

## **Tools available to aid mobility: help for students and institutions. Case-studies of internships in Chemical Engineering at Porto University and in Chemistry at the University of Cologne**

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### **Introduction**

The mobility of European higher education students really began in 1987, when the Erasmus programme was created by the European Commission. Until that time, only a few countries like France, UK and Germany had their own mobility programs [1, 2]. Already in the first year, the Erasmus programme had the adhesion of 3244 students, while in the 2012/13 academic year more than 2 million students had benefited from EU Erasmus grants [1, 2]. For many European students, Erasmus was their first opportunity to live and study in another country, and thus this programme has become a true cultural and social phenomenon [1-3].

Today the Erasmus+ programme is the new EU programme for Education, Training, Youth and Sport for 2014-2020 [4]. The seven-year programme will provide opportunities for over 4 million Europeans to study, train, and gain work experience. Within the Key Action 1 – Learning Mobility, this programme allows higher education students to remain 3-12 months for studies and 2-12 months for traineeships in another European country.

At present, a clearly favourable context exists for the involvement in international networks for higher education and research, to foster cooperation and bridge the worlds of education and work. This includes the numerous bilateral agreements with universities and companies, particularly in Europe but also worldwide, enabling the involvement of students in different mobility programmes.

In the framework of the “EC2E2N-2 European Chemistry and Chemical Engineering Education Network 2” project [5], and of the activity carried out by the Members of the Work Package 06 “Broadening Student Horizons” (led by one of the Authors, GB), a common commitment was to discuss and identify obstacles to the mobility and exploit study and training opportunities. Special attention was devoted to students’ traineeships with the aim to seize the opportunities offered through education and training and to transferring the know-how already acquired. In this context, this manuscript presents the experiences from two universities of the EC2E2N-2 consortium, providing their overviews of internships in companies (Porto University, in the field of Chemical Engineering) and in universities (Cologne University, in the field of Chemistry).

## **Case-studies**

In the particular case of Chemical Engineering at FEUP (Faculty of Engineering – University of Porto), an effort has been made in the last 15 years to strengthen collaborations with higher education institutions of internationally recognized level and to motivate students to get involved in mobility programmes, mainly in Europe (through the Erasmus initiative) but also in the USA and Brazil. Chemical engineering undergraduate students from FEUP have been deeply involved in studying abroad within the framework of such mobility programmes, particularly during their last academic year, to complete final projects, currently dissertations.

The Department of Chemistry of the University of Cologne (UoC), to mention another example, has established in the same time period an international office, which encourages students to make use of mobility programs (mainly the Erasmus initiative) and the possibility to get in contact with several partner universities. The department is also strongly involved in a strategic partnership with the Université de Montréal, Canada.

The current syllabus of the Integrated Master in Chemical Engineering degree at FEUP is 5 years long which corresponds to 300 ECTS. Students will finish the first cycle of this degree when they achieve 180 ECTS, at which point they can obtain a diploma of Licenciante in Engineering Sciences – Chemical Engineering profile. However, most of them perform the 5 years at FEUP (1<sup>st</sup> + 2<sup>nd</sup> cycle, the reason why it is called Integrated Master), ending the degree with a MSc dissertation (30 ECTS - 1 semester dedicated exclusively to this).

It is worth mentioning that the Integrated Master in Chemical Engineering degree at FEUP was awarded in 2012 the international EUR-ACE® quality label [6]. EUR-ACE® is the European quality label for engineering degree programmes at First Cycle (Bachelor) and Second Cycle (Master) level. The EUR-ACE® system encompasses all engineering disciplines and profiles, is internationally recognised and facilitates both academic and professional mobility [6]. This certifies the degree as a high-quality program which meets the international standards for professional engineering education at the master level.

The Department of Chemistry at the University of Cologne offers a 3-years bachelor programme in chemistry and since 2013 additionally in biochemistry, of 180 ECTS each. The following master course is 2 years long, corresponding to 120 ECTS. Students finishing the bachelor degree most often choose to continue with the master programme, but not necessarily at the UoC. Traditionally most students finish their academic education with a doctorate, which takes on average another 3 years. The chemistry study programmes have been accredited in 2007 and are now undergoing a model accreditation of the whole UoC. The Department of Chemistry at the University of Cologne was among the first ones which gained the Eurobachelor® and Euromaster® labels in Chemistry, respectively [7, 8]. These labels, awarded by the European Chemistry Thematic Network Association (ECTN Association) [9], can facilitate mobility because ensure for students in Chemistry the high quality of the programme, similar to other Institutions in Europe awarded with the same label.

## **Options for mobility and applications from students**

Chemical engineering outgoing students from FEUP are normally selected among 4<sup>th</sup>/5<sup>th</sup> year-students, particularly for mobility in non-Portuguese speaking countries. They can either attend subjects or perform their MSc thesis in the framework of any mobility programme,

depending on the chosen institution/country. Different types of mobility programmes are available for them with a large number of partners. As shown in Figure 1, such mobility programmes include mainly the following:

- Erasmus+;
- Erasmus Mundus;
- Erasmus Internships / Placements (in companies and R&D centres in Europe) – this is only available for 5<sup>th</sup> year students, to allow them to perform the experimental part of their MSc dissertation abroad;
- Study overseas (namely in Brazil, through the MOBILE and other mobility programmes, and also in the USA, namely at UMBC - University of Maryland, Baltimore County, among others).

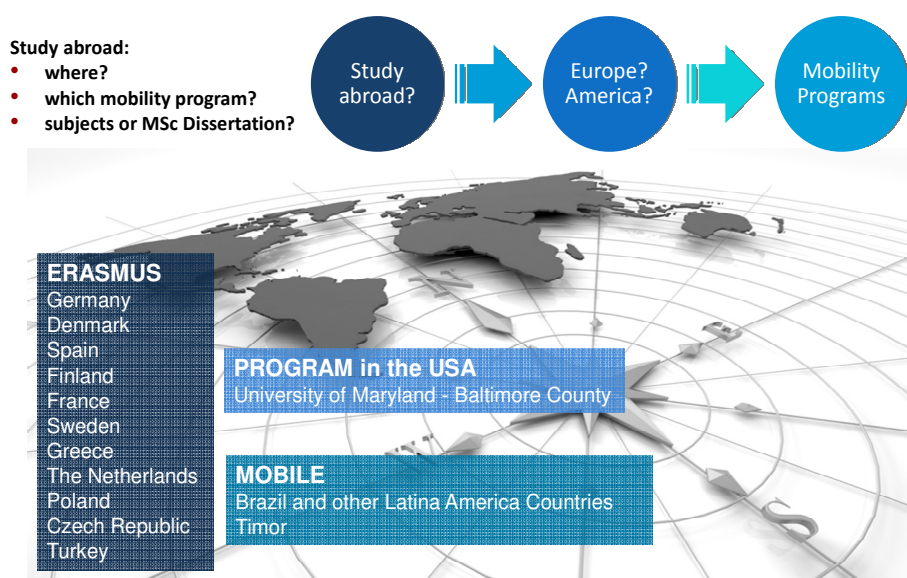


Figure 1 – Choices of internationalization available for Chemical Engineering students at FEUP.

Students apply, during a given period, for the mobility programme(s) that they are interested in, selecting one of the many host institutions available; they are then ranked according to criteria which are mostly related to their marks and academic success rate. Top students are the first ones to be granted the possibility to select the host institution for the mobility, while the choice of students ranked at the bottom is limited by what their colleagues have already chosen and by the number of places available (in total and per university/institution).

Outgoing students from the Department of Chemistry at the UoC are free to choose when to undergo a mobility programme. However, the 5<sup>th</sup> and 6<sup>th</sup> bachelor semesters, as well as the 3<sup>rd</sup> and 4<sup>th</sup> master semesters, have proved to be the best time slots. Students can either take classes or perform their B.Sc. or MSc thesis abroad. As in the FEUP case, most students choose the ERASMUS programme within either the study or the internship scheme. Students are selected based on their marks. At the moment the number of places exceeds the number of students willing to take advantage of the programme.

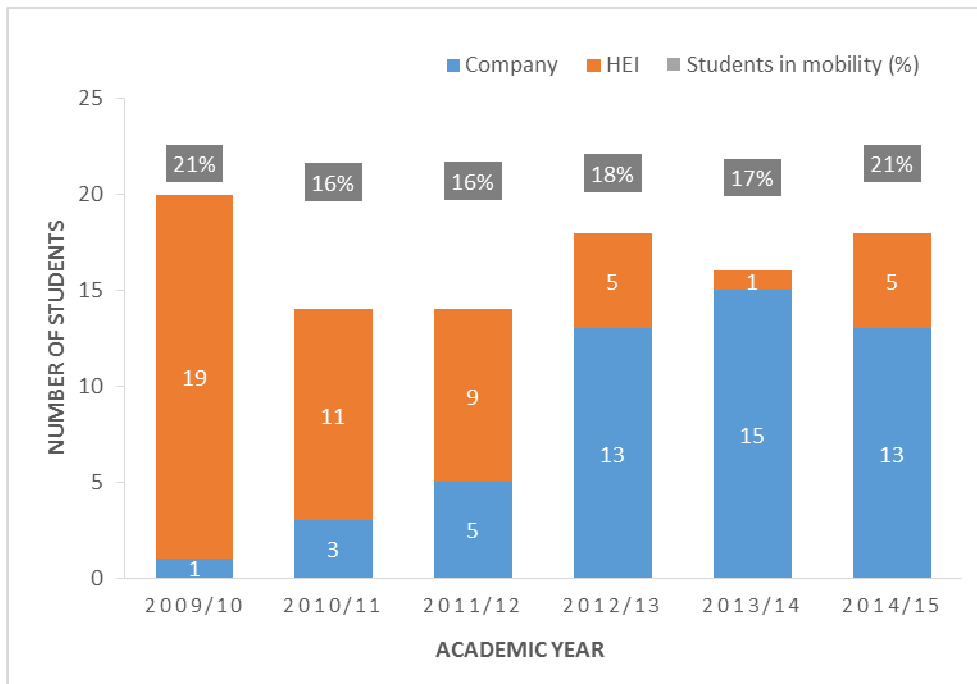
## **Erasmus Internships**

Since 2007 European students have also been offered the opportunity to travel abroad to gain work experience in a company or other types of organizations through the so-called Erasmus Internships / Placements programme.

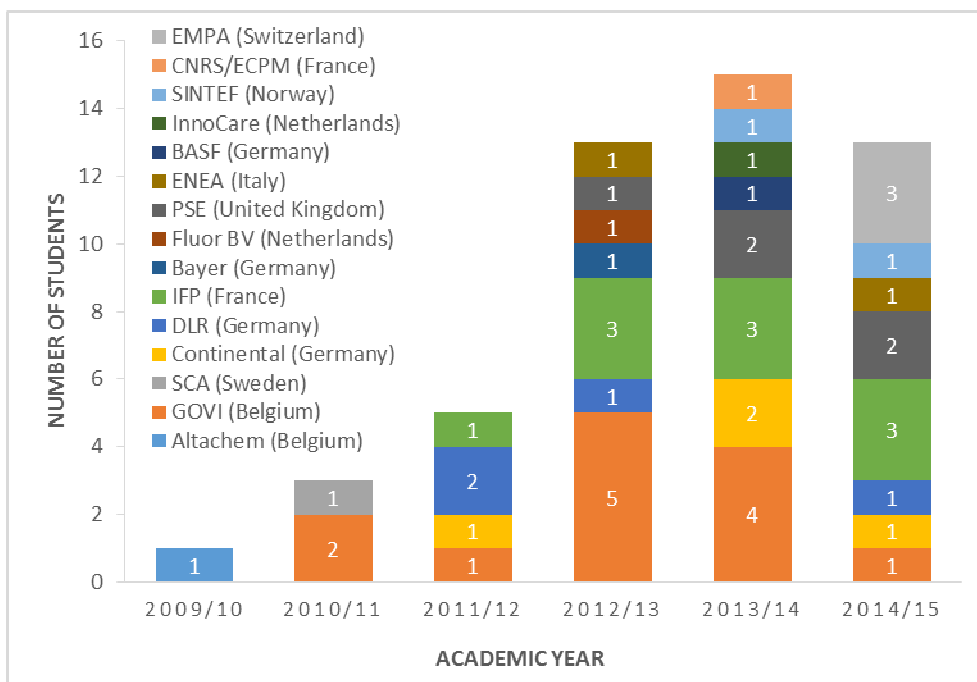
Due to historical and language reasons, most of Chemical Engineering students at FEUP who apply for mobility programmes choose to perform the final project / integrated master thesis abroad (>90%) rather than attending classes. This circumstance provided an easier adaptation for the more recent Erasmus-Internship program, which consists in performing the MSc thesis abroad (or simply a traineeship/internship) in a company or R&D centre. This programme began in 2007/08 but it was only in 2009/10 that the first Chemical Engineering student from FEUP applied. Until then, all students had chosen to perform their mobility in other Higher Education Institutions (HEI).

Figure 2 shows that in average 18% of potential candidates for the mobility (students in the 5<sup>th</sup> academic year) are engaged in mobility programs. It also shows that, although the number of students going abroad has remained nearly the same during the last 5 years (Fig. 2a), there is a trend of increased demand for internships in companies rather than in HEI (Figs. 2a and b). Several reasons for that can be anticipated, like the desire of students to finalize their thesis in an industrial environment, the perception of increased possibility of employment, and also financial incentives, which are also worth mentioning. In fact, while for mobility in universities in most cases students receive the established fellowships (e.g. EU grants for Erasmus), which are typically around 300 € per month (this depends of course on the period and mostly on the host institution/country), very often for mobility in the framework of the Erasmus Internship / Traineeships programme further financial support is provided to them (air tickets, accommodation, supplementary grant, etc.). However, this depends on the host institution policy.

Within the Erasmus Internships / Placements experience (in companies or R&D centres in Europe), senior (i.e. 5<sup>th</sup> year) students perform the experimental part of their MSc dissertation abroad, which must however be presented and defended at FEUP. For this reason, alongside the industrial advisor, one academic advisor from FEUP must be involved, as detailed further below.



a)



b)

Figure 2 – Number of Chemical Engineering students from FEUP going abroad in the framework of different mobility programmes during the last 6 academic years: (a) total, i.e. Erasmus, Erasmus Placements and other mobility programs (to higher education institutions vs. companies) and (b) by company/R&D centre, in the framework of the Erasmus Placements programme only.

As an integral part of its international strategy, the University of Cologne is also keen on attracting and enabling the international students to become a part of its academic tradition. Following the simple motto of learning by doing, the students should avail themselves of the benefits of the offered academic programmes.

Sometimes it is difficult for students to attend lectures/classes, especially if the period of their stay only partially overlaps the semester schedule. In such cases, international students have the opportunity to undergo intensive research training in one of the research groups. Outgoing chemistry students of the UoC as well as incoming students from other universities are strongly encouraged to attend classes even if they perform a laboratory project.

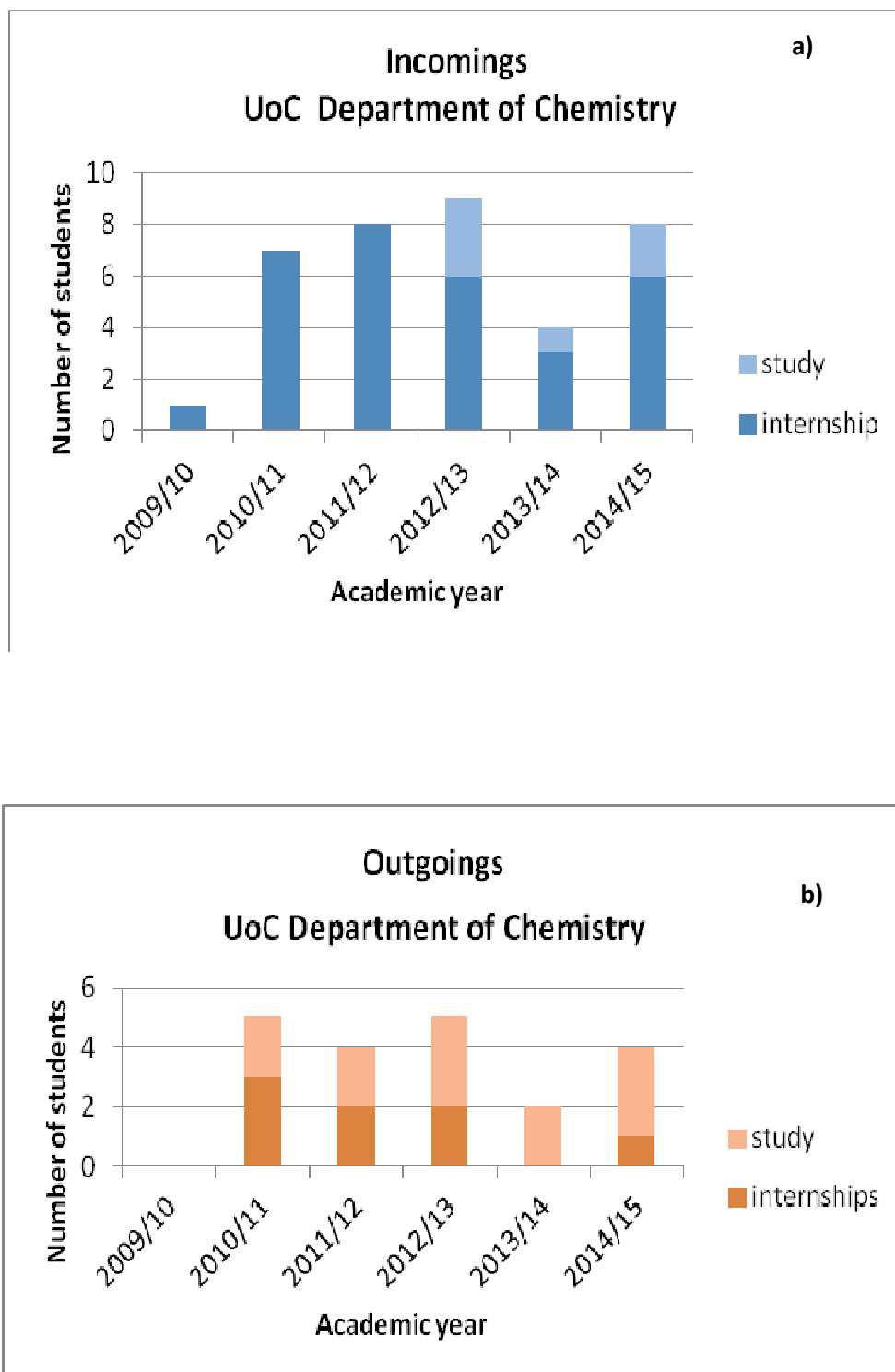


Figure 3 – Number of chemistry students: (a) coming to UoC or (b) going abroad from UoC, in the framework of the Erasmus programme only.

UoC recommends its incoming students, even if enrolled in laboratory research projects, to opt for project modules that are conceptualized to provide an insight into the research expertise of the Department of Chemistry. These modules typically require attending specific series of lectures, writing exams and attending related practical courses. UoC incoming students should meet the following criteria:

1. Students should already have gained laboratory experience before.
2. Students should be at the end of their bachelor studies, or preferably be master students.
3. Students must directly approach the Group Leaders to make arrangements. Since these internships are not part of the bilateral agreement of the two universities, there is no guaranteed right for students to get a place within a laboratory. This offer is always dependent on availability.
4. As soon as a student gets the acceptance of a professor and before joining their host university, they should send their learning agreement to the Erasmus coordinator of the Department of Chemistry.

As illustrated in Fig. 3, incoming and outgoing students benefit differently from the Erasmus programme. Mainly due to lack of knowledge of German language and to the obligation to gain 30 ECTS per semester, most incoming students opt for an internship.

Nevertheless the internship might also be a chance for outgoing students (Fig. 3b) to choose a university where no bilateral agreement exists. In the past 7 years there have been no Internships in companies or R&D centres.

## **Partnerships and study programmes**

Over the years partnerships and mobility cooperation with foreign universities and other HEIs have been developed through the formalization of bilateral agreements, namely through Erasmus. Since 2009/10, the demand and students commitment to find places for internships in companies were (and still are) very important to complement the mobility opportunities offered by FEUP with other types of institutions. Numerous companies (and some independent R&D centres) were contacted in order to establish new partnerships, so that a large database has been created. Even more important, the FEUP's international office and particularly contacts given by Chemical Engineering department staff members were a very good starting point for this task. Fig. 2b gives some examples of companies/R&D centres where Chemical Engineering students from FEUP have been performing their internships in the framework of the Erasmus Placements initiative. Every year such institutions are contacted to gather suggestions on MSc topics.

Students that apply are ranked, and a student - project relationship is established, as it occurs for all other mobility programs. After acceptance by the company, the more "bureaucratic" process is initiated (filling of application forms, finding accommodation, etc.), for which support from the company as well as from the university international office is of utmost importance. If students meet all requirements, a grant is provided by the Erasmus programme, although it is common that extra conditions are ensured by the hosting company.

## Evaluation

### i) Erasmus internships in companies

At FEUP, if an MSc thesis is performed in a company, two supervisors are proposed, one by the company, and the other among the FEUP Chemical Engineering Department staff members, who will perform “long distance” supervision and ensure the scientific quality of the work. At the end of the internship, a traineeship certificate ('transcript of work') and an evaluation (both qualitative and quantitative) from the foreign supervisor is required.

An opponent, external to the Chemical Engineering Department, preferably with a PhD degree, is invited to participate in the thesis defence at FEUP. In order to establish the final mark, the opinion of everyone involved (academic supervisor, company supervisor, opponent and president of the jury) is taken into account. The final mark is the one corresponding to the subject Dissertation, with 30 ECTS.

### ii) Erasmus internships at university

The Department of Chemistry at the UoC can only provide credits, i.e. in a transcript of records, for laboratory projects if it is in length, workload and content comparable to one of its accredited modules, since there is no 'internship' module.

If this is not the case, UoC will provide a written report that can be evaluated, for the number of credits and the grading, by the sending institution. If the internship is used to write the bachelor or master thesis, UoC strongly recommends that the final colloquia take place at the sending university. This guarantees that the level of marks is comparable to the ones of the respective cohort in the university and that no misleading change between the mark systems of the respective countries takes place.

## Conclusions and Future Perspectives

In our globalized society, markets are more accessible, but competition is also stronger, which increases the need for professionals with linguistic and intercultural skills, and with a broad perspective of the world. The international mobility experience offers the possibility to make use of one's knowledge in a different environment, probably from a different point of view, diving into a different culture and broadening horizons across borders while also reducing national differences. Given the continuous development in Europe of mobility programmes, creating a network of international contacts and opportunities for students becomes of paramount importance.

Due to language barriers, students in Chemical Engineering at FEUP have traditionally been performing «research» activities abroad (recognition of final project / Dissertation in the Integrated Master). For this reason and also due to financial reasons, they are more and more interested in the Erasmus-Internship mobility programme (carrying out their Dissertation in companies), which offers far better economic conditions.

The experience of the Chemical Engineering Department at FEUP is clearly positive in this Erasmus Internships / Placements programme. However, there is awareness around the fact that it can be further improved. Several strengths can be highlighted, particularly the fact that:

- A big network with many companies across Europe allows Chemical Engineering students to have an international experience abroad, in an industrial environment;



- Top level R&D centres are also involved in this network, enlarging the spectrum of possibilities for the mobility experience abroad;
- The extension of network mobility to companies helped soften financial problems students were experiencing, since companies usually offer extra benefits to students, which are better than Erasmus scholarships.

Understandably the process is not perfect and there are also weaknesses that can be pointed out, namely:

- Financial difficulties: grants, namely from EU for Erasmus, are about 300€ per month, which is a too low sum for students who do not receive any extra support;
- Linguistic barriers that still exist across Europe, although they have been clearly attenuated over time;
- Investment of time and resources.

From the point of view of the Department of Chemistry of the UoC, laboratory projects / internships can be very useful if students are already skilled in a specific research field and are keen on getting to know a neighbouring research field or technique.

However, this programme should not be seen as a way to escape from difficulties like learning the language of the host country, doing exams or participating in enough courses to meet 30 ECTS per semester. Assistance is provided to find the right modules and create individual timetables.

UoC strongly recommends that incoming students take German courses.

In the future, there are some measures that can be taken in order to improve the mobility offer and experience such as to involve more companies / R&D centres / universities in mobility programmes and thus enlarge the network and increase the possibilities of training for undergraduate students. Other recommendations are engaging / enlarging universities international offices in this activity, attenuating the bureaucratic load for teachers as well as increasing the financial support provided to given groups of students.

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## **References**

[1] "History of the Erasmus Programme", (2013). Retrieved September 5, 2015 from [http://web.archive.org/web/20130404063516/http://ec.europa.eu/education/erasmus/history\\_en.htm](http://web.archive.org/web/20130404063516/http://ec.europa.eu/education/erasmus/history_en.htm)

- [2] Erasmus – Facts, Figures & Trends. The European Union support for student and staff exchanges and university cooperation in 2011-12, Luxembourg; Publications Office of the European Union, 2013/doi:10.2766/43672, ISBN: 978-92-79-30652-5
- [3] “Erasmus programme in 2011-12: the figures explained”, (2013). September 5, 2015, from [http://europa.eu/rapid/press-release\\_MEMO-13-647\\_en.htm](http://europa.eu/rapid/press-release_MEMO-13-647_en.htm).
- [4] “Erasmus+ Programme Guide”, (2014). Retrieved September 5, 2015, from [http://ec.europa.eu/programmes/erasmus-plus/documents/erasmus-plus-programme-guide\\_en.pdf](http://ec.europa.eu/programmes/erasmus-plus/documents/erasmus-plus-programme-guide_en.pdf)
- [5] “European Chemistry and Chemical Engineering Education Network”, Retrieved September 5, 2015, from <http://www.ec2e2n.net/>
- [6] “The EUR-ACE® System”, (2015). Retrieved September 5, 2015, from <http://www.enaee.eu/eur-ace-system/>
- [7] “The Chemistry Quality Eurolabels® Official Website”, (2015) [www.chemistry-eurolabels.eu](http://www.chemistry-eurolabels.eu) and <http://ectn-assoc.cpe.fr/chemistry-eurolabels/>
- [8] EC2E2N NewsLetter – Special Edition: **Eurolabels®, 10 years of success**, 16 (3) (2015), [http://www.ec2e2n.info/news/2015/1603\\_201506](http://www.ec2e2n.info/news/2015/1603_201506)
- [9] The European Chemistry Thematic Network Association (ECTN Association), <http://ectn-assoc.cpe.fr/>