valid for retention studies conducted within the scope of the ATTRACT project. Some educational terms have also been added. Whenever possible, the definitions were retrieved from the ECTS Users' Guide, the OECD Glossary on Education Terms or the Life Long Learning Programme Glossary.

Terms and concepts	Definitions
Academic integration	One of two complementary processes by which students become part of the higher education context. Academic integration is seen as having two dimensions. The structural, and more formal, part represents meeting explicit standards of the education, such as passing sufficient grades. The normative, and more informal, part represents coming to terms with the more implicit normative structure of the education, such as valuing certain things more than others. This process is an integral part of theoretical models for student retention, such as the Student Integration Model (Tinto, 1975; 1987) and the Student Attrition Model (Bean, 1983).
Advice	Involves a brief consultation in order to give someone accurate and adequate information, and to give suggestions about the implications of that information; this may involve the use of counseling skills, and of information technology and other forms of accessing data. (Pereira 1997)
Attrition	The process of students leaving their education, primarily due to institutional structures and processes. The process is an important part of Beans (1983) Student Attrition Model and draws on an organizational perspective. Sometimes the term is used to describe all processes making students leave their education.
Attrition rate	The percentage of students who leave education within a specified period of time.
Coaching	Working with the student, identifying his or her skills, needs and aims, developing a coaching plan that he or she agrees to, owns and wants to action, then working with the student to help him or her achieve it. (Wisker et al. 2008)
Completion rate	The percentage of students who graduate.
Counseling	A range of activities such as information, assessment, orientation and advice to assist learners to make choices relating to education and training programs or employment opportunities. (The LLP Glossary)
Counselor	Someone who focuses on facilitating a student's work, always respecting the student's values and working with the student's resources; the counselor creates a trusting relationship with a positive climate in order to permit the student's expression of feelings and clarification of life situations. (Wisker et al. 2008)
Credit (ECTS)	Quantified means of expressing the volume of learning based on the workload students need in order to achieve the expected outcomes of a learning process at a specified level. One ECTS credit generally corresponds to 25–30 hours of work. One Academic year consists of 60 ECTS credits. (The ECTS Users' Guide)
Dropout	(1) The act of leaving university prematurely (commonly before completing a degree). (2) A student who leaves university prematurely (commonly before completing a degree).
Dropout, Permanent	(1) The act of leaving university prematurely and never returning. (2) A student who leaves university prematurely and never returns.

Dropout, Temporary	(1) The act of leaving education temporarily and returning later. (2) A student who leaves the education temporarily and returns later. Often used synonymously with Stopout.
Dropout rate	The proportion of students who leave the specified level in the educational system without obtaining a first qualification. (The OECD Glossary)
Early warning system	Monitoring system for identifying students likely to fail academically or to encounter serious problems assimilating into the college environment. (Beck and Davidson 2001)
First-year experience	Students' experiences of their studies during their first year of study. The term is also used about institute initiatives to enhance and improve student experiences during this time. (Willis 2008)
First-year student questionnaire	Questionnaire to students during or after their first year of study students to learn about their first year experience.
Graduate	A former student who has achieved an academic degree.
Graduation	The act of achieving or conferring an academic degree.
Graduation rate	Graduation rates – a measurement practice used by for example OECD – usually represent the estimated percentage of an age cohort that has completed certain type of education (net graduation rate) or the number of graduates, regardless of their age, divided by the population at the typical graduation age (gross graduation rate (The OECD Glossary)
Guidance	A range of activities such as information, assessment, orientation and advice to assist students to make choices relating to education and training programs or employment opportunities. (The LLP Glossary)
Incoming student questionnaire	Questionnaire to beginners/incoming students to learn more about background of students and to increase knowledge of the impact of different recruitment initiatives.
Learning Outcomes	Statements of what a learner is expected to know, understand and be able to do after successful completion of a process of learning. (The ECTS Users' Guide)
Mentor	A role model who offers support to another person. A mentor has knowledge and experience in an area and shares it with the person being mentored. (The LLP Glossary)
Mentoring	Broadly encompasses a more experienced, possibly older, peer mentoring someone less experienced, to empower and enable them to develop necessary skills so that he or she can be effective as a learner, depending on the context, and to enhance his or her own personal coping strategies, sense of self-worth and success. (Wisker et al. 2008)
Non-persister	A student who leaves university prematurely.
Peer mentor/ tutor	Students who are trained and supervised to provide practical assistance and personal support to persons of similar age or experience, including problem-solving, decision-making, listening, mutual sharing, and action planning. (Wisker et al. 2008)
Persistence	The desire and action of students to remain in higher education and complete their degree. (Berger et al. 2012)
Persister	A student who enrolls in university and remains enrolled.

Program, Educational	A set of educational components based on learning outcomes that are recognized for the award of a specific qualification. (The ECTS Users' Guide)
Progression	The process which enables learners to pass from one stage of a qualification to the next and to access educational programs that prepare for qualifications at a higher level that those he/she already possesses. (The ECTS Users' Guide)
Progression rules	Set of rules that define conditions for learners' progression within qualifications and towards other qualifications. (The ECTS Users' Guide)
Retention	The ability of an institution to retain students from admission to graduation. (Berger et al. 2012)
Retention rate	The percentage of a defined group of students who remain in education for some defined time.
Retention policy/strategy	A formal policy or strategy by the university regarding how to work on improving retention.
Social integration	One of two complementary processes by which students become part of the higher education context. Social integration represents the congruency between a student and the social environments of the education. This process concerns both interaction with peers and between university staff and students. Social integration is an integral part of theoretical models for student retention, such as the Student Integration Model (Tinto 1975, 1987) and the Student Attrition Model (Bean 1983).
Stopout	(1) The act of leaving education temporarily and returning later. (2) A student who leaves the education temporarily and returns later. Often used synonymously with Temporary dropout.
Survival rate	The proportion of new entrants to the specified level of education who successfully complete a first qualification. (The OECD Glossary)
Tutor	An experienced and competent professional who will support the learner during the learning process. (The LLP Glossary)
Tutoring	Any activity of guidance, counseling or supervision of a learner by an experienced and competent professional. (The LLP Glossary)
Withdrawal, Forced	Dropout from university studies arising from insufficient levels of academic performance, from the breaking of established rules or as a result of some external events. (Tinto 1975, 1993)
Withdrawal, Voluntary	Leaving university studies based on students' own decisions. (Tinto 1975, 1993)
Work load	An indication of the time students typically need to complete all learning activities (such as lectures, seminars, projects, practical work, self-study and examinations) required to achieve the expected learning outcomes. (The ECTS Users' Guide)

Appendix

National Recommendations

It stands to reason that since the present circumstances and education systems are different in each of the ATTRACT partner countries, the measures needed to address the specific challenges posed by each system would necessarily be different. Therefore, each partner was asked to draw up a set of recommendations particular to their own national context. The purpose of these recommendations is to propose changes to current systems which can usefully be expected to facilitate the aims of this work package; that is to expand the numbers of motivated, qualified and suitable students applying for and taking up places in engineering programmes in our countries.

In some cases, this means changes to student selection methods, admission practices, or entry requirements. In others, promotional campaigns to increase uptake among under-represented groups is required. Some are changes that can be undertaken by the involved universities themselves, while others are proposed actions to be implemented by other individuals and bodies such as policy-makers and relevant government agencies. The tables in this chapter present the recommendations developed for each of the partner countries.

It is acknowledged that some of these actions would be easier to implement than others. However, in light of the fact that admissions to many engineering programmes in Europe have remained static and in some cases declined, it is important that all possible solutions are explored if there is to be a real and sustained increase in uptake.

This section is divided according to country and presents the recommendations for each national system individually, laid out according to the specific barrier category they target as per Section 1. In each case, the entries under the 'Ease of implementing change' heading are estimated by partners based on their own experiences and expectations.

Belgium (Flanders)

Education is a regional authority in Belgium; therefore these recommendations have been formulated specifically for Flanders.

Table 16: Recommendations (A) – Changes to admission requirements

	Issue	Recommendation(s)	Other relevant recommendations	Ease of implementing change
A.1	Higher Maths Requirement – at least 6 hours per week of math is recommended to pupils intending to start the engineering programme.	The predictive value of the grades in secondary school needs to be researched. KU Leuven introduces a calibration test for mathematics, for the engineering programme, bioengineering, mathematics and physics. This test helps students in orientation.		Moderate Moderate
A.2	Physics and Chemistry achievement. Physics (in particular) and chemistry are predictive of student progression, but are not formal requirements.	More promotion of these subjects to increase poor uptake at school level		Easy
A.3	Aptitude testing. Generalised aptitude tests (for information only, not selection) in Italy have been found to correlate highly with student performance.	Such tests should be introduced by the universities – different weightings could be applied to different courses if and when the tests are used for selection.	A.1 (b)	Moderate

Table 17: Recommendations (B) – Structural changes to the education system

	Issue	Recommendation(s)	Ease of implementing change
B.1	A significant number of first-year-students lack the right preparatory training, not only in the engineering programmes but also in general on an academic level. This results in student dropout, changing programmes or demotivation.	Introduction of a comprehensive orientation test for all academic programmes	Difficult

Table 18: Recommendations (C) – Socio-economic and cultural factors

	Issue	Recommendation(s)	Ease of implementing change
C.1	There is a strong and persistent gender divide in the area of subject uptake at high school level, particularly in relation to engineering-relevant subjects. This has a knock-on effect on the uptake of engineering at university level by female students.	An updated examination into the causes of and possible solutions to this gender divide should be carried out An interest in engineering and basic mathematics should be cultivated in students of both genders at an early age (12 – 13 years) through summer camps, design competitions, etc.	Moderate
C.2	Research into the student profile in engineering and science programmes have shown at certain places significantly lower representation of socio-economically disadvantaged students, mature students, and students with disabilities than do other programmes within the university.	This under-representation holds true for female students in Flanders. It should be investigated whether this is also the case for other groups in Flanders, and if so what the underlying causes might be. Subsequent action plan should be developed to increase the numbers of students from these groups.	Moderate Moderate
C.3	There is a significant gender gap in achievement at university. At present, female students are more likely to progress successfully in certain disciplines at university level than male students, even when all other factors are normalised for.	Conduct further research into the reasons for this and into what measures might be successfully employed to target it.	Moderate
C.4	The performance of Flemish students in PISA tests is traditionally very strong. Other countries display strong correlation between higher scores in mathematics and higher socio-economic status of the student	It should be investigated whether this impact of social status is also valid in Flanders and if so, measures should be put in place to address it.	Difficult

Finland

Table 19: Recommendations (A) – Changes to admission requirements

	Issue	Recommendation(s)	Expected impact	Ease of implementing change
A.1	Wrong choice of programme or dissatisfaction with education are often identified as the most significant factors named by students in affecting their decision to withdraw. The current entry requirements in Finland, however, tend to focus more on determining whether the applicants hold the requisite knowledge for their chosen program. Student motivation or aptitude is not measured. Generalized aptitude tests (for information only, not selection) in Italy for example have been found to correlate highly with student performance and even students are in favour of them; according to a recent survey to the general upper secondary school students in Finland (2011), about 82 % of the respondents either fully or partially agreed that the current entrance examinations should focus more on measuring student aptitude.	Universities should diversify their current entrance examinations to test also applicants' aptitude and motivation.	Improved student performance (progression) and fewer students dropping out.	Difficult

Table 20: Recommendations (B) – Structural changes to the education system

	Issue	Recommendation(s)	Expected impact	Ease of implementing change
B.1	The number of students specializing in mathematics, physics and chemistry at secondary level is somewhat of concern. In 2009, about 42 % of all upper secondary school graduates in Finland had completed the advanced syllabus in mathematics, while the advanced syllabus in physics had taken only by 17 % and the advanced syllabus in chemistry also by 17 % of the upper secondary school graduates. And although the entry mechanisms to higher engineering education in Finland are many, access to university-level engineering education is rather difficult without the advanced-level skills in mathematics, physics and/or chemistry. Indeed, according to a recent survey in the four schools of technology at Aalto University (2011), majority of the new students (~99 %) had completed the advanced syllabus in mathematics at secondary level. The advanced syllabus in physics had completed more than 85 % of the respondents and the advanced syllabus in chemistry almost 60 % of the respondents. However, another recent survey to the general upper secondary school students (2011) showed that only 65 % of the respondents found that they had had enough information to make the decision about their areas of specialization when starting upper secondary education and only 41 % of them had been aware of the consequences of their choices.	Schools should systematically support their students in building and maintaining positive conceptions and attitudes towards mathematics and science subjects – not only at secondary level but also at primary level. Teachers in mathematics, physics and chemistry play an important role in creating positive image of studying mathematics, while study counsellors play an important role in helping the students with their decisions about areas of specialization in secondary education as well as in making sure that the students are aware of the consequences of their choices.	More positive conceptions and attitudes towards mathematics and science subjects among children and young people, increased number of students taking advanced-level studies in mathematics, physics and chemistry at secondary level and increased number of eligible applicants to engineering education	Difficult

Table 21: Recommendations (C) – Socio-economic and cultural factors

	Issue	Recommendation(s)	Expected impact	Ease of implementing change
C.1	According to a recent study on the selection for admission to Finnish universities and fields of study in the beginning of the 21st century (2010), there is a strong geographical division in terms of the universities with widest socio-economic diversity of applicants. Those in the capital are largely classified as elitist based on the social status of the father, while many of those outside major cities receive applicants from the lowest socio-economic backgrounds. The placement of different fields of study on the elitist-populist axis varies greatly between universities. Engineering, mathematical and natural sciences and economics, however, are placed above average while education and pharmacy are considered more populist. The offspring of the most educated and high social status parents also gain a study place more often than other applicants.	Universities should overhaul their image to attract students from various socio-economic backgrounds and geographical locations, and aim their recruitment activities accordingly.	More students from various socio-economic and cultural backgrounds studying engineering	Easy
C.2	The relatively small share of female students (~25 %) attending engineering education is partially due to the fact that also fewer women specialize themselves in mathematics, physics and chemistry at secondary level. In 2009, the percentage of female students among all upper secondary school students studying advanced mathematics, physics and chemistry was less than 50 %, about 26 % and 42 % respectively. Furthermore, only about a quarter of the female upper secondary school students took the advanced level mathematics in the matriculation examinations between spring 2006 and fall 2009, and over a quarter of them did not take mathematics at all. A recent survey to the general upper secondary school students in Finland (2011) also	Schools and universities should systematically support young girls in building and maintaining self-confidence as well as positive conceptions and attitudes towards mathematics and science subjects already at primary level. Occasional projects are not enough. Both teachers and study counsellors at primary and secondary level play an important role here.	More girls who are self-confident, motivated and have positive attitude towards mathematics and science subjects, and more girls taking advanced-level studies in mathematics, physics and chemistry at secondary level	Moderate

	shows that male students generally give more emphasis and recognition on mathematics and science subjects than female students. Similar results were found in the PISA 2003 assessment, which indicates that in Finland girls' interest in mathematics is significantly different from the level of interest among boys in comparison to other countries. While the level of know-how is rather similar between boys and girls, it is the self-confidence, motivation and attitudes that differ.			

Ireland

Table 22: Recommendations (A) – Changes to admission requirements

	Issue	Recommendation(s)	Other relevant recommendations	Ease of implementing change
A.1	Higher Maths Requirement – most engineering courses require 55%+. Evidence suggests that mathematics is highly predictive of student progression.	The marginal effect of grades in the vicinity of 55% should be studied more deeply – particularly in institutions not requiring the 55% threshold. Only 12% of Leaving Certificate students achieve this level. Therefore more promotion of higher level maths is required.	A.4	Moderate Difficult
A.2	Prior achievement in Physics (in particular) and chemistry are predictive of student progression, but are not formal requirements (some institutions require a science subject, but not specifically one of the above).	Award bonus points for these subjects to students choosing engineering Increase promotion of these subjects to overcome poor uptake at school level	A.4	Easy Difficult
A.3	Generalised aptitude tests (for information only, not selection) in Italy have been found to correlate highly with student performance.	Such tests should be introduced by the universities – different weightings could be applied to different courses if and when the tests are used for selection.		Moderate
A.4	Many students appear to be choosing subjects at LC level based on perceived difficulty in 'getting points'. Evidence also suggests that students get larger proportions of their points from certain subjects (substantiating notions of certain subjects being easier). Furthermore the discretised nature of the grading can mean small differences in ability are disproportionately weighted – particularly at the very high and low ends (where failure risks going from 45 points to 0 at higher level).	Introduce percentile grading – e.g. 100 for being in the top 1%, 80 for being in the top 20%, 30 for being in the top 70% etc.		Easy

Table 23: Recommendations (B) – Structural changes to the education system

	Issue	Recommendation(s)	Other relevant recommendations	Ease of implementing change
B.1	The current high school system does not measure a student's performance over time, but rather is solely based on his/her grade from one set of exams.	Introduce a significant component of continuous assessment at high school level. This would allow grades from on-going assessment to be considered in combination with Leaving Certificate results in the awarding of university places.		Difficult
B.2	Currently Irish is the only compulsory subject for Leaving Certificate. As a result, there is no common framework for knowledge/competencies shared by all students across a range of subjects.	Define a standard level of achievement across a broad range of subjects which must be demonstrated by students at each level of the education system.	B.3	Moderate
B.3	The present division of subjects into Higher and Ordinary Level makes it difficult to compare knowledge held by students taking different levels of the same subject.	A modularised system should be established, similar to that in Finland and Sweden. All students would take a basic level in set subjects, and additional, optional modules would be available on top of this foundation.	B.2	Difficult

Table 24: Recommendations (C) – Socio-economic and cultural factors

	Issue	Recommendation(s)	Ease of implementing change
C.1	There is a strong and persistent gender divide in the area of subject uptake at high school level, particularly in relation to engineering-relevant subjects. This has a knock-on effect on the uptake of engineering at university level by female students.	An updated examination into the causes of and possible solutions to this gender divide should be carried out	Moderate
C.2	Research into the student profile at Trinity College shows that engineering and science programmes have significantly lower representation of socio-economically disadvantaged students, mature students, and students with disabilities than do other programmes within the university.	An investigation should be carried out into the causes behind this imbalance. A subsequent action plan should be developed to increase the numbers of students from these groups.	Moderate Moderate
C.3	There is a significant gender gap in achievement at university. At present, female students are more likely to progress successfully in certain disciplines at university level than male students, even when all other factors are normalised for.	Conduct further research into the reasons for this and into what measures might be successfully employed to target it.	Moderate
C.4	The performance of Irish students in PISA tests displays a strong correlation between higher scores in mathematics and higher socio-economic status of the student.	Further investigation should be carried out into this finding, and measures put in place to address it.	Difficult

Italy

The primary challenge faced by many universities under the Italian system is over-subscription of programmes in the first year, due to the nature of the admissions system in place and the absence of a *numerus clausus*.

Rather than recommendations, the changes detailed here have already been approved for introduction and will target this particular issue.

The Academic Senate, on March the 2nd 2012, approved the introduction of the *numerus clausus* for access to degree courses in Engineering.

The maximum number of enrolling students is fixed at 5,000 of which:

- 4,400 EU students
- 600 non-EU students

This number equates to the maximum number of students for Politecnico di Torino in relation to its sustainable teaching, financial and logistical resources.

Under the new regulations, students wishing to enrol in any Engineering programme will take a mandatory test. Admission will be dependent upon achieving a total score of at least 50%.

The test will be called TIL (Test in Lab) and will take place on-line at the computer labs of the University.

The structure of TIL is as follows:

- 18 mathematic questions in 40 minutes
- 6 verbal comprehension questions in 12 minutes
- 6 logic questions in 12 minutes
- 12 physics questions in 26 minutes

A student seeking admission who does not reach the required 50% score at the test will be able to re-take the TIL in one or more later sessions (April, May, July and September) or can be selected from a ranking (resulting from the tests) if there are more available positions.

Portugal

Table 25: Recommendations (A) – Changes to admission requirements

	Issue	Recommendation(s)	Ease of implementing change
A.1	Ensure students have 3 years of Maths in secondary education (Evidence suggests that mathematics preparation is predictive of student progression)	To access a Engineering programme 3 years Maths in Secondary Education is mandatory	Will be applied after 2012/13
A.2	Ensure students have Physics and Chemistry in Secondary Education. The contact with Physics is a good predictor of student progression in an Engineering programme.	To access an Engineering programme an exam in Physics and Chemistry should be mandatory	Will be applied in most Engineering programmes after 2012/13
A.3	Generalised aptitude tests for information only, not selection(in Italy these have been found to correlate highly with student performance).	Such tests should be introduced by the universities – different weightings could be applied to different courses if and when the tests are used for selection.	Moderate

Table 26: Recommendations (B) – Structural changes to the education system

	Issue	Recommendation(s)	Ease of implementing change
B.1	There is a big gap between the studies in secondary and higher education, causing the dropout of some students in the first year.	Develop/improve programmes to decrease this gap.	Difficult

Table 27: Recommendations (C) – Socio-economic and cultural factors

	Issue	Recommendation(s)	Ease of implementing change
C.1	IST students usually come from higher socio-economically status backgrounds, and there is under-representation of socio-economically disadvantaged students. This situation is not that different from other universities and areas, but it should be addressed.	Review the budget and the rules to access scholarships, which are currently low and difficult to obtain.	Moderate
C.2	Living away from home or taking too long to get to IST (travel time) decreases academic performance in the first year (at least) of studies at IST.	Review the programmes to welcome and integrate the students. Facilitate (or develop) access to e-learning contents.	Moderate

Sweden

Table 28: Recommendations (A) – Changes to admission requirements

	Issue	Recommendation(s)	Ease of implementing change
A.1	When applying for an engineering programme, the applicant's grades in relevant subjects like mathematics, physics, chemistry and/or biology are not weighted. Hence, an applicant with relatively better grades in the subjects most relevant for the study programme he/she applied for does not get a relative advantage over other applicants.	Evaluating the results of tests such as the Mathematics-Physics test, for instance by judging the "success rate"; which students enter through the test and how do these students perform in comparison to students who enter through their secondary school grades or the scholastic aptitude test?	Moderate.

Table 29: Recommendations (C) – Socio-economic and cultural factors

	Issue	Recommendation(s)	Ease of implementing change
C.1	Research shows that students from an academic background are more likely to choose engineering programmes at university.	An investigation should be carried out into the causes behind this imbalance. A subsequent action plan should be developed to increase the numbers of students from these groups.	Moderate Moderate
C.2	The number of women choosing engineering programmes is significantly less than men. There are also great differences between the genders within the engineering area.	A study to establish why certain engineering courses are less attractive to women than men.	Moderate
C.3	Fewer women than men, after having completed the Science foundation Year, choose to move on to an academic programme in the field of natural sciences or technology.	Investigate the underlying causes behind this trend, with the aim of reaching possible solutions.	Moderate

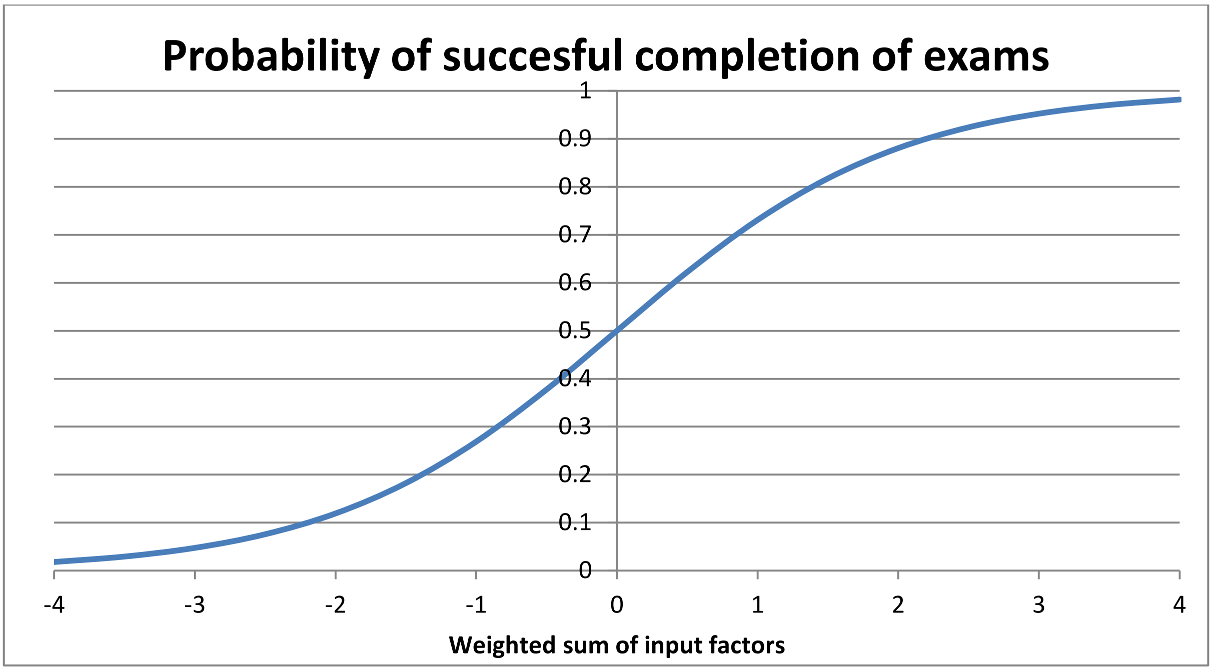
Appendix A-Explanation of Logistic Regression

The form of the model is:

$$p(Progress) = \frac{1}{1 + e^{-x}}$$

where ‘x’ is a linear (weighted) combination of the variables below.

The table shows the minimum and maximum effects of the input variables on the weighted sum, ‘x’. For each subject there exists a ‘critical mark’ above which the student is more likely to progress (than if they hadn’t taken the subject) and below which they are less likely.



Appendix B-Subjects significant for Engineering

In the extreme case of a student entering engineering as their 10th choice, with failing grades in all the above subjects with the exception of the minimum entry standard in mathematics, their probability of passing the examinations would be 8% (x=-11), while a student with maximum grades entering with their first preference would be predicted to pass with a probability of 81%(x=1.46).

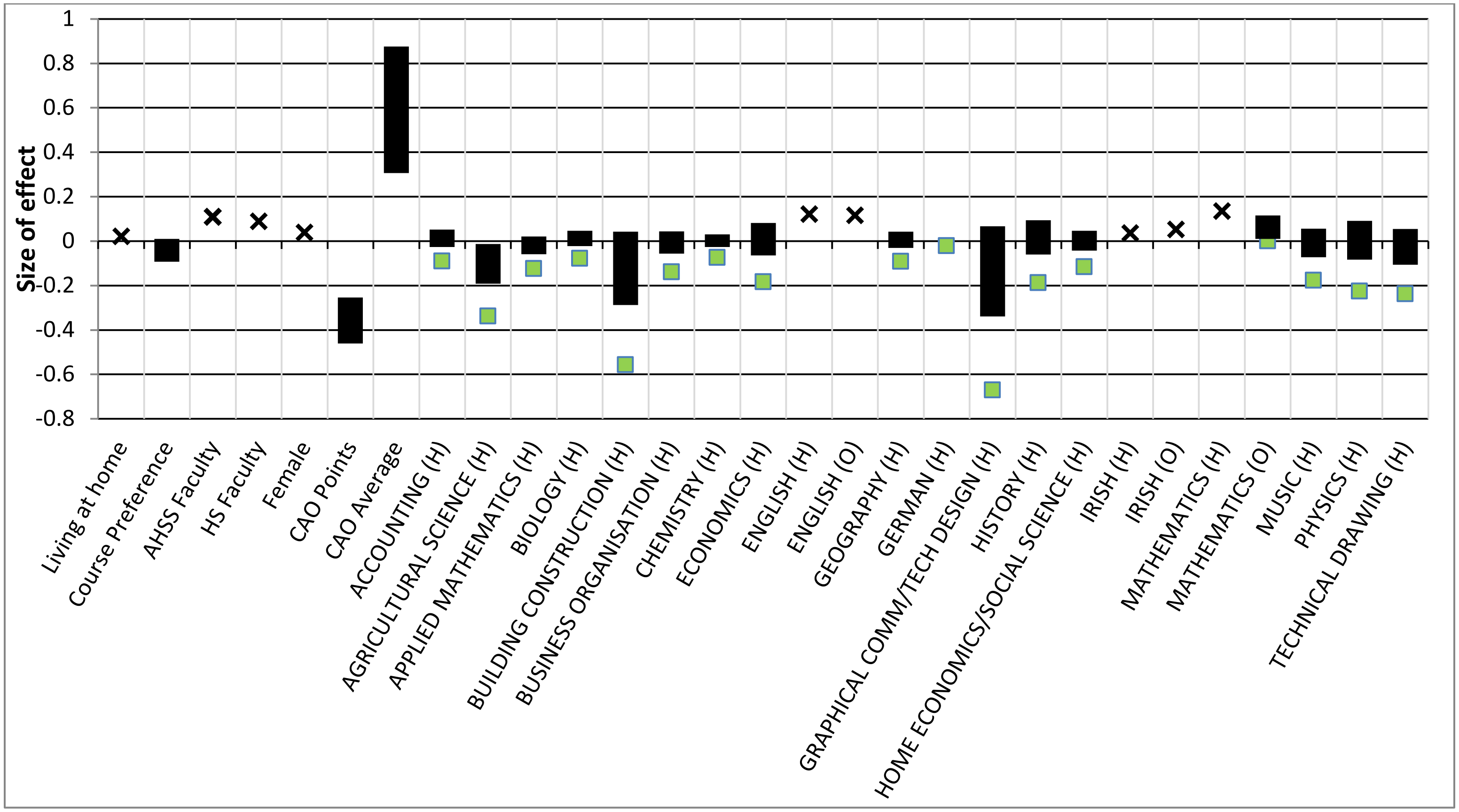
Subject/Parameter	Fail/Minimum	Pass/Minimum	Maximum	Notes
Course Preference	-0.171		-0.017	Preference from 1 to 10
Mathematics	N/A	0.401	0.668	Between 60 and 100 is required for entry
Chemistry	-0.399	-0.142	0.172	Critical/Neutral Mark of 65%
Physics	-0.376	-0.117	0.270	Critical/Neutral Mark of 55%
Building Construction	-0.973	-0.477	0.134	Critical/Neutral Mark of 85%
Economics	-0.599	-0.300	0.065	Critical/Neutral Mark of 85%
Accounting	-0.303	-0.098	0.153	Critical/Neutral Mark of 85%
Irish (Lower)	-0.046	-0.046	0	Simply taking Lower Irish has a negative effect, irrespective of grade

Appendix C-Progression for All students in TCD

Subject/Parameter	Fail/Minimum	Pass/Minimum	Maximum	Notes
(Intercept)	0.499929	0.499929	0.499929	
Pref	-0.1662		-0.01662	Preference from 1 to 10
MATHEMATICS	0	0.045531	0.10118	Always positive benefit from taking higher maths
MATHEMATICS (Lower)	-0.13251	-0.116	0.065612	Critical/Neutral Mark of 80%
ENGLISH	0	0.039717	0.08826	Always positive benefit from taking higher English
Home	0.023764	0.023764	0.023764	Students who live at home get a benefit
Female	0.062486	0.062486	0.062486	Benefit gained by being female
PHYSICS	-0.32302	-0.1399	0.083902	Critical/Neutral Mark of 75%
APPLIED.MATHEMATICS	-0.20864	-0.10609	0.01926	Critical/Neutral Mark of 90%
CHEMISTRY	-0.16408	-0.1546	0.025425	Critical/Neutral Mark of 85%
HISTORY	-0.23877	-0.07891	0.116482	Critical/Neutral Mark of 65%
ECONOMICS	-0.23038	-0.08073	0.102174	Critical/Neutral Mark of 65%
IRISH	-0.06995	-0.06366	0.055794	Critical/Neutral Mark of 50%
ACCOUNTING	-0.16678	-0.15522	0.064369	Critical/Neutral Mark of 70%
FRENCH	-0.06088	-0.05499	0.056792	Critical/Neutral Mark of 50%
BIOLOGY	-0.12611	-0.04759	0.048372	Critical/Neutral Mark of 70%
GEOGRAPHY	-0.15152	-0.06094	0.049764	Critical/Neutral Mark of 75%
BUSINESS	-0.20289	-0.08384	0.061654	Critical/Neutral Mark of 75%

It may be observed that mathematics and English have a universally positive effect – i.e. those students taking these subjects at higher level ALWAYS do better than those not taking these subjects. Living at home and being female present an advantage to students.

Figure C.1: Factors influencing progression for all students in the university



Appendix D-Progression for All students in TCD, by Faculty

Students in Trinity College belong to one of three faculties:

Engineering, Maths and Science

Arts, Humanities and Social Studies

Health Sciences

The analysis below presents the progression data of students broken down by faculty

Figure D.1: Factors influencing progression for students in the Faculty of Engineering, Maths and Science

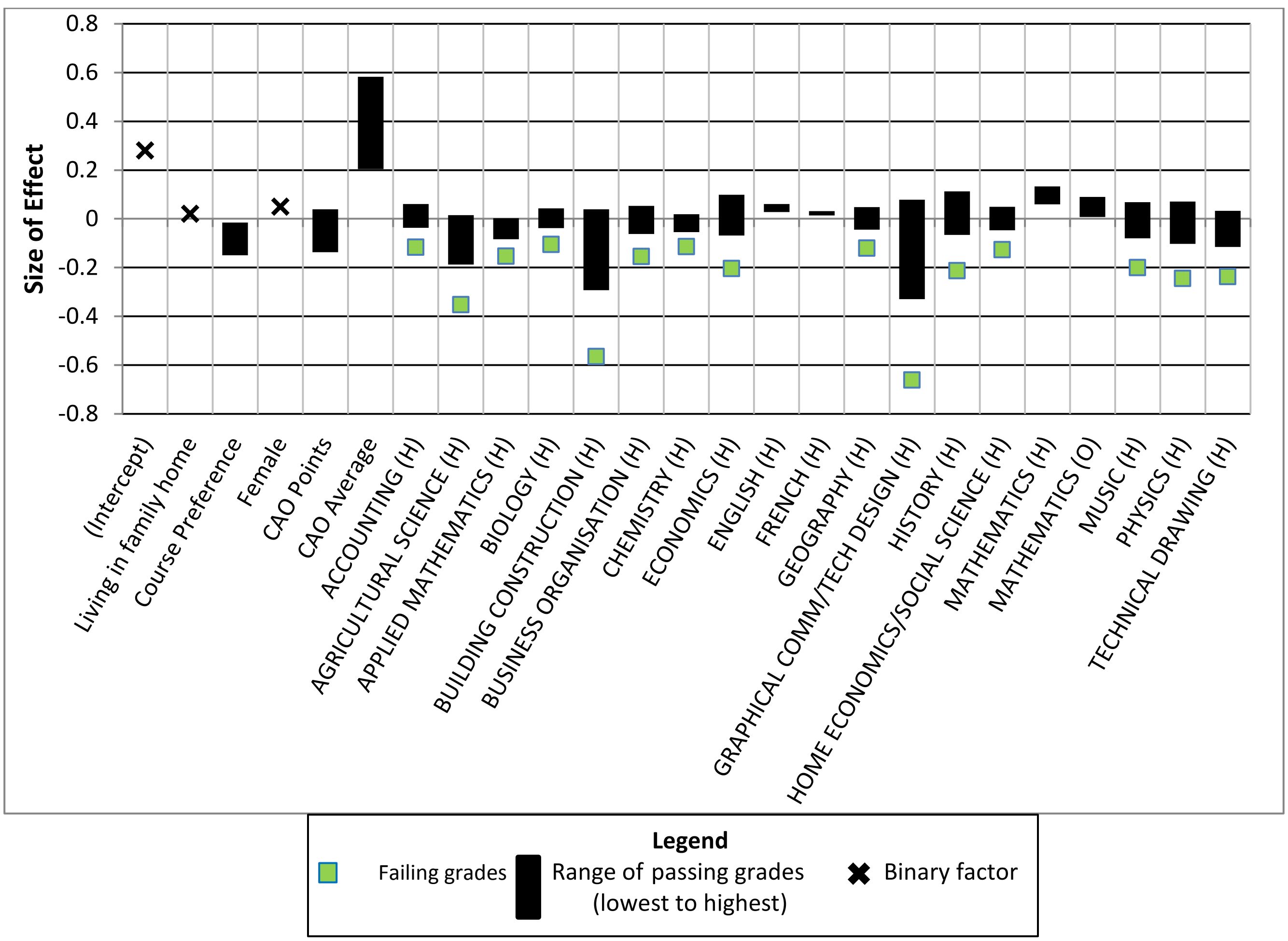
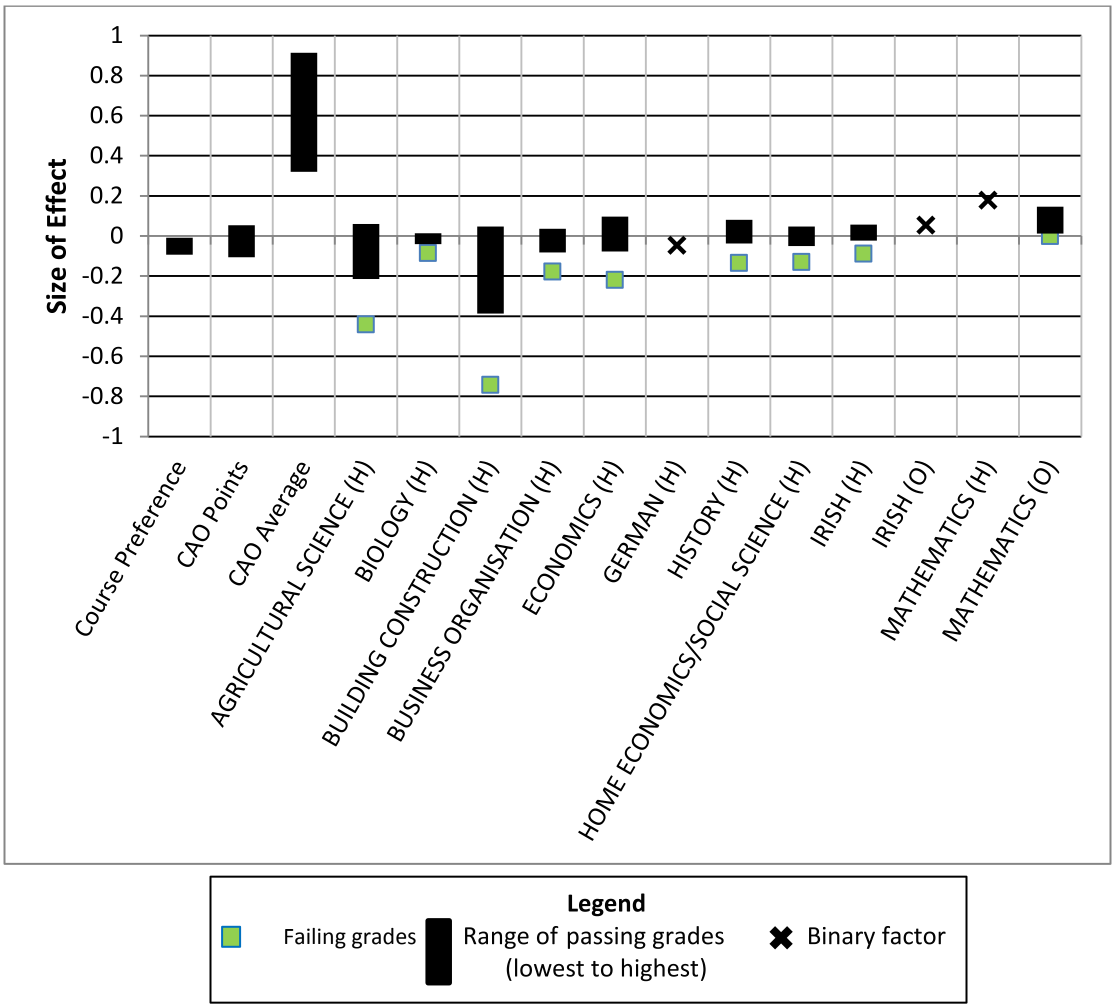


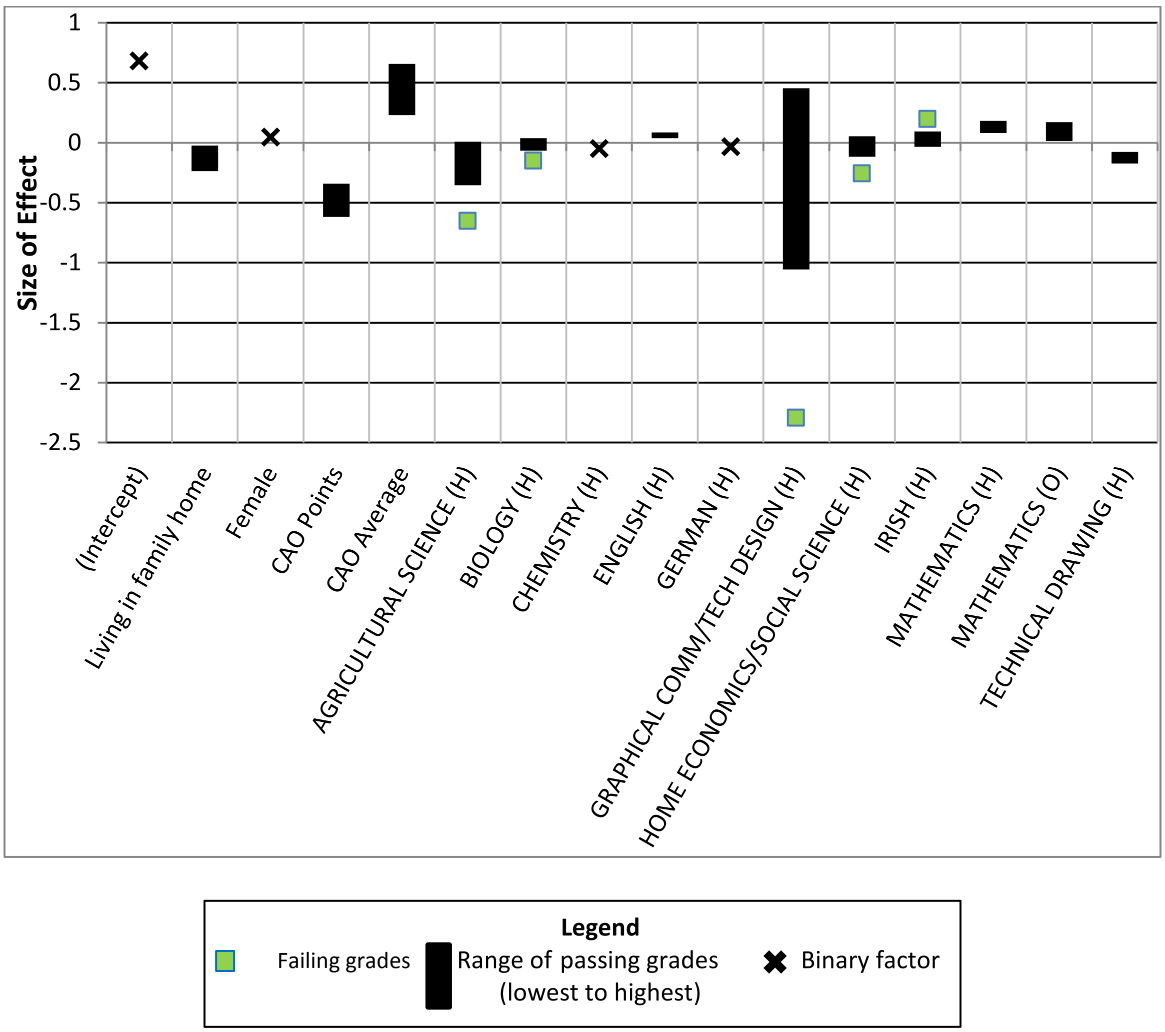
Figure D.1 demonstrates that for students in the Faculty of Engineering, Maths and Science, the factor with by far the biggest positive influence on progression is CAO Average. This refers to the average score students receive in all of the subjects studied at Leaving Certificate, rather than the average of only their best six, as measured by CAO points. The higher a student scores according to this measure, the more likely she/he is to progress. Building Construction and Graphical Communication/Technical Design are the most significant negative influences on progression for students who do not attain the very top scores in these subjects, but overall the effect is small as only a very low proportion of students take these subjects.

Figure D.2: Factors influencing progression for students in the Faculty of Arts and Humanities



Interesting observations from this data set include the fact that there is universally positive benefit to having taken Mathematics at the higher level. This reinforces the findings of the HEA study on national data (HEA, 2010).

Figure D.3: Factors influencing progression for students in the Faculty of Health Sciences



Appendix E-Gender Uptake and Achievement in various subjects at High School

Students have a wide range of subjects from which they choose typically 6 or 7 subjects, although students may in some instances take more. Results in their best 6 subjects are used to determine entry to the university system. Subjects may be taken at a ‘higher’ or ‘ordinary’ level. Students passing the examinations (i.e. >40%) achieve a score of between 45 and 100 for higher level subjects and between 5 and 60 for lower level subjects.

There are considerable differences in the uptake rates for various subjects between male and female students. The first graph below presents the percentages (split into male and female students) of the total TCD student population presenting with the higher level in the most popular subjects. Subjects highlighted with blue outlines are those found to be statistically significant predictors of student progress in engineering.

There are also significant differences between male and female students in achievement in particular subjects. For this analysis, the achievement of students in each subject was considered when compared to their CAO score. The CAO score is comprised of their best 6 grades, so this analysis will show whether a particular subject tends to make a larger or smaller contribution to their overall performance. It isn’t possible to discriminate between putative differences in the ‘easiness’ of various subjects and student motivation, effort etc., but the results do present an insight into typical achievement levels when normalised for average student ability.

Figure E.1: Uptake of selected Leaving Certificate subjects by gender

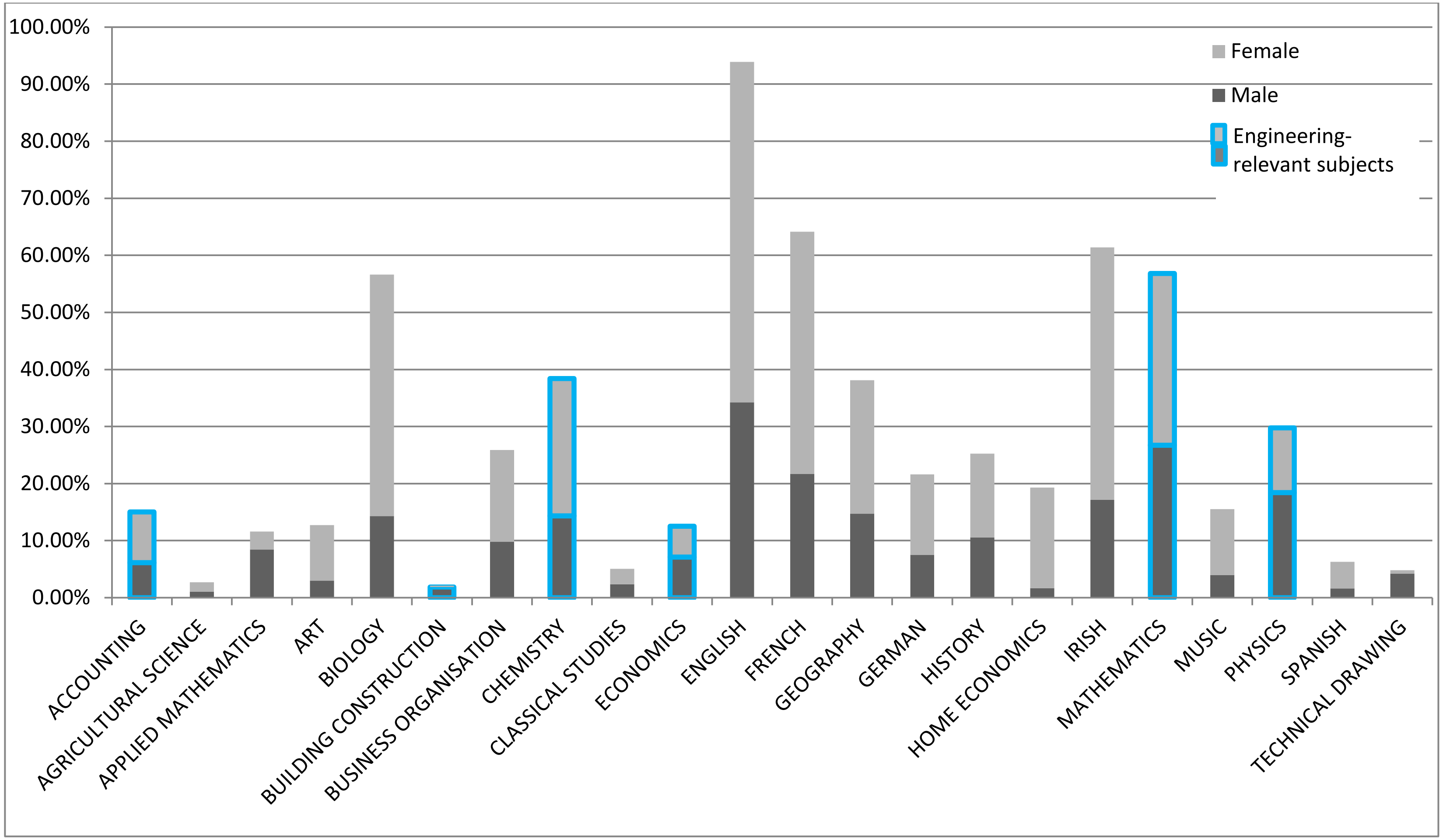
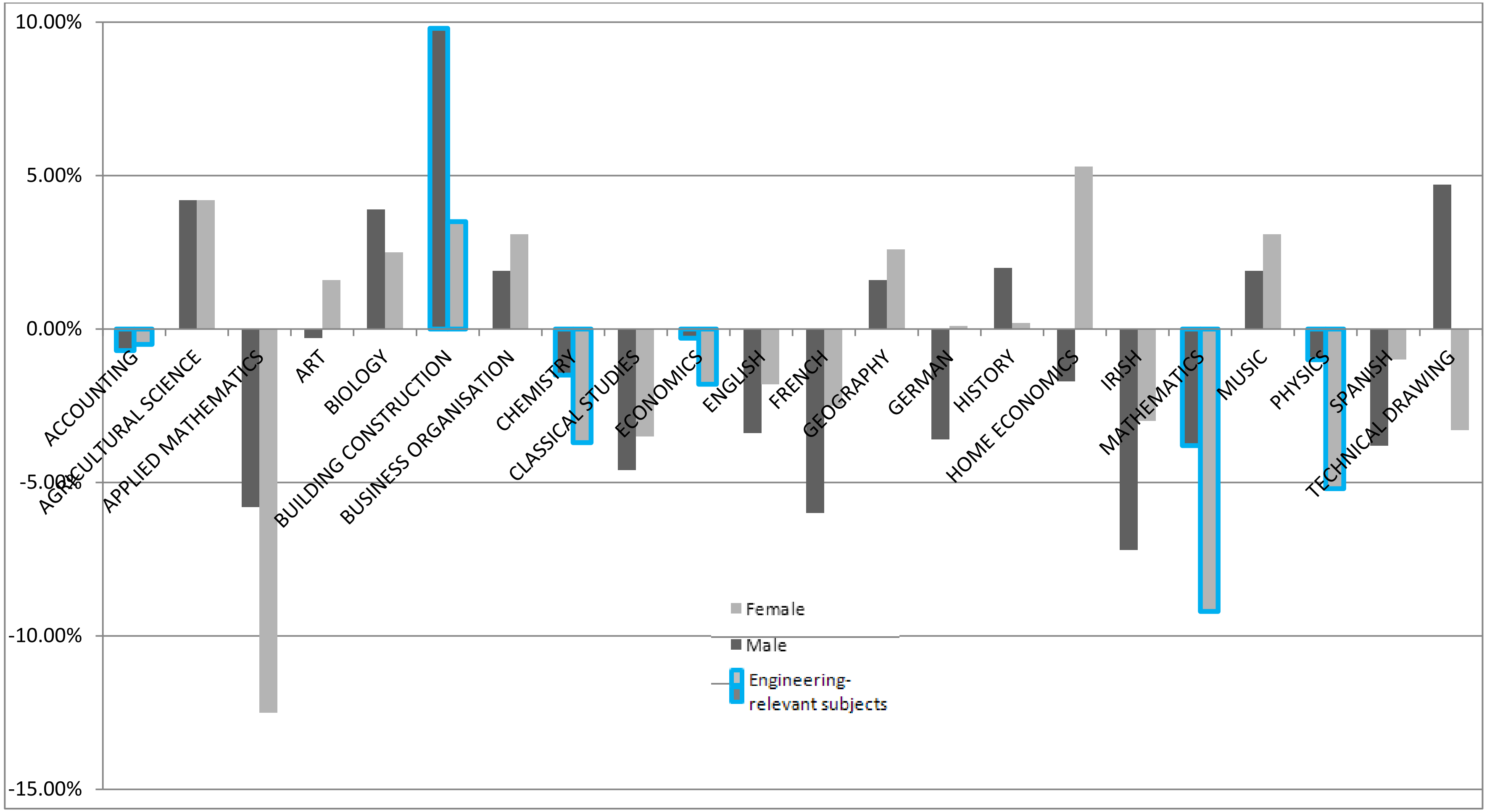


Figure E.2: Relative difficulty of selected Leaving Certificate subjects



National Actions

At European level, there is a contest for young scientists, EUCYS[67]. It is an initiative of the European Commission, which is designed to promote the principles of co-operation and exchange between young scientists. The event is held in a different European city every year. During the competition, the young scientists also have the chance to meet other scientists with similar abilities and interests and to be guided by some of the most prominent scientists in Europe. Thus, the Commission seeks to strengthen efforts made in each participating country to attract young people to careers in science and technology.

Finland

Project	Aim	Target Population	Description
Millennium Youth Camp	To increase the awareness of the Millennium Technology Prize	16 – 19 year olds	Participants take part in the ceremony and meet the winner and the laureates during that week.
Tekniikan päivät	To increase the general public awareness of S&T importance.	General Public	It is a 2-day fair, organized for everyone interest in technology and natural sciences.
Heureka	To increase the general public awareness of the importance of S&T.	General Public	Finnish Science Centre is an information and activity centre for everyone interested in science
LUMA Centre	To promote the learning, studying and teaching of natural science, mathematics, computer science and technology on all levels.	Finnish Schools, teachers and students	LUMA Centre is coordinated by the Faculty of Science of the University of Helsinki to bring schools, universities and industries together. The LUMA Centre works together with schools, teachers, students and several other cooperation partners in order to achieve its goals.
Opiskelupaikka.fi	To promote postsecondary education.	Secondary Students	Websites and social media sites (in Finnish) focused on promoting and providing information about higher engineering education, and the nationwide application procedure.
TiNA	To promote technology studies as an attractive and realistic career option.	Young Girls	TiNA project organises various types of events designed for women in technology supporting their career choice.
Teekkari.fi	To promote university technology studies	Students and those considering to apply for technology studies	Provides information on working life in the field, study culture, professional education
MIRROR	To increase the proportion of girls participating technology, especially in mechanical engineering, IT and electronics.	Young students, Parents, Teachers, Study counsellors	The increasing opportunities in these industrial sectors were disseminated, as well as new learning materials for use in all levels of education.
GISEL	To improve teaching and learning in science, technology in Finnish schools.	Grades 5 – 12, particularly girls	To help teachers adopt and develop new approaches for including S&T education. To foster collaboration between schools and universities/industry to provide professional development opportunities for teachers.

[67] http://www.eucys2012.eu/

Project	Aim	Target Population	Description
WomEqual	To support women careers, especially in the technological fields.	Females	WomEqual is like a mentoring programme in which more experienced professionals guide less experienced ones, based on their own experience.
Tämä Toimii! Teknologiakilpailu	To get familiar with young children with technology.	Elementary school children.	Technology competition.
Tutki-Kokeile-Kehitä	To promote S&T among students.	6 to 20 year olds	Annual science and technology competition, where the Finnish representatives for EUCYS are selected.

Ireland

Project	Aim	Target Population	Description
ICT in schools	To increase the levels of Information and Communications Technologies (ICT).	First and Second Level of Education	To increase the number of computers in schools, train teachers to develop IT skills and to increase the level of ICT in the curricula.
Exploration Station	To raise the level of science awareness among young people.	Children Young Adults Teachers Families	Interactive science centre, which provide visitors a hand-on experience and understanding science.
Discovery Primary Science	To promote science, emphasising the sense of fun, discovery and adventure among children.	Primary school teachers	The program provides teachers with the tools to make science interesting and funny for young children.
Greenwave	To encourage students to understand that science experiments can take place outside the laboratory environment.	Primary level children	It is a mass science experiment to measure how quickly spring arrives to Ireland in which students are encouraged to observe and record when certain plants and animals react to the longer days and warmer temperatures.
Discover Sensors	To facilitate active learning and promote hands-on scientific investigations through the use of sensor technology.	Junior certificate students and their teachers	With a number of practical examples, teachers can promote science experiments in class and students can learn how to use sensor equipment.
My Science Career	To disseminate information about STEM careers and demonstrate that a qualification in these areas can lead to an exciting and varied career.	Young People	The website operates a "science ambassadors" scheme, which features women and men working across a wide range of STEM fields, providing interviews about their careers and their work entails,
NanoQuest	To garner students' interest in nanotechnology and science generally.	13 – 15 year olds	A 3D computer game which introduces nanotechnology concepts through various challenges, while providing fun and challenging game play with many topics that appear on Junior Certificate Science syllabus.
Project Blogger	To provide students with a web space to create science experiences.	Second-level students	Website where second-level students and teachers can create blogs based on their science experiences and interests,
Science.ie	To provide information about STEM in order to stimulate interest in these	Youngsters	The site includes advice, information and support for people of all ages who are interested in these

Project	Aim	Target Population	Description
	areas.		topics.
Science Week	To make science more interesting and accessible to children and adults alike.	General Public	Ireland's largest annual promotion of science through a week-long programme of events.
SCOPE TV	To increase the interest in science.	Young people	Series showing science experiments and science-related activities taking broadcasted on Irish national service.
Web 2.0	To increase the teenagers' awareness of science, engineering and technology.	Teenagers	Online media coverage on science-related topics in an informal way through Twitter, YouTube and a blog.
Engineers Week	To promote the engineering profession.	General Public	Nationwide events designed to celebrate all aspects of engineering, e.g. careers talks, site tours, and practical hands-on workshop.
K'NEX Engineering Challenge and K'NEXperience	To give pupils a chance to experiment engineering experiments.	Young students	Students create models in their classrooms, which can afterwards compete nationwide.
Extreme Engineering Show	To stimulate curiosity and imagination within pupils and bring science and engineering to life.	Primary students	Introduces engineering through a show with a scientist-turned-magician, who delivers an even more captivating, wacky and fun show allowing for real experiential learning opportunities
Engineering Seminars	To inform students about engineering as a career and encourage them to study it at third-level.	Second-level students	Engineering professionals are brought into a talk to the students about their careers and provide an insight into their work.

Italy

Project	Aim	Target Population	Description
National Plan for Science Degrees	To consolidate science knowledge and skills among the students.	Second-level students	Workshops are designed so that students take an active part, observing and reflecting upon teachers directives about daily-life situations.
Alpha	To increase students' interest in science.	Teachers	Support teachers developing new approaches to teach mathematics and physics.

Portugal

Project	Aim	Target Population	Description
E-Escola	To support students and teachers knowledge in Biology, Physics, Mathematics, Chemistry and Engineering Sciences.	Secondary Students and Teachers	E-Escola is a web portal of basic sciences and engineering promoted by Instituto Superior Técnico (IST).
Ciência Viva	To promote scientific and technological culture among population.	General Public	Science teachers support program; Science centres with interactive areas of science; Nationwide campaigns to promote science among students.

Plano Tecnológico	To develop youngsters' competences in the use of ICT.	Young students	Schools are being equipped with ICT equipment and access to Internet. Also, personal computers and Internet access are being promoted among students.
Career guidance	To inform secondary students about the career available.	Second-level students	At secondary schools, there are an educational and a professional guidance office, which promote a conscious decision about the future.

Sweden

Project	Aim	Target Population	Description
Science and Technology for All (NTA)	To support teachers in their efforts to stimulate pupils´ curiosity, interests and knowledge in S&T.	Children teachers	The NTA program offers and develops methods, services and products for improving learning and teaching in S&T, both at overall municipal level and at individual schools/schools districts level.
KomTek	To develop students' creativity through technology.	Children	This initiative focuses on children's activities after school, and is a kind of technology club.

There are also numerous initiatives for children held by professional interest groups, such as the Swedish Plastic and Chemical Federation, or the Technology Industry (Teknikföretagen). Moreover, engineering universities also collaborate on a nationwide competition for 14-15 year olds, such as Teknikåttan.

Variables Definition

Secondary Students

	Belgium	Finland	Ireland	Portugal
A – Students who wish to pursue engineering from students total	Same	Same	Results relied on a "-3 to +3" scale. Results from "1 – 3" were used as intending to study engineering	Same
B – Students who wish to pursue engineering and whose parents have engineering from students total	Same	Results concern only parents' background.	Results relied on a "-3 to +3" scale. Results from "1 – 3" were used as intending to study engineering	Same
C – Students who decided to undertake an engineering programme after entering 9 years of compulsory education from students total	Same	Same	Same	Same
D – Students who believe that engineers are very important or important to the country development and whose area of studies is S&T from students total	Same	The question was "How the importance of engineers to the society is being recognized". Results considered the answer "very well" or "well" of students who completed the advanced-level mathematics at secondary level.	Engineers importance relied on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for VI + I	Same
E – Students who believe that engineers are very important or important for the country development and whose parents have a tertiary education	Same	The question was "How the importance of engineers to the society is being recognized". Results considered the answer "very well" or "well" whose parents had completed tertiary education, in both types of HEIs – polytechnics and universities.	Engineers importance relied on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for VI + I	Same
F – Students who consider that engineering duties requires a high level of difficulty and whose area of studies is S&T from students total	Same	Considers the students who had completed the advanced-level mathematics at secondary level.	Ireland does not have S&T area of studies and the difficulty of engineers job relied on a "-3 to +3" scale. Results from "1 – 3" were used as inclusive for VH + H.	Same
G – Students who believe that undertake an engineering programme requires a great deal of effort and whose area of studies is S&T from students total	Same	Considers the students who had completed the advanced-level mathematics at secondary level.	Ireland does not have S&T area of studies and the effort required was on a scale of "-3 to +3". Results from "1 – 3" were used as inclusive for GDE.	Same
H – Students who believe that engineers are well paid and whose area of studies is S&T from students total	Same	Considers the students who had completed the advanced-level mathematics at secondary level.	The question was "how well is an engineer paid on a-3 to 3" scale. Results from "1 – 3" were used as inclusive for remarkable wage.	Same
I – Students who believe that engineers have a remarkable recognition and whose area of studies is S&T from students total	Same	Considers the students who had completed the advanced-level mathematics at secondary level.	Not Available	Same
J – Students who think that engineers have easy access to the labour market from students total	Same	Same	The question was about engineers employment prospects, and relied on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for good prospects	Same

Entrant Students

	Finland	Ireland	Italy	Portugal	Sweden
A – Students who studied S&T in secondary education from students' total.	Considers the students who had completed the advanced-level mathematics at secondary level.	Ireland does not have S&T area of studies so included students who had selected one of our listed S&T subjects.	Not Available	Same	Same
B – Students whose parents have an engineering background from students' total.	Results concern only parents' background.	Same	Same	Same	Not Available
C – Students who decided to undertake engineering after 9 years of compulsory education.	Same	Same	Not Available	Same	Not Available
D – Students who believe that engineers are very important or important to the country development from students' total.	The question was "How the importance of engineers to the society is being recognized". Results considered the answer "very well" or "well" of students who completed the advanced-level mathematics at secondary level.	Engineers' importance relied on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for VI + I	Same	Same	Not Available
E – Students who believe that engineers are very important or important for the country development and whose parents have a tertiary education	The question was "How the importance of engineers to the society is being recognized". Results considered the answer "very well" or "well" whose parents had completed a university degree.	Engineers importance relied on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for VI + I	Not Available	Same	Not Available
F – Students who consider that engineering duties requires a very high or a high level of difficulty from students' total.	Same	Ireland does not have S&T area of studies and the difficulty of engineers job relied on a "-3 to +3" scale. Results from "1 – 3" were used as inclusive for VH + H.	Same	Same	Not Available
G – Students who believe that undertake an engineering programme requires a great deal of effort from students' total.	Same	Ireland does not have S&T area of studies and the effort required relied on a "-3 to +3" scale. Results from "1 – 3" were used as inclusive for GDE.	Same	Same	Same
H – Students who believe that engineers are well paid from students' total.	Same	The question was "how well is an engineer paid on a-3 to 3" scale. Results from "1 – 3" were used as inclusive for remarkable wage.	Not Available	Same	Not Available
I – Students who believe that engineers have a remarkable recognition from students' total.	Not Available	Not Available	Not Available	Same	Not Available
J – Students who think that engineers have easy access to the labour market from students' total.	Same	Question was about engineers employment prospects, answered on a "-3 to 3" scale. Results from "1 – 3" were used as inclusive for good prospects	Same	Same	Same

Extended Results

Secondary Results

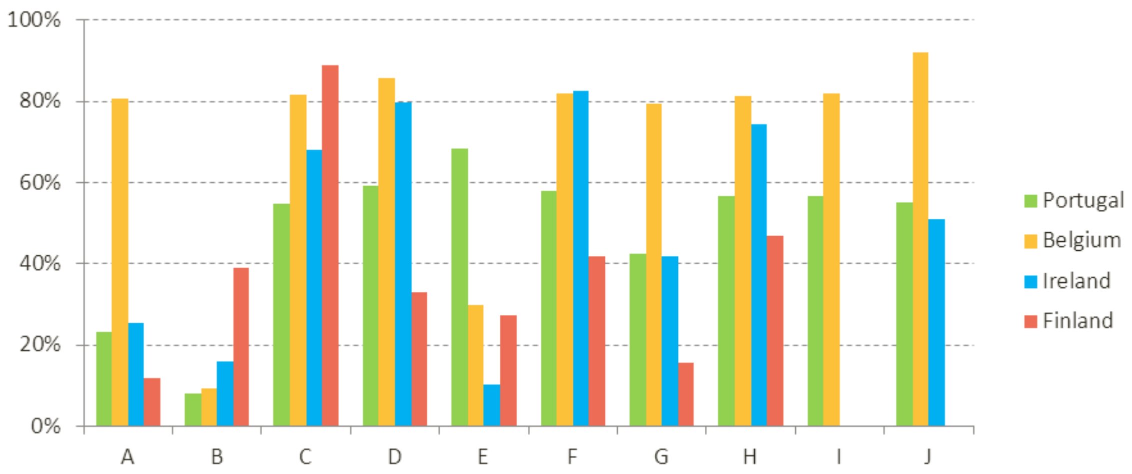


Figure 42 – Secondary students' perceptions of engineering.

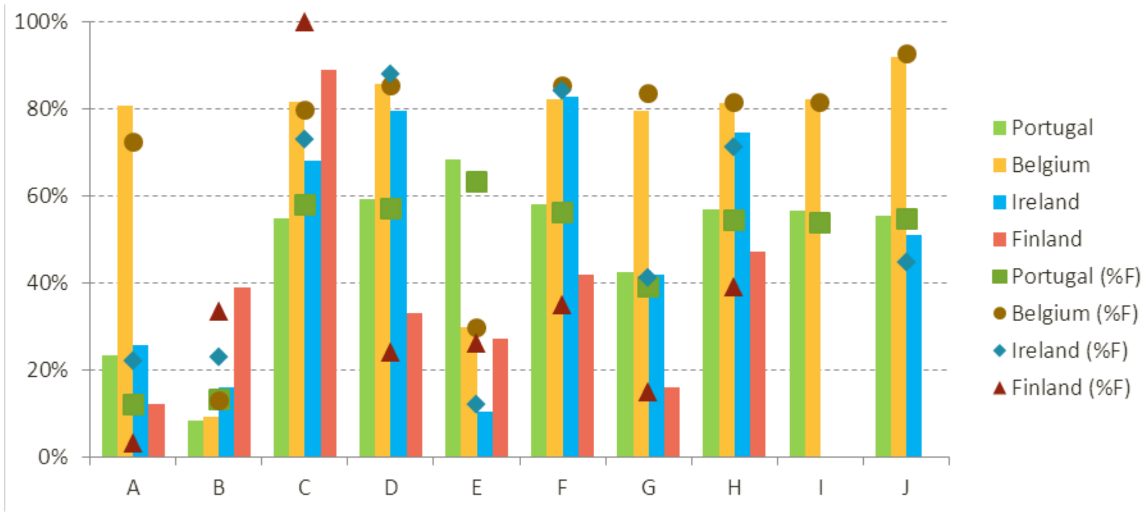


Figure 43 - Secondary students' perceptions of engineering, with females' perception.

A Students who wish to pursue an engineering programme (from students' total).

B Students whose parents have engineering background (from students who want to become an engineer).

C Students who decided to undertake an engineering programme after 10th grade (from students in S&T fields).

D Students who believe that engineers are important to the country development and whose area of studies is S&T (from students' total).

E Students who believe that engineers are important for the country development and whose parents have university background (from students' total).

F Students who consider that engineering duties requires a high level of difficulty and whose area of studies is S&T (from students' total).

G Students who believe that undertake an engineering programme requires a great deal of effort and whose area of studies is S&T (from students' total).

H Students who believe that engineers are well paid and whose area of studies is S&T (from students' total).

I Students who believe that engineers have a remarkable recognition and whose area of studies is S&T (from students' total).

J Students who think that engineers have easy access to the labour market (from students' total).

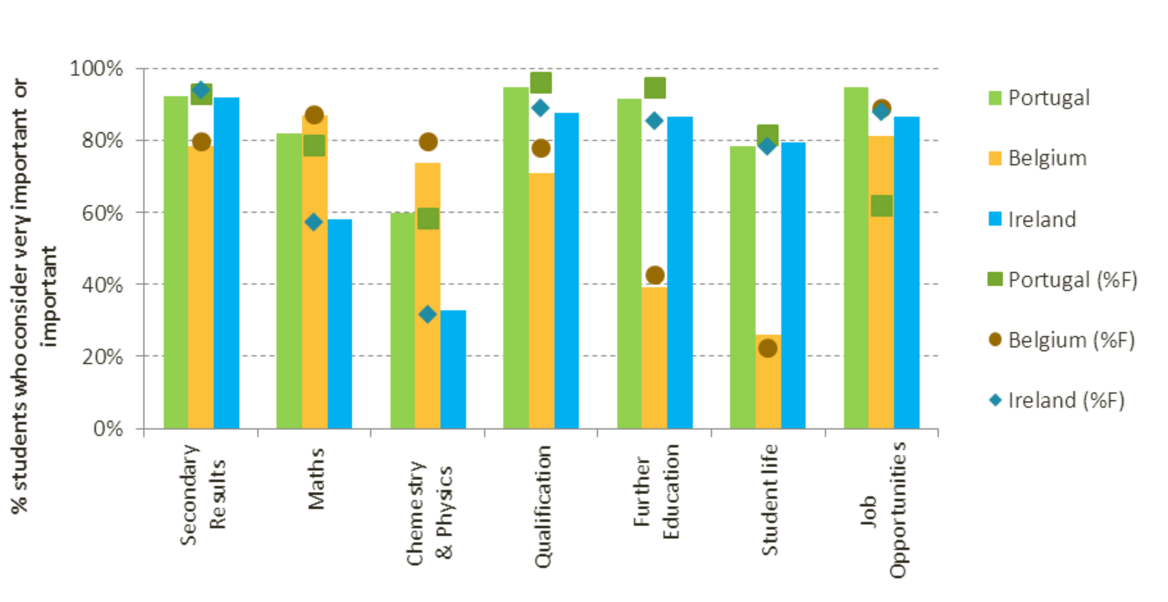


Figure 44 – Weight of factors on taking up a university programme.

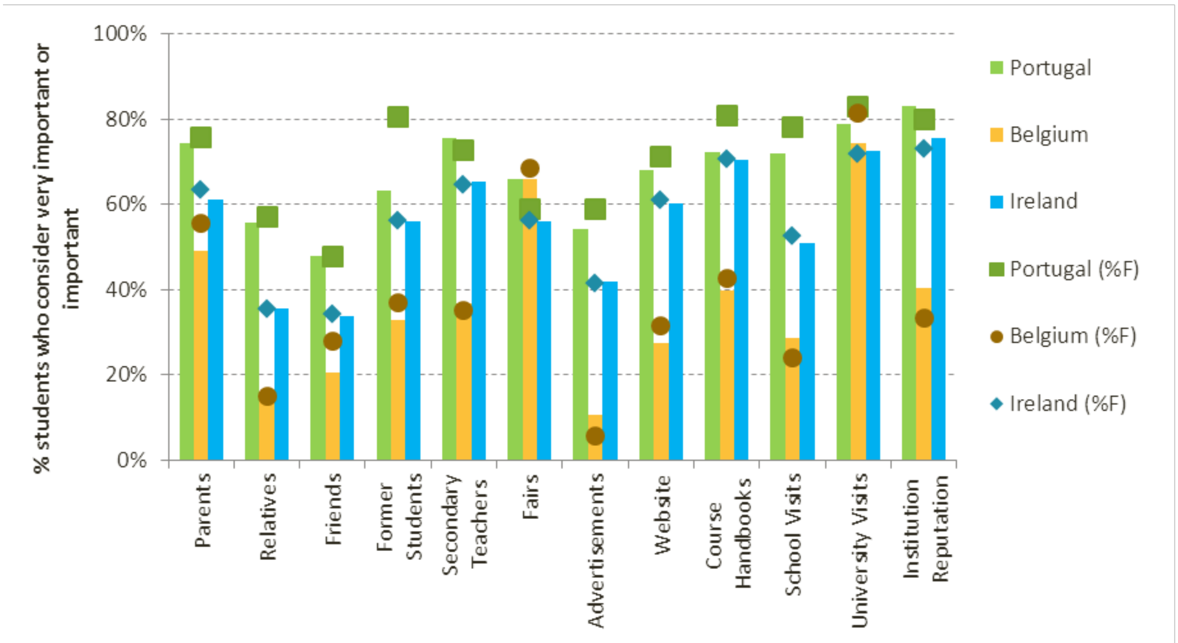


Figure 45 – Weight of factors on taking up a programme.

Entrant Results

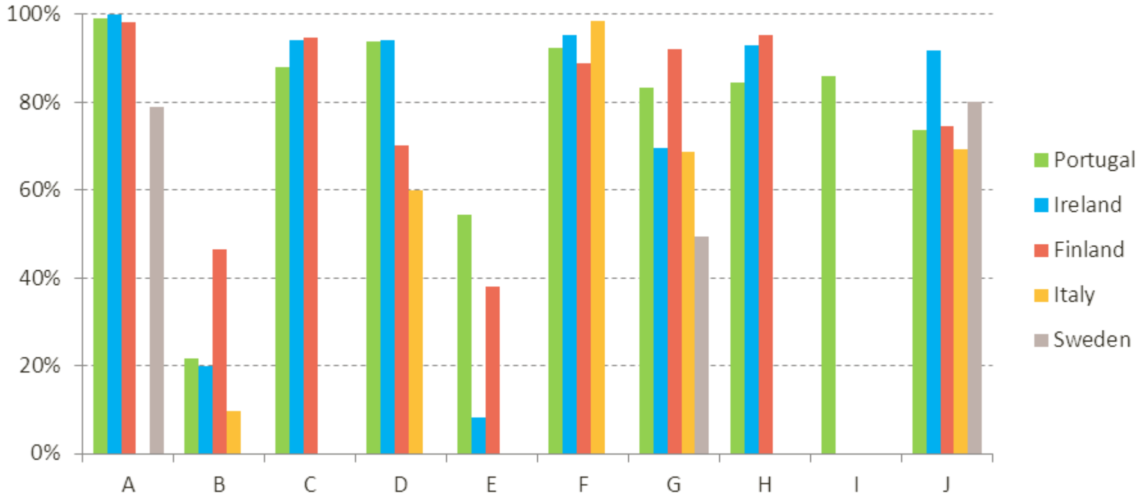
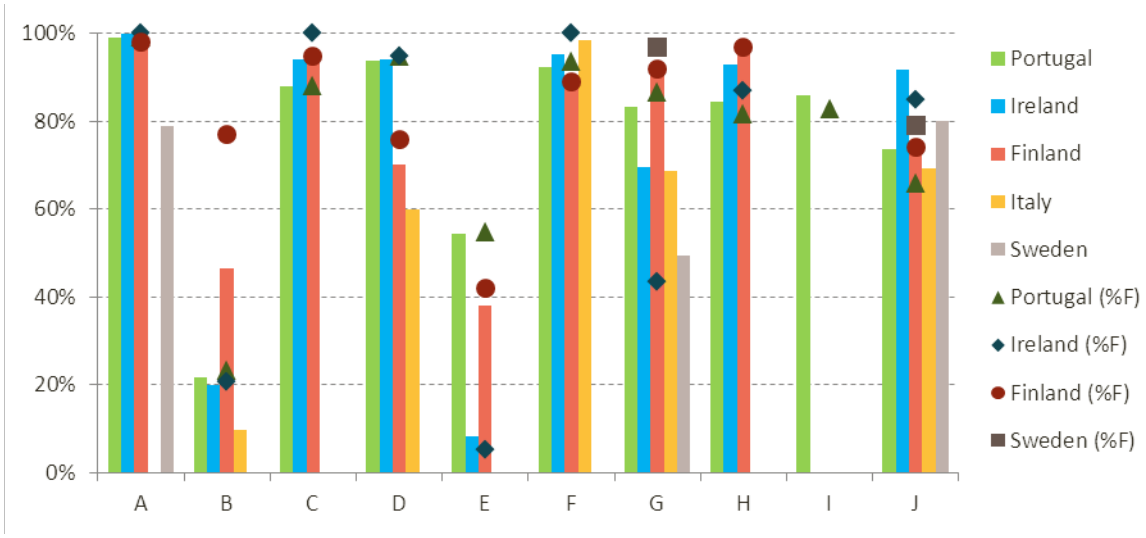


Figure 46 - Entrant students' perceptions of engineering.



A	Students who studied S&T at secondary school (from students' total).	**F**	Students who consider that engineering duties require a high level of difficulty and whose area of studies is S&T (from students' total).
B	Students whose parents have an engineering background (from students' total).	**G**	Students who believe that taking up an engineering programme requires a great deal of effort and whose area of studies is S&T (from students' total).
C	Students who decided to take up an engineering programme after the 10th grade (from students' total).	**H**	Students who believe that engineers are paid well and whose area of studies is S&T (from students' total).
D	Students who believe that engineers are important to the country's development (from students' total).	**I**	Students who believe that engineers have a remarkable recognition and whose area of studies is S&T (from students' total).
E	Students who believe that engineers are important for the country's development and whose parents have University background (from students' total).	**J**	Students who think that engineers have easy access to the labour market (from students' total).

Figure 47 - Entrant students' perceptions of engineering, with female students' perception.

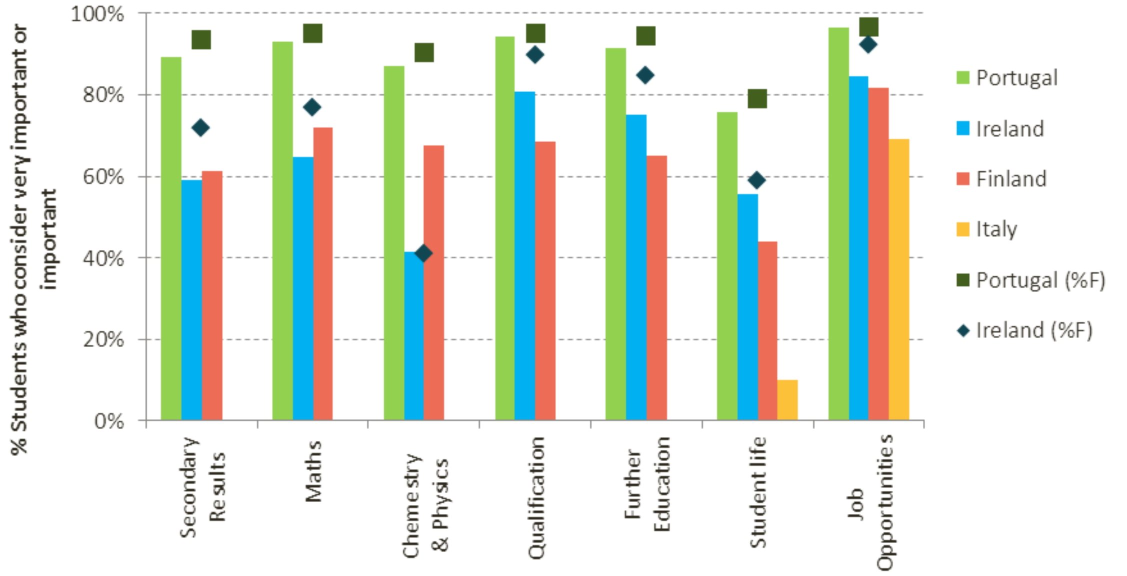


Figure 48 – Weight of factors on the decision to attend a university programme.

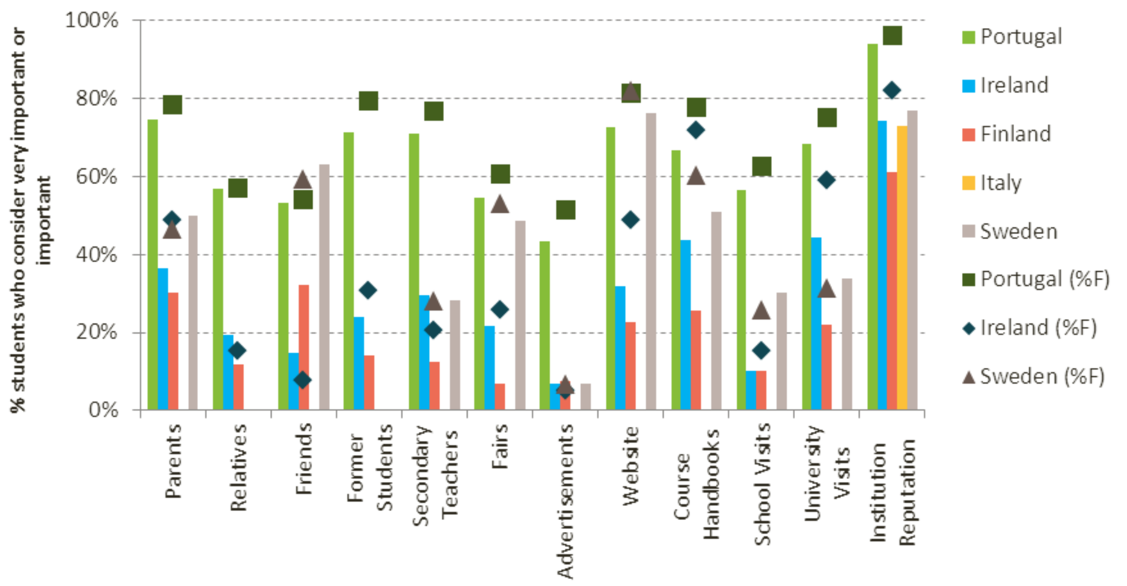


Figure 49 – Weight of factors on the decision of taking up an engineering programme.

Case studies on
Academic Integration, Tutoring and Mentoring

ATTRACT Retention field trial on Academic Integration, Tutoring and Mentoring generated altogether 21 case studies out of which the WP8 working group decided to publish the 12 most interesting ones. One of the case studies (scholarly attitude to the retention practice) acts as an introduction to what the working group considers as the methodology for universities to approach their actions in the field, while the rest are clustered under seven different themes:

1. Learning soft skills
2. Mathematics supports
3. E-learning
4. Student monitoring practices
5. Counselling and guidance
6. Future career opportunities
7. Activities in the curricula

The learning soft skills category assembles practices where students complement their core skills in engineering with extra classes, while the mathematics support covers all activities or programmes aiming to help students to achieve better results in mathematics especially during the first (two) year(s). The e-learning category assembles learning activities that occur online, and the student monitoring practices all formal and informal processes by which universities track and monitor their student progression and retention. The counselling and guidance covers all activities and programmes such as tutoring, mentoring and study psychologist services where students can get pedagogical, social and psychological support for their studies, while the future career opportunities refer to all activities aiming to link the engineering profession/practice and the labour market with the engineering education. Finally, the activities in the curricula assemble practices which are mandatory and part of the regular curricula for all students.

SCHOLARLY ATTITUDE TO THE RETENTION PRACTICE (UU, Sweden)

This case study provided by Uppsala University acts as an introduction to what the working group considers as the methodology for universities to approach their actions in the field.

Background

The target group for this activity are the programme directors and all teachers involved in the programmes. The goal is to change attitudes towards the model of teaching and learning, meaning that each so-called retention activity must be evaluated. In Uppsala the model has been developed in the Department of Physics Education Research by Staffan Andersson and his co-workers.

Description

"There are few, if any, social institutions in our culture that have not been the object of systematic inquiry by college and university faculty. Unfortunately, this same level of rigorous inquiry has not been brought to bear on many of the policies, programmes, and practices that shape the nature of American undergraduate education. Rather, I believe, there is a tendency to base policy decisions on what some have called "rational myths." That is, if a policy or programme is rational and sounds like it should be beneficial, we assume that it is—even if there is no corroborating evidence." [68] In Uppsala it has been discovered that some activities that have been going on for years actually have little or no influence on student retention. This conclusion has been made by measuring the number of active students in the programmes every year since 1995.

This is not the same thing as to state that the activities have no effect. On the contrary some of these projects have had a strong influence on the already well-motivated students by making them even more motivated. In some cases, however, these good activities might work in non-intended way for retention in the sense that the less-motivated students become even more of the track. Therefore, it is vital that the aim of each activity is obvious for the programme director, the programme board, students and all actors involved in the practice. The aim for each project must be presented in advance, as well as the results must be shown afterwards. The involvement of students in the development of activities is in itself of high importance.

Consequently, it has been suggested that each time a new activity is introduced at UU it shall be evaluated against the aim of the activity, the results shall be well presented, discussed and documented and afterwards when the project turns into a regular activity, it shall be further developed or reconsidered. Evaluation shall be systematic. Furthermore, as stated above some projects that have originally been launched as retention projects but have later shown little or no impact on student retention can also continue under another aim afterwards. Such projects are also important for education research.

Conclusions

The strengths of this type of approach include:

- Immediate impact and knowledge of how any activity affect student retention
- Increased knowledge of what really works
- Increased retention

[68] Pascarella, E.T. (2006) How College Affects Students: Ten Directions for Future Research, Journal of College Student Development, Volume 47, Number 5, September/October 2006, pp. 508–520.

1 Learning soft skills

An example of good practices in learning soft skills is the **To Exclude Exclusion Workshop** carried out by IST. In what follows, we describe the case study in more detail.

TO EXCLUDE EXCLUSION WORKSHOP (IST, Portugal)

Background

The To Exclude Exclusion Workshop is a tool developed in the 2006/2007 academic year and it is specially oriented for students with low academic outcomes. The workshop was created after the implementation of the Portuguese law related to HE funding – the law states that a student with persistently low academic outcomes should be excluded from the university for one year and consequently the university will not be funded for that student. The workshop is part of university's Tutoring Programme, among other workshops. Its main aim is to avoid or prevent high rates of dropout among students in academic stress. In order to reach that aim, the workshop focuses on improving students' time management skills, study methods, priority assessment and resilience.

Description

To Exclude Exclusion is a 4-session workshop, two hours each session, with compulsory attendance, each one devoted to a specific theme. Sessions are weekly. Workshops are directed at groups of 5–9 students. The participating students are students identified by the Low Academic Outcome System (LAOS) or students who have been directed to the Tutoring Programme by their tutors, colleagues or professors. All students with low academic outcomes are allowed to participate in the workshop regardless of their academic year.

- **Session 1** covers topics such as learning motivation, time management and study organisation skills, but also group dynamics that allow students to present themselves. The general idea is to help the students to get to know each other (in order to be more open while they present their difficulties in groups) and to get feedback on how they present themselves. A lot of attention is directed at hopelessness, loneliness, pessimism and shameful feelings since those attitudes seem to underlie inadequate school behaviour. Also supplemental reading is provided: http://tutorado.ist.utl.pt/files/Energy-Management.pdf.
- **Session 2** promotes the relationship between students and tutors and the relationship between students and their peers in order for them to understand the difference between being autonomous (you ask for help when you are not capable of meeting your aims by yourself) and being independent (you keep on trying to solve your problems by yourself even if you are not succeeding in a long time). Supplemental reading from session one is explored and the students are invited to work on their weekly study plans and regular schedules that allow free time, study time and leisure time. Individual plans and/or schedules are then discussed in groups. Supplemental reading is provided: "Possible characteristics of successful students", "Where should I study" and "Matrix of your aims".
- **Session 3** deals with issues such as learning how to define appropriate aims (S.M.A.R.T.) and ways of making the most out of one's study time (either in class or during individual study). The group starts by discussing what went wrong and what went as planned in the previous week. Doubts, decisions and adjustments are discussed and all group members profit from their peers' difficulties. In order for the group to identify what, in their attitudes/behaviours towards the school, are to be preserved, eliminated, reached in the near future or to be avoided, the "matrix" is first worked upon individually and then discussed in groups. Supplemental reading is provided: "The importance of social support", "The importance of teamwork", "The importance of being resilient" and "The importance of being optimistic''.
- **Session 4** includes closure and evaluation of the workshop, as well as defining the possible follow-up of students. Group members are invited to make a kind of mind map to summarise all the information they have gained during the sessions. General concepts are discussed within

the group. Supplemental reading is provided: "There is no luck, only hard work", "Differences between high achieving and low achieving students" and "Preparation for the exams".

Furthermore, students who do not have a tutor but who want one are directed to one, and students who request for an individual meeting with a member of the tutoring team will meet one as soon as possible. If necessary, students are also directed to the universities' counselling services or to the stress management group.

Conclusions

With six years of experience it can be concluded that the majority of participating students are not first-year students (79.6 %), reinforcing the idea that students in their first year are reluctant in recurring to institutional help despite of their poor academic performance. Students seem to ask for help only when they are in immediate risk of exclusion. Furthermore, 66.9 % of the participants consider the workshop motivating regarding their motivation towards their programme, 57.4 % consider the workshop motivating regarding the increase of their motivation to learn, and 54.7 % consider the workshop very important regarding the increase of their capacity to organise their study and time/energy management. Finally, 46.7 % of the participating students are never excluded and finish their instruction at IST. On the other hand, the impact of the workshop can only be partially measured, in addition to which there may have been also other factors contributing to this good end result.

In the future it should also be considered how to compel first-year students' participation, assure continuous monitoring and follow-up of the participating students to assure that the competences learned are correctly applied (in the sense that they assess and adapt the new strategies and study methods to their needs), and students are autonomously able to achieve their academic goals. Consequently, it can be said that one of the success factors of this workshop is the way how students are identified and approached to participate in the workshop – through the LAOS system (see chapter 3.5). Another success factor is the fact that the workshop is organised in fours weekly sessions, giving time for the students to absorb the information between sessions, allowing them to clarify any doubts or questions they may have. And last but not least is the possibility of following students after the workshop, which gives the students a more secure feeling knowing that they can rely on someone who already knows them if they need support.

2 Mathematics support

In what follows, two examples of good practices in mathematics support are given. The first one is the **Math Workshop** carried out by Aalto and the other one **The Mentor & Nestor Programme** at LiTH.

MATH WORKSHOP (Aalto, Finland)

Background

The teaching of mathematics, physics and probability calculus in the four schools of technology at Aalto University (former Helsinki University of Technology, TKK) has always been based on traditional lecturing and assignments. The exercise sessions and laboratory experiments are usually done in smaller groups in contrast to the "mass lectures", which even hundreds of students can attend at the same time. However, the students seldom consider the lectures very rewarding and the percentage of students actively attending them has remained quite small. The low participation percentage in lectures also reflects to the exercise sessions.

In 2007, a survey of the status of basic studies in the four schools of technology was made, which led up to several measures to improve the teaching of basic mathematics and physics at the university. One of the initiatives then launched was the math workshop. The purpose of the workshop is to provide guidance for homework and help for problem solving for students as part of the mathematics, physics and probability calculus service courses.

Description[69]

The teaching of mathematics and physics in the four schools of technology at Aalto University is the responsibility of the Degree Programme of Engineering Physics and Mathematics, namely the Department of Mathematics and Systems Analysis and the Department of Applied Physics. The mathematics and physics service courses supplied by other engineering programmes at the university constitute a substantial part of the work conducted in these two departments. The Department of Mathematics and System Analysis provides the teaching of mathematics for all engineering programmes, which corresponds to more than 10 % of the all-included total sum of credits delivered each year in the four schools of technology, while the Department of Applied Physics is responsible for the teaching of physics, which amounts to ca. 3 % of the total.

The math workshop is targeted at all students taking basic studies in mathematics, physics and/or probability calculus (usually grades 1–2) in the four schools of technology. Its aim is to provide guidance for homework and help for problem solving for students as part of the mathematics, physics and probability calculus service courses provided by the Degree Programme of Engineering Physics and Mathematics. The workshop is a separate facility, which is open for all students and there are senior students, assistants or lecturers present approx. 30 hours per week to guide the students and answer their questions. No pre-enrolment is required, and a student may come to the workshop as often as needed.

The workshop has a responsible teacher who answers for overall responsibility of the workshop, while the teaching assistants are responsible for the actual support and guidance during the opening hours of the workshop. The workshop is open about 30 hours per week during the academic year (excluding exam periods), and there are usually 2–3 teaching assistants specialised in mathematics, physics and/or probability calculus present at a time. In the 2011 autumn semester, the workshop was open during 12.9.– 21.10.2011 and 31.10.–9.12.2011 excluding the exam periods in October and December.

[69] References:
Levander, L. and Koivisto, R. (2011) TEE, Teaching and Education Evaluation 2010–2011. Final report DRAFT. Aalto University. Teaching and Education Evaluation 2010–2011. Project Report.
TEE Teaching Evaluation Exercise 2010–2011: Self-Evaluation of the Degree Programme of Engineering Physics and Mathematics.
TEE Teaching Evaluation Exercise 2010–2011: Self-Evaluation of the Basic Level Studies in Mathematics.
TEE Teaching Evaluation Exercise 2010–2011: Self-Evaluation of the Basic Level Studies in Physics.
Math workshop [website] [quoted 8.12.2011]: http://math.tkk.fi/fi/opinnot/perus/laskutupa/

Conclusions

The math workshop has had a positive impact not only on student progression in mathematics and physics but also on students' attitudes towards studying mathematics. As a result, the percentage of all first-year students who pass their mathematics courses according to the schedule has risen from 52.8 % to 70.7 % between 2005 and 2009. In physics, the amount of credits from physics courses has risen from 5.0 ECTS to 7.9 ECTS per student during that time.

The workshop has also been discovered to influence students' attitudes towards studying mathematics in a positive way, and in 2009 it received an honourable mention from the Student Union. In the Teaching and Education Evaluation 2010–2011, the math workshop was identified as a best practice in implementing teaching in the Degree Programme of Engineering Physics and Mathematics.

THE MENTOR AND NESTOR PROGRAMME (LiTH, Sweden)

Background

At LiTH the all engineering programmes start with either a course in calculus or chemistry. Both these courses are known to be "high risk" courses because they are difficult to pass. Several surveys have confirmed that early success in studies has a great impact on students' career. By creating opportunities to increase the possibility of succeeding from the beginning, both the students and the university gain advantages. With this background LiTH decided to implement a mentor activity in calculus and chemistry by using the Supplement Instruction (SI) method for all first-year students in their engineering programmes. At first the activity was organised by the counsellors at LiTH but now the Department of Mathematics is responsible for the Mentor Programme.

At the time when the counsellors were still responsible for the programme, also another dimension was added to the activity mainly focusing on students' attitudes towards studies and study habits. Although some courses are indeed difficult to pass, also other factors such as study habits and attitudes can influence one's study results. These habits and attitudes are often very hard to identify and even harder to change. The organisation of SI groups gave a unique possibility to reach the students for this purpose, namely to make them reflect on their own study behaviour and exchange their experiences in small groups.

Description

The main purpose of the Mentor Programme is:

- To improve students' academic performance
- To reduce dropout
- To provide students with role models
- To help the students to improve their attitude towards studying
- To support the students in effective use of time
- To create opportunities for new peer relationships and collaboration
- To learn study techniques while learning subject matter

By offering support in these difficult introductory courses and by using older and experienced students as mentors it is believed that both the academic performance and the feeling of belonging to the university can be improved. As a newcomer to the academia one can easily feel that he/she does not fit in and the gap between students' and teachers' perceptions is often great. When the first-year students have the possibility to meet older students, not only in social activities but also in study sessions, it is also easier for them to see themselves in the future and as a part of the university. The mentors also share their experiences at the university.

Every autumn almost 1,500 new students arrive at LiTH. At the start of the semester the students are divided into groups of 15 students. Older students are recruited to work as SI leaders. The SI leaders are selected based on their application and study results.

In some programmes it is relatively easy to find SI leaders, while in others it has proved to be more difficult. Mostly it seems to depend on the length of the programme – it is harder to find SI leaders in the bachelor's programmes. Before the mentoring activities begin all mentors participate in 1-day training on SI methodology. The training consists of a review of the SI method and the underlying theories, the SI conducted at the Institute of Technology as well as experiences from previous mentors.

The SI meetings are scheduled for two hours a week during the first semester (altogether 14 weeks). The SI leaders are paid for five hours a week, thus covering preparation, hours in the classroom and writing of the meeting reports.

A thorough evaluation of the SI Mentor Programme was done after the first year in full scale. The evaluation revealed that the students' overall opinion of the programme was very enthusiastic. The statement "As a whole I am very pleased with the SI sessions" received a value of 5.76 on a scale from 1–7 (1 stands for "not agreeing with the statement at all" and 7 stands for "totally agree with the statement"). The reports from the meetings with the first-year students also showed similar results. A vast majority of the students highly appreciated the SI meetings. However, the evaluation of the examination results for the SI programme did not give such a positive picture. Although the students were very pleased with the SI sessions, the examination results did not improve significantly. On the other hand, it is neither known what the result would have been like without the SI programme.

With the positive reception of the mentor programme plans were made to broaden the support to students who seemed to be at risk of failing their first mathematics exam. The Mentor Programme evaluation showed that students who gained the highest grades were the ones who without the Mentor Programme might have passed the course but with the help of it now got higher grades.

In order to reach and help the weaker students a so-called Nestor Programme was offered to those students who had received low results in a smaller exam at the beginning of the mathematics course. Instead of having students leading the groups of students, now older and experienced teachers, "Nestors", were appointed to lead the sessions which involved a lot of problem solving and active learning. The teachers who were appointed had a reputation of excellent pedagogical skills. As a result students' experiences of the Nestor Programme has been very positive from the beginning and the results in the first mathematics exam approved. Also dialogue with the students has shown that it can prevent early dropout.

The appreciation of the Nestor Programme among the students has led to further demand of such kind of support activities also in the following mathematics courses. The students who have attended the Nestor Programme can also attend the SI sessions and thus get quite a lot of support during the course. The Nestor Programme does not, however, involve as much peer learning as the SI sessions.

Conclusions

The support programmes have been highly appreciated by the students, and there are also indicators that in the long run both study results have improved and that the programmes seem to prevent unnecessary dropout. The programmes also contribute to the creation of long-term study groups.

3 E-learning

An example of good practices in e-learning is the **PoliTo Online** practice carried out by PoliTo, which is described in more detail below.

POLITO ONLINE (PoliTo, Italy)

Background

PoliTo offers several online tools:

- Video classes
- Online material
- Self-assessment tests

All students signed up for the online guidance services are able to access these tools. Thus, the target group is around 6,000 students each year, and over the years the number of students enrolled in the platform has also steadily increased (see figure 2). The material aims to help students to bridge any gap between their preparation and what is required for engineering education. Furthermore, the candidates can use the material to prepare for the admission tests.

Description

Video classes

Politecnico di Torino offers its students an online learning service. The classroom lectures are recorded, integrated with educational materials and distributed online through the portal (streaming). The service also provides the option of viewing the videos offline by downloading them. The online courses allow students to complete courses with greater flexibility in time by using advanced technological tools.

Online material

PoliTo offers an online vocational guidance and enrolment tool enabling the following actions:

- Obtaining all the information needed for university career choice
- Applying for the different admission test sessions
- Using the admission test simulator software
- Consulting multimedia educational material as a useful tool to prepare for the admission tests and to catch up in case of any achievement gaps emerged while using the admission test simulator software
- Enrolling online and paying tuition fees by using a credit card; using the intranet email service

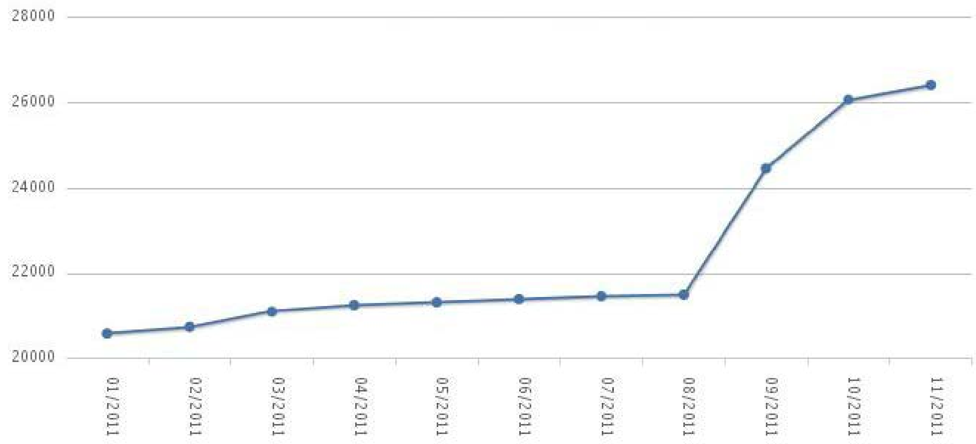


Figure 2. Students enrolled in the e-learning platform (2011).

E-math

The aim of this tool is to provide a reliable, common base of knowledge about standard mathematical subjects for students who want to enrol at a scientific faculty. To attract students who have had difficulties with mathematics, PoliTo has adopted a non-standard approach by using games such as Memory, Indiana Jones and Tetris. The use of an informal language and comics always supports the introduction of the most relevant or difficult topics, which otherwise would not necessarily find an enthusiastic welcome from the students. The e-math provides a self-evaluation instrument together with educational materials to bridge the gap between high school mathematics and the university entry requirements in mathematics. It does not intend to substitute the high school courses, but it can be used to support students to recognise required topics they have not studied at high school and to facilitate a deeper comprehension of known topics.

A specific section is devoted to a multiple choice test that the students may use to check their level. This test is very similar to the one that the students must afford in order to enrol at any kind of scientific faculty in Italy. It is important to note that questions are not trivial and cannot be solved just by looking at the screen: some easy computations with pen and paper are required. This part is very important for students who need to know what kind of questions are included in the test and specifically request the opportunity to practice.

The E-math section called Mateburg offers a different kind of self-evaluation tool. The aim is to give a more informal and attracting way to check one's mathematical level. The e-math also includes teaching material: the aim of this part is to give to the student some support material in a concise, essential and not exhaustive form. Every chapter is self-contained and, in order to fill the gaps highlighted by the self-evaluation process described in the previous section, the student is invited to review the more doubtful topics. One of the main points of the project is to use the language and the interactive potentiality of internet that should characterise any e-learning product. Regarding mathematics the web is full of false e-learning proposals: in fact, most of the time students can just find links to standard textbook pages and there is no possibility to interact, while e-math involves the student as an active subject of the project asking him to play, to answer questions, to choose the right solutions.

Physics review

From their own webpage the students can also access to a review of physics, divided into different educational paths. The base path is designed to introduce the language and tools of physics, as well as to present some basic concepts of mechanics by using concrete examples. The other paths provide more in-depth information about mechanics and electromagnetism. At the end of each trail it is possible to do a verification test.

Bridging course in mathematics

PoliTo realises a bridging course in mathematics dedicated to students who during the route guidance, and particularly in the admission tests, show deficiencies in mathematics. This course is also available online via:

- Tabs containing texts and exercises
- Slideshows
- Recorded video lectures

This material, specifically addressed to students in their final year at high school, is available online after the user has logged into the portal and/or participated in any of the tests for admission.

Self-assessment test

Finally, the students also have the opportunity, through interactive tests, to check the consistency of their preparation. The students can navigate freely between questions, read, reply, and change their answers. When the students finish their tests, the software provides an assessment of the preparation. The correction table shows how many questions are correct and how many are not. With a click, a window appears and explains and justifies the outcome of the application.

Conclusions

All course materials (classes, tutorials, workshops,...) are available on the students' personal webpage and they are easily accessible from any PC or other location that has an Internet connection at any time.

4 Student monitoring practices

In what follows, three examples of good practices in student monitoring are given. The first example is the **Low Academic Outcome System (LAOS)** used by IST. In the other example we describe how UU uses **questionnaires to explore students' experiences of the first year of study**, and finally in the third example, we present the system of **First-Year Coordinator** used by TCD.

LOW ACADEMIC OUTCOME SYSTEM, LAOS (IST, Portugal)

Background

The Low Academic Outcome System (LAOS) was created in 2010 after the take-off of the Portuguese law related to HE funding. Each year the HEIs have to deliver a list of students with persistently low academic outcomes and who cannot enrol at any HEI the next year. The law implies not only a loss of students, but also a loss of funding for the HEIs. Low academic outcomes are defined as:

- After 3 enrolments ≤ 60 ECTS
- After 4 enrolments ≤ 120 ECTS
- After 5 enrolments ≤ 180 ECTS

At IST the LAOS allows for the identification of students with persistently low academic outcomes before their third enrolment, and it is complemented by an intervention plan that aims to reverse the low academic outcomes and to prevent the students from being excluded.

Description

LAOS is based on an informatics tool, integrated in the school intranet system. The system allows for the identification of students at risk by following a set of sequential moments, each moment being defined by specific rules to be described.

The system had a 2-step implementation, in the first step the system identified all the students that were at risk of being excluded, in order to test the informatics integrity of the tool as well as to effectively identify the students at immediate risk of being excluded. However, the moments used in this test phase do not correspond to the current moments or to the general aim of LAOS itself. The system test identified 1069 students with low academic outcomes. As LAOS includes preventive measures (e.g. proposed actions directed at students at risk of being excluded, such as the To Exclude Exclusion Workshop, see chapter 3.2), 54 of the students identified during test phase enrolled in the workshop, however only 19 participated. From the total of identified students, three were excluded for one year; none of them had participated in the workshop previously.

The second step of the implementation of LAOS brought some changes to the 1st draft of the system. Initially the system was targeted all students in their second and third enrolment. However, considering that most of the students have low academic outcomes in their first year, and the dropout rate is higher in the first two years, the LAOS was changed to identify also the first-year students. From the initial three moments, the system was finally enlarged to include five moments as shown in figure 3.

The production of lists of students at risk strongly depends on the timely release of student assessments by their teachers – It is crucial that all the information is available by the time the system is activated; otherwise, students with low academic outcomes may be wrongly selected. Although the system is sub-sequential, the five moments occur only in two periods of time. Three of them occur simultaneously in March, and the remaining two occur simultaneously in July as shown table 1.

Table 1. The LAOS moments.

LAOS Moment	Semester	Enrolment Year	Month
1	1st	1st	March
2	2nd	1st	July
3	3rd	2nd	March
4	4th	2nd	July
5	5th	3rd	March

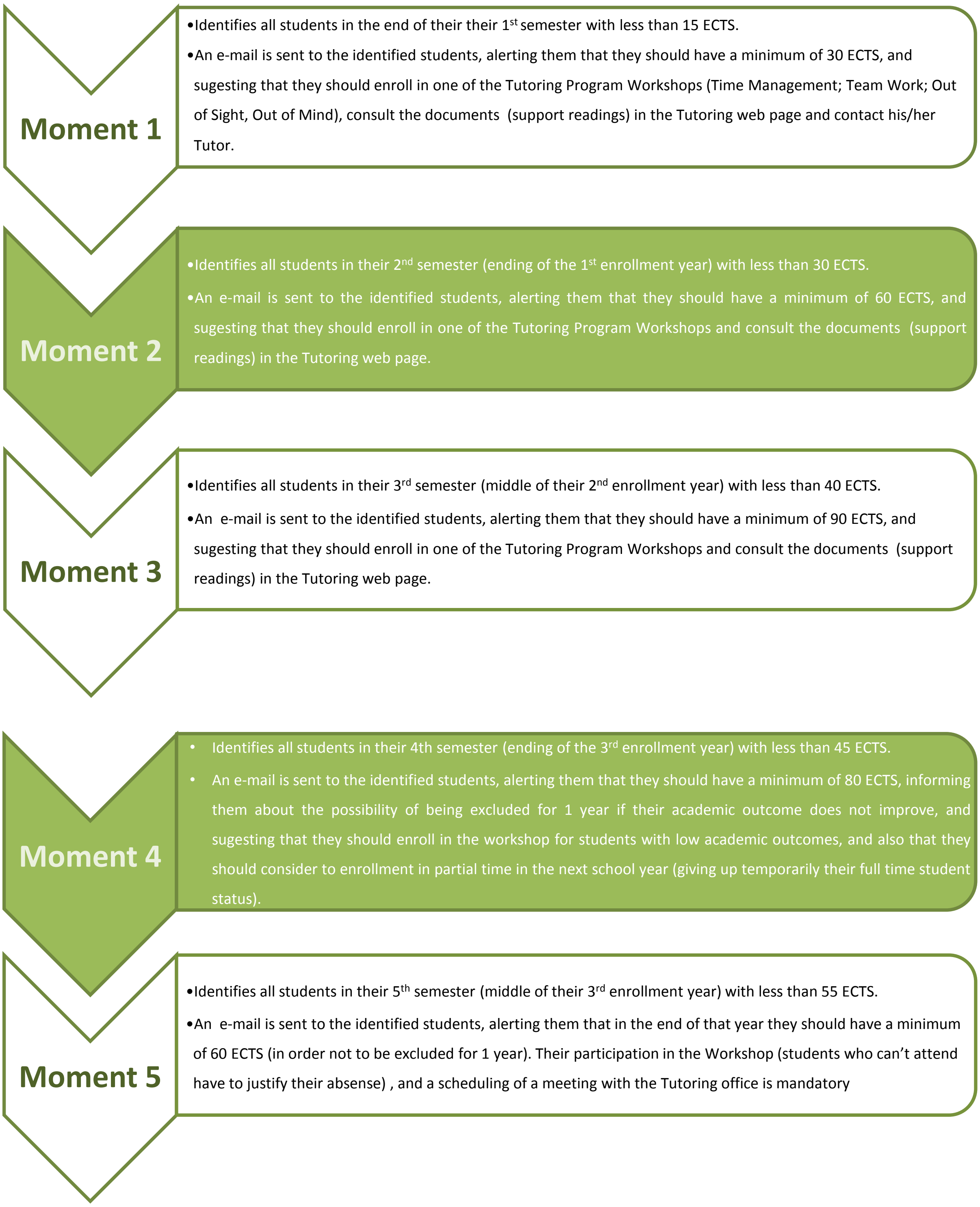


Figure 3. The five moments of LAOS.

The first application of the latest version of LAOS occurred in 2010, students in their second year enrolment being the target. 461 students were identified, 122 where considered as dropouts, leading to a total of 339 students contacted by e-mail. Only two of the students actually enrolled in the workshop. Another factor that was found to be crucial for the success of LAOS interventions directed at students – the timely offer of the workshops.

In 2011 the five moments where produced, reflecting an interesting trend: the first, third and fifth moments (winter semester) seemed to have more students with low academic outcomes than the second and fourth moments (summer semester). This fact could be explained by one or both of the following situations:

a. Students respond positively and actively to the warning, acknowledging the risks and being confronted with the goal they are supposed to achieve and this acts as a trigger to improve their attitudes towards school (even if they do not follow any of the suggestions included in LAOS).

b. Some students drop out between semesters, and this accounts for a decrease in the number of students identified (although this is true only for a small number of students).

In the same analysis the percentage of students with low academic outcomes seems to decrease from one enrolment year to another. This fact may elapse from one or both of the following situations:

a. The impact of the transition between secondary and higher education decreases from year to year and slowly students start to adapt to the new demands and improve their grades.

b. The decrease in the number of students identified reflects those students that drop out in the first two years.

Conclusions

Since its beginning the system seems to work better in the fourth and fifth moments, when students are closer to the possibility of being excluded – students in that situation tend to enrol and participate more in the workshops. The response rate to the e-mail is also higher among the third-year students, not only to schedule a meeting with one member of the staff and apply for help, but mainly to clarify questions regarding retention rules and part-time enrolment.

In the previous applications of the system, it has also been noticed that the system mainly has an "alert" or informative effect. However, in the first two semesters the student response is very low. First-year students tend to consider their low academic outcomes as part of a rite of passage into higher education, and therefore tend to minimise the effects of the first years on their academic path. The students seem to considerer that they are able to reverse the situation by themselves, considering external help as a demerit to their abilities.

It is also important to acknowledge that the five different moments refer to different groups (e.g. students that are in different stages of their academic career), so the message has to be specifically directed to each one of them in order to maximise their response. The students' response is one of the major setbacks of the system. Although part of the fifth moment is mandatory, the truth is that there is no way to control or to oblige the students to participate or to meet with their tutors/members of the Tutoring Programme. Therefore, it would be important if the schools could backup more making some of these actions really mandatory for the identified students.

Besides the first contact with the identified students (in the workshop and/or in the meeting) the Tutoring Programme is in the process of implementing a methodology to continuously follow the students, at least during the next one or two semesters after being identified by the LAOS. It is also important that all the information be updated and easily accessible in the school intranet system to allow timely interventions. Besides the total number of ECTS, the lists should include the student's name, degree, student number, status (student-worker; part-time student, etc.), e-mail, number of enrolments and date of the first enrolment information. In this sense a good relationship and mutual understanding with the Informatics Department is crucial.

QUESTIONNAIRES TO EXPLORE STUDENTS' EXPEPERIENCES OF THE FIRST YEAR OF STUDY (UU, Uppsala)

Background

Research on retention and academic success has clearly shown the connection between students' experiences of their education and their future results. This is especially critical during the first year of study (for example Pascarella and Terenzini 2005). Improved understanding on student experiences can give valuable information for educational development (Tinto 2010). A questionnaire was used at Uppsala University to explore student experiences of their first year of study and to investigate possible connections to their study satisfaction.

Description[70]

At UU the Course Experience Questionnaire (CEQ) (Ramsden 1991, 2003; Wilson et al. 1997) was adapted to the institutional context. This well-established questionnaire consists of a number of statements about students' educational experiences. The students are asked to rank their agreement on a five-grade Likert scale (Likert 1923) from "definitely disagree" to "definitely agree". The statements are chosen to reflect experiences favouring a deep approach to learning. The statements are grouped into different areas: good teaching, clear goals and standards, generic skills, appropriate assessment and appropriate workload. There was also a Swedish translation of the questionnaire (Warfvinge 2003, Borell 2008) that formed the basis for UU's design.

The questionnaire was administered through a web portal. All 998 students who started in the science or engineering programmes at Uppsala University in the autumn of 2010 were invited. A total of 279 students answered the questionnaire. Exploratory factor analysis (Kim and Mueller 1978) of responses showed that the responses to the questionnaire followed the expected categories, thus indicating that the adapted questionnaire was a valid instrument.

The majority of students (70 %) were satisfied, to large or full extent, with their first year of studies. 10 % were dissatisfied, to large or full extent. Answers regarding experiences were also collected. The distributions between positive, neutral and negative experiences in the different categories are shown in figure 4, which shows that assessment and generic skills are the component where first-year students reported the most positive experiences. Good teaching was the component with the smallest fraction of positive reported experiences.

The correlation between experiences and satisfaction was explored in a correlation analysis. Answers in different components were correlated to agreement on a general statement, "I am overall satisfied with my courses during the first year". There were two components where the majority of statement responses showed a significant correlation ($\rho \geq 0.32$, significance ≤ 0.01) to the answers regarding satisfaction. These were generic skills (4 of 7 statements) and good teaching (4 of 6 statements).

[70] References:

Borell, J. (2010). Course Experience Questionnaire och högskolepedagogik, Lund: LTH.
Likert, R. (1932). A Technique for the Measurement of Attitudes, Archives of Psychology 140:1–55.
Pascarella, E. T. & Terenzini, P. T. (2005). How college affects students (Vol. 2): A third decade of research, San Francisco: Jossey-Bass.
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Tinto, V. (2010). From theory to action: Exploring the institutional conditions for student retention. Higher Education: Handbook of Theory and Research, 25: 51–89.
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Wilson, K.L., Lizzio, A. & Ramsden, P. (1997): The development, validation and application of the Course Experience Questionnaire, Studies in Higher Education, 22(1), 33–53.

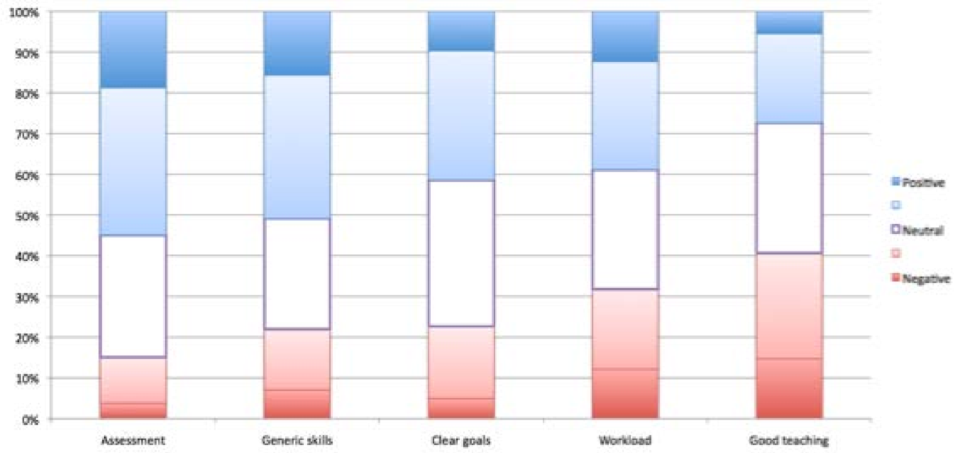

Figure 4. Response distribution within the different experience components.

Conclusions

The correlation between satisfaction and experiences of generic skills and good teaching can inform both current practice and future development. The influence of generic skills highlights the importance of practical skills training, also during the early stages of the education. The influence of good teaching highlights the fact that what teachers do in the learning situations is of great importance. There is also room for improvement in this area, as this was the only component where students reported more negative than positive experiences. It would also be interesting to explore in more detail what students really find as positive and negative experiences.

Furthermore, it is worth noting that the students were more satisfied with their first year in general than with any of the explored components. A possible explanation for this could be that there are other components in the first-year experience not explored by this instrument, which also have a major effect on student satisfaction. A further exploration of this could be interesting.

The study shows that a research connection for on-going questionnaire activities can give further information and inform practice. The results have not only affected the on-going questionnaire development at UU, but they have also been reported on different levels and are currently informing changes in educational practice.

FIRST-YEAR COORDINATOR (TCD, Ireland)

Background

Retention studies carried out at Trinity College and nationally have identified first year as a critical point for student withdrawals from university (TCD 2009, HEA 2010). One of the reasons frequently cited as contributing to this is a lack of student integration into the college community, both in academic and social terms (Tinto 1987, 1993). A study of withdrawal in Trinity College sought recommendations from students as to what they thought could be done to target retention. The students consulted suggested that the university should "provide more individualised support and advice" (Baird 2002). In particular, they commented that a more communicative and supportive department that takes "a personal interest in the students" would be helpful.

As a result of this, many programmes have designated one member of academic staff who acts as "first-year coordinator". This ensures that there is one person within the student's own department who is assigned to take an active interest in their progress, and who communicates any important matters to them.

Description[71]

The role of the first-year coordinator is to monitor the progress of first-year students, as well as to act as a single point of contact for them. This practice arises out of a 2009 report on retention carried out in the university, which recommended that each programme should have a "year head" responsible for first-year students.

On any given programmes, individual modules may be taught by lecturing staff from a wide range of disciplines, not solely from the student's own department. As a result, they may have little contact with the students outside of the lecture theatre, and may have different practices and ways of doing things, which can be unfamiliar to new students. Having a first-year coordinator ensures that there is one individual to whom incoming students can address their questions if they wish, without the need to be tracking down lecturers across multiple departments.

While the role is unrelated to that of the tutor (or staff-student mentor), there are certain parallels. Both are figures to whom students may turn if they need advice or information; however the tutor is the one who is responsible for formal interactions between the student and the university such as transfer between programmes, appealing grades, requests for financial aid, etc. Additionally, any serious personal matters which a student experiences would be referred to his/her tutor, even if a student chooses to raise them first with the first-year coordinator. Conversely, students may prefer to address issues that relate directly to their programme and/or its content to the first-year coordinator. It should be noted, however, that much of this is up to the individual student and in most instances he/she can choose who to turn to initially, and both the coordinators and tutors will do their best to accommodate any queries or requests they are presented with.

The specific activities performed by the first-year coordinator can vary from programme to programme, and are determined by each department or course director to best suit their particular needs, rather than being embedded in a broader formal structure. In some programmes, the coordinator will hold regular meetings with students (typically one per term) to check in with them, update them of any news, and address any questions or concerns that either students or faculty members may have. Students would be encouraged to attend but these would typically not be mandatory. The meetings allow for any potential difficulties students may be experiencing to be flagged and dealt with in a timely fashion. In this way it can function as an early warning system. Students may also request a meeting with their Year Head at any point.

In some departments, the role of the year head includes also assessing and monitoring student satisfaction with teaching and learning. In this case, he/she would conduct an in-class review at the end of each term.

[71] References:
Baird (2002). An Inquiry into Withdrawal from College: A study conducted at Trinity College Dublin.
HEA (2010). A Study of Progression in Irish Higher Education. Dublin: Higher Education Authority.
TCD (2009). Report on Retention. Dublin: Trinity College Dublin.
Tinto, V. (1987). Leaving college: Rethinking the causes and cures of student attrition. London: University of Chicago Press.
Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition (2nd ed.). London: University of Chicago Press.

Conclusions

This is a relatively straightforward practice to implement across university programmes, since it draws on existing staff and expertise, and in many cases merely formalises existing practices. While the majority of faculty are happy to make themselves available to students to address questions or concerns, new students can be hesitant about approaching them. The presence of a designated individual whose role it is to be a contact point for these incoming students helps to overcome this potential difficulty.

5 Counselling & guidance

In what follows, two examples of good practices in counselling and guidance are given: the **Study Psychologist Services** of Aalto and the **Tutorial Service** of TCD.

STUDY PSYCHOLOGIST SERVICES (Aalto, Finland)

Background

The study psychologist services are fairly new in Finland; about ten years old. Currently there are about 35 study psychologists in Finland, but the number is constantly increasing. Two important background factors that have had an impact on the increasing number of psychologists were the school shootings in Finland in 2007 and 2008. These tragic events raised the question, whether educational institutions could benefit from psychological knowledge. Moreover, in the beginning of 2000 a number of projects were initiated to improve the wellbeing of university students.

There are currently four study psychologists at Aalto University. In the schools of technology (former Helsinki University of Technology, TKK), the service was first introduced in 2006. The Student Union played an active role in the process of getting study psychologists to the university. The study psychologists mainly work with students, but they also train teachers and develop the learning experience throughout the university. Study psychologists are also educational developers. They aim to make an impact on the students' wellbeing and study processes. All the information the study psychologists gather from the students benefit also the development projects they are involved in.

Description

At Aalto University, the study psychologists work as a part of the Educational Development Team. The team serves and develops teaching and studying at the university by:

- Offering pedagogical training and development programmes, courses and opportunities for teachers
- Offering support for students in their study efforts
- Offering support for degree programmes and programme leaders to help their development efforts
- Offering local support for programmes and teaching personnel in their educational development efforts
- Participating and starting educational development projects

Psychological services for the students include individual counselling, workshops for groups, lessons and material on learning skills. Mental health care is provided by FSHS – Finnish Student Health Service, which provides health care services for all university students in Finland. So the main purpose of the study psychologists is not mental health care. However, the line between can sometimes be thin. Typical reasons for the students to seek counselling are improvement in study skills (e.g. reading, writing, note taking), time management skills, motivation, goal setting and coping with stress. Usually individual counselling consists of 1–5 appointments. Students book the appointments via e-mail.

The workshop topics include time management, motivation, coping with stress and study skills. There are usually 5–10 students in a group and a total of four or five meetings. Methods are discussions and exercises (e.g. how to set realistic goals or how to make a schedule). The study psychologists also lecture on study skills as part of the introductory/orientation courses at the university. At later stages, the lessons could also deal with e.g. thesis writing. Furthermore, the study psychologists produce information on study skills and well-being on the Aalto students' intranet. They also train both teacher tutors and student tutors.

Both in individual counselling and at group level, the study psychologists meet about 200 students each year. Indirectly they affect more widely e.g. through produced material and in the introductory/orientation courses where they meet almost all new students. Also the teachers have the possibility to consult the study psychologists, if they encounter difficulties with students. The study psychologist services complement the other student services at Aalto University as shown in figure 5.

Why is it good to have psychologists at the university parallel to other services? The study psychologists can provide a more holistic view on counselling, taking into account students' personal characteristics, individual features and life situations. They also have the required knowledge to work with thoughts and moods, through which they can try to influence behaviours and study processes. Context knowledge is also a strength and important in counselling and it is possible to achieve only if psychologists are a part of the organisation.

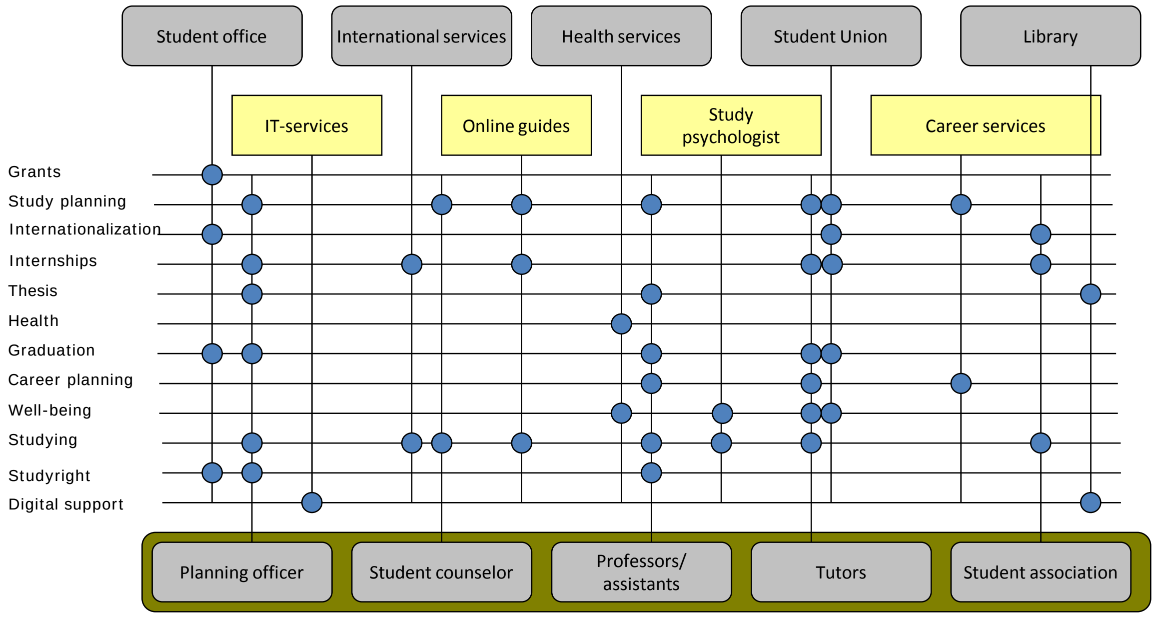

Figure 5. Student service chart.

Conclusions

Study psychologists generate services that society does not provide in any other way. This kind of work also offers the possibility to create preventive healthcare. Even a short intervention can make a big difference for the study effort. On the other hand, four study psychologists cannot reach all students but only a small percentage of them. In the future, more attention should be paid to the systematic evaluation of the study psychologist services. The study psychologists have already collected feedback, but the process needs to be systemised so that the whole university can make more use of the information gained. The study psychologists have the kind of information that nobody else has, but which could benefit the whole university.

TUTORIAL SERVICE (TCD, Ireland)

Background

The Tutorial Service[72] which operates in Trinity College is a college-wide programme that covers all undergraduate students in the university, across all programmes and faculties, for each year that they are enrolled at the university. In total, this represents approximately 11,400 students. Each undergraduate student is assigned to one of the approximately 125 tutors on entering college.

The main actors are the individual tutors, who are members of the academic staff, the senior tutor[73], who co-ordinates the scheme, and the students themselves. The purpose of the scheme is to provide each student with an individual who they can go to for information, advice and guidance on matters both personal and academic, and who will act as an advocate on their behalf if necessary.

Tutors hold individual meetings with the incoming first-year students in their care (approximately 20 students) during first year orientation week. New students receive a letter during the month before they commence university which informs them who their tutor will be. The senior tutor's office organises the initial meetings between the tutor and each of their incoming tutees. The timing of this initial meeting is felt to be critical in order to facilitate successful integration into the university. Thereafter tutors are advised to contact their tutees at least once per term, and to be available for additional meetings if the student requests them.

Description[74]

Overview

The function of the Tutorial Service is to act as a support service to students at the university. Tutors look after the general welfare and development of the students for whom they are responsible. Their role is to provide personal and academic support, and to promote the development and welfare of the students allocated to them. Their main function is to advise, listen to concerns, help tutees deal with concerns as far as possible and refer more serious issues to the appropriate student service or outside agency. The service is confidential.

Tutors are members of the academic staff, but their role as tutors is entirely separate to their normal academic duties. Instead, it is an additional role which they volunteer for, and must carry out over and above their usual duties. Tutors are not compensated either by means of payment or reduced teaching hours, although having served as a tutor may be considered favourably when it comes to applying for promotion.

Mandatory training is provided for new tutors, who must attend each session prior to their appointment being confirmed. Refresher training is provided for those who have occupied the role for some time, typically after three years. Repeat training sessions are offered so as to accommodate the busy schedules of the academics.

Typically a single tutor will be responsible for approximately 84 students, spread across each of the four undergraduate years. Tutors are appointed initially for a five-year period, after which their position is reviewed and they may be reappointed if they wish to continue and if their evaluation is successful.

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72 Despite the "tutor" element of the name, the service provided is one of mentoring or guidance, and not of learning support, which is covered elsewhere within the university. However this is the name by which service is referred to in Trinity College.

73 The senior tutor is a member of the academic teaching staff who has previously served as a tutor. He/she is elected to the role by the current tutors for a period of three years, renewable once. The senior tutor is responsible for administering all aspects of the Tutorial Service, encompassing student appeals, withdrawal/transfer requests, recruitment and training of new tutors, etc.

74 References:
Report of the Tutorial Service Review 8-9 November 2007 (2007). Available online at: http://www.tcd.ie/vpcao/quality/assets/pdf/Reviewers%27%20report%20for%20Tutorial%20Service.pdf
Provost's Report to Council on the Review of the Tutorial Service (2008). Available online at: http://www.tcd.ie/vpcao/quality/assets/pdf/Provost%27s%20report%20to%20Council%20for%20Tutorial%20Service.pdf
Trinity Tutorial Service website: http://www.tcd.ie/Senior_Tutor/

Role of the tutor

The programme functions on a number of levels. The first is basic information provision and advice. Upon first arriving at the university, a new student meets with his/her tutor for an introductory session. The tutor can provide information and guidance on all aspects of college life – academic and otherwise. During this initial period, one of the main functions of the tutor is to advise and facilitate new students who may wish to transfer from their initial programme to another. In this, the tutor can explain the available options to the student, and, in the case that a transfer is requested, the tutor is responsible for making the application on behalf of the student. In relation to retention, tutors also operate a key role as student withdrawals and requests to go off-books are facilitated through the tutor.

Other examples of the advice or pastoral element to the role include arranging financial assistance for students in particular cases (this does not cover tuition fees, but rather aims to assist students who find themselves in financial difficulty or experiencing unexpected hardship), or arranging support for personal matters.

The other key role of the tutor is to act as an advocate for students in relation to the institution. This arises particularly in the cases of academic appeals and disciplinary matters. In any issues where a college decision may disadvantage an individual student, the presence of a tutor who will advocate for the student ensures that the university is required to justify its decision. Additionally, this aspect to the role can help to create trust in the tutor-student relationship, as the student knows that the tutor will act on his/her behalf.

Relationship to other services

In terms of integration with other support services within the university (see figure 6), tutors can act as de facto "gateways" to other student services. While the other student services available within the university are open to students without the involvement of a tutor, students may be hesitant to avail of them. Where they feel that a student would benefit from it, a tutor can recommend that a student seek out other services as appropriate. Tutors can also refer individual students directly to the Student Counselling Service if the student is experiencing difficulties.

With regard to structural integration of the programme itself, the service is seen as complementary to the wider student support services, while remaining somewhat separate from them. This arises out of the fact that the tutorial service is headed up by the senior tutor, who is an academic, and this sets it apart from the other student services within the university. However, the fact that the senior tutor is an academic and also a former tutor is recognised as a strength of the programme.

Tutor-student relationship

In general, the tutor-student relationship should be largely student-led. The tutor is responsible for making initial contact to establish the relationship, and for checking in with the student at certain key points (it is recommended that this take place at the end of each term, and is done via email). However, additional contact and meetings should be led by the student in most circumstances. By and large it is up to the student to go to his/her tutor if they require assistance of either a personal or academic nature. Students can contact their tutors via email, phone, or in person by dropping in to their office.

One exception to this, however, is if the student is experiencing significant academic difficulties, and receives a mark of "non-satisfactory". This mark indicates that the student has failed to meet the course requirements either in terms of attendance or of submission of coursework. In such cases the tutor and student both receive a letter from the Senior Tutor's office notifying them. The tutor is instructed to contact must contact the student and can offer support as needed. If there were any mitigating circumstances, such as illness or personal difficulties, the student can report these to his/her tutor and the "non-satisfactory" mark may be cancelled.

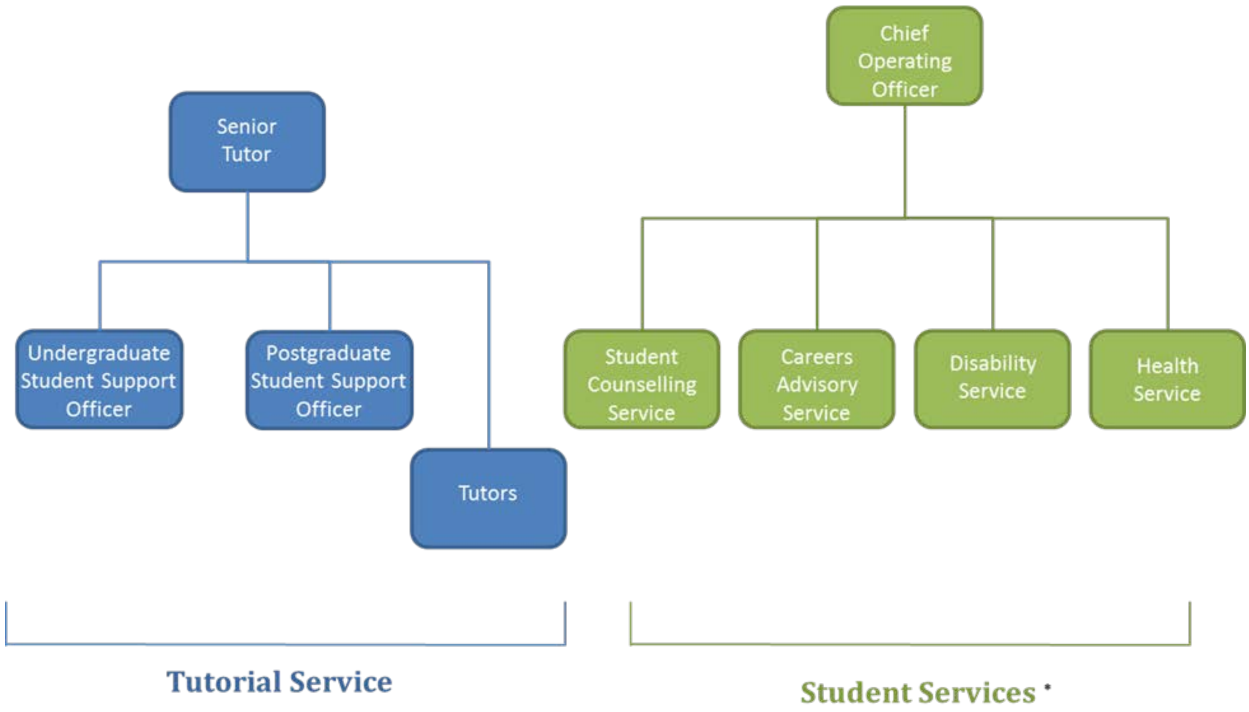

Figure 6. Organisational structure of services (the full list of student services is not shown here for clarity).

Since the personal relationship between the tutor and student is at the heart of this service, the experience can naturally vary significantly across individual cases depending on the personal dynamics. However, if a student has any difficulties with his/her tutor, or feels there is any incompatibility in terms of personality, he/she can be easily transferred to a new tutor. During an external quality review of the service in 2007, this facility was remarked on by students who commented that the instances of problems were low, and that the Senior Tutor's office was always available to assist where needed.

Furthermore, overall feedback from the external reviewers was very favourable. They reported that the service provided an effective means of support to the students, and that the students themselves perceived it as "very positive". The reviewers commented that the service "provides an exemplary standard of support for students and is held by staff to be an integral part of Trinity's student experience".

Conclusions

The existence of the Tutorial Service is generally perceived within the university as something that is integral to the Trinity College experience. In part this may be due to the fact that it is unlike anything offered in neighbouring universities. In fact, the external reviewers who examined the service declared that it was unique in Ireland and the UK.

The relationship between tutor and student is of fundamental importance to the service. While in many ways this is the great strength of the programme, it also means the possibility for variation of experience is significant, and that problems may arise in individual cases. Therefore, it is hugely important that there be a straightforward facility for students to transfer to a new tutor should they wish to, as has been discussed above. It is also important that the body responsible for overseeing the programme, the senior tutor's office, should be always available to assist should any issues arise in the relationship, and students have reported that this is the case.

6 Future career opportunities

An example of good practices in demonstrating future career opportunities to the students is the **Presentation of the programme and alumni experiences** practice carried out by LiTH. In what follows, we describe the case study more in detail.

PRESENTATION OF THE PROGRAMME AND ALUMNI EXPERIENCES (LiTH, Sweden)

Background

The students in LiTH's engineering programmes are often quite uncertain about where the programmes will lead to professionally and also experience difficulties in seeing the connection between various courses within the programme. They may also experience difficulties in motivating themselves in the mathematical and theoretical courses, which are placed at the beginning of the programme, because they do not understand the benefits of these courses.

Engineers can do almost anything professionally and this is both an advantage and a disadvantage for students' motivation. It is easier to understand the career possibilities and how a typical working day looks like for a doctor for instance. To help the students to get a better picture of the programmes and their career opportunities in relation to their education, the student counsellors for each programme invite the first-year students to two seminars.

Description

At the beginning of the first semester all first-year engineering students are invited to a seminar with the main purpose to present the whole five-year programme and how the different courses are built and connected with one another. The seminar is organised and coordinated by the student counsellor responsible for the study programme but the presentations are held by teachers. The outline of the programme is presented by the chairman of the programme board. An important task for the different presenters is to show the students the main contents of the programme and that the courses are not isolated islands but are necessary for the development of becoming a skilled and attractive engineer. Usually a more historic view of the programme is also presented; why the programme has been created and on which demands in the industry is the programme based. This is an excellent opportunity for teachers to inspire the students and to make them feel more certain about their choice of programme. Another element in the seminar are the presentations held by older students. The students describe their experiences of the programme so far and can give a more vivid and concrete picture of the contents of different courses. They can also share advice on how to organise one's studies and can assure the first-year students that they as well have felt confused in the beginning.

At a later stage the alumni are engaged to present their professional careers. The seminar is organised by the student counsellor and the invited alumni are supposed to represent different career paths and fields of engineering. Usually the invited speakers start by giving an overview and by sharing their experiences of the time at university, and continue by describing what they do on a daily basis for work. What does a product developer for instance do when he/she starts the day at the office? Does he/she travel a lot, interact with other professionals, do advanced calculations, and so on?

Conclusions

The seminars help first-year students to get a better picture of their chosen programme, improve their motivation and provide them with real-life role models. The seminars are highly appreciated by the students, and especially the alumni presentations are rather popular also among the older students.

7 Activities in the curricula

As an example of good practices in various curricular activities we present a case study from KTH, namely the **Programme integrating courses with a mentor system**.

PROGRAMME INTEGRATING COURSES WITH A MENTOR SYSTEM (KTH, Sweden)

Background

In the KTH Development Plan, retention is one of the several areas in focus. One of the goals is to implement an academic introduction into all educational programmes at first level and another goal is to develop a mentor system for new students. The programme integrating courses described here correspond to the goals of an academic introduction and a mentor system. In several educational programmes at KTH, there are on-going initiatives to implement similar courses.

Description

The two programme integrating courses described below are compulsory courses in two separate five-year engineering programmes (300 ECTS). The goal of these courses is to give the students insight into the structure of the programme and to help them to see connections between courses and subject areas. Another goal is to give the students options for reflection and documentation of the learning processes. They also aim to give an overview of the education and thereby give an improved understanding of the importance of every single course. This includes an introduction of how course plans, learning outcomes, grading criteria and examination work at KTH, how the university and the programme are organised, who is who at KTH, and where to go if one needs support. Yet another goal is to improve the students' study skills and to make them reflect on their own studies and courses, and to give the students a good contact with their teachers, the university staff and other students in first, second and third grade.

At KTH, each academic year has four study periods. During each study period the programme integrating courses focus on a specific topic (see figure 7). Both programme integrating courses start directly when the first semester starts and run over first, second and third grade. Therefore, the course runs over three years, with different topics each study period. Each study period includes a group session; consequently there are three to four group sessions per student per year. The groups contain six to ten students from first, second and third grade mixed in each group. One programme has 250 students divided into 36 groups and the other 390 students divided into 39 groups.

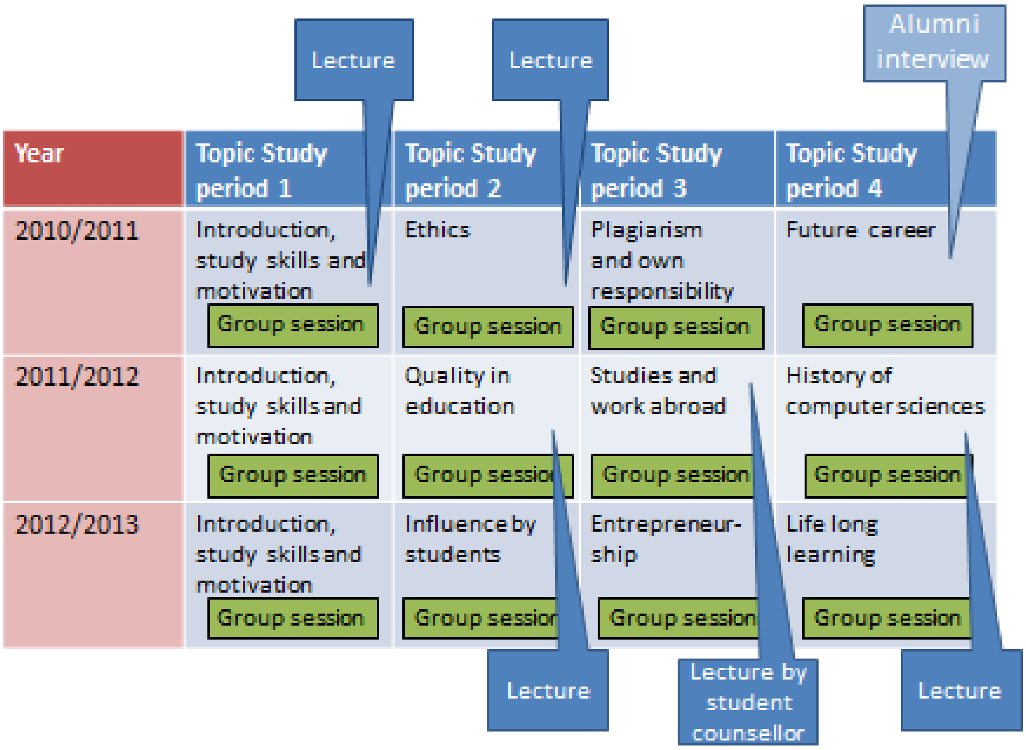

Figure 7. Topics and activities in the programme integrating course during each study period over the years of 2010/2011, 2011/2012 and 2012/2013.

The group sessions are led by teachers, so-called mentors or facilitators or discussion leaders for the group sessions. Each teacher/mentor is responsible for 3–4 groups of students. To prepare all teachers/mentors involved, an introduction regarding goals of the programme integrating course and how to work with the mentoring groups is offered. The different topics in the courses and the additional reflective questions also guide the mentors on what to talk about during the group sessions. After the group sessions, or once per semester, the teachers have a meeting. Then they reflect, discuss and give each other advice on how to deal with different kinds of situations, such as how to make a group of timid and silent students talk more. One of the programmes has 10 teachers engaged as mentors, the other has 13 teachers. All of them are teachers in specific programmes (there are no mentors from other departments of the university involved). Thus far, finding teachers/mentors has not been a problem.

To prepare for the group sessions, students write a reflection upon a specific topic by answering a set of questions. In one of the courses, these questions are set in advance by the course coordinator/examiner. In the other course, the teacher/mentor and the students decide together on how to enter deeply into the topic. Examples of questions to reflect upon in the topic “Introduction, study skills and motivation” are “Why did you choose this programme?”, “Reflect upon one of your courses, how does it match the learning outcomes of the programme?” and “How much time did you spend on studying last week and which subject did you focus on?”. Each study period the students also have to reflect upon the questions “What did you learn during the course?” and “How do you plan to study from now on?” to help them to focus on their own learning and to plan their studies. Besides writing their own reflections, the students have to read the other students’ reflective documents and be ready to discuss their own as well as the others’ thoughts. Students are encouraged to be active and these discussions, where students share experiences and thoughts with each other, help them to see the topics from different viewpoints. The group sessions also give students an opportunity to be seen as individuals by their teachers/mentors. Afterwards, the mentors give feedback to students on their written reflections.

In addition to some of the group sessions, the teachers give lectures in for example “Introduction, study skills and motivation” and “Ethics”. Also the student counsellors have a couple of lectures. When it is time for the students to choose their master's programme, teachers/mentors are also available for personal guidance and student counsellors are available for individual counselling.

Both courses are mandatory. All activities, the group sessions and the reflective tasks are mandatory and all lectures and group sessions are in the schedule. This means all students benefit from the courses and will take part in discussions about their choice of programme and will learn about study skills, not just the students who are asking for help and support. This also means that the programme integrating courses work as early warning systems. Since the courses are mandatory and all students must do the tasks and go to the group sessions, the mentors will notice if a student is absent and will contact students who do not carry out their obligations and may be at risk of withdrawal.

Conclusions

Evaluations from one of the programme integrating courses have shown that the course gives students a better picture of their programme as a whole. In the other course, evaluations have also shown that almost 75 % of the students think they have a better understanding of both the programme and the courses after the program integrating course. Just above 50 % have given thought to and improved their study skills. An impact of the group sessions has been that the teachers/mentors have got a better understanding of the structure of the programme, the content of other courses and of the programme as a whole. The programme integrating courses have also shown to be tools for programme development since students and teachers discuss the programme and the courses in the group sessions and teachers continue this discussion afterwards in the teacher meetings.

A questionnaire has also been sent to the mentors, and the results show that the mentors are content with the introduction, that the group sessions work rather well and are rewarding for the teachers since they learn more about what students think about their studies and the programme. Consequently, it works for the teachers to be mentors for groups of students, when they are well prepared. When implementing a mentor system, it is important to give the teachers/mentors an introduction and explicit topics to work with in the groups.

The evaluations have also shown that the students appreciate that the group sessions give them contacts with older and younger students and an opportunity to share their experiences with others. The course also gives them a better and more personal and continuing contact with the teachers. Consequently, one of the strengths of this course is the group sessions since these mixed sessions give the students a chance to develop a more personal and continuing relationship with the teachers which strengthens the student-teacher interaction.

Another strength, as identified by the participants, resides in the actual reflections. Evaluations from one of the courses show that almost 70 % of the students think that the written reflections are fruitful and 75 % find the discussions about their reflections rewarding. The reflective questions and discussions give the students opportunities to think about and to talk to others about their learning, studies, choice of programme and future career.

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