

# EACH Evaluation Report 2017

**In this report** we have evaluated the design, implementation and progress of the EU-funded Erasmus Mundus Excellence in Analytical Chemistry Joint Master Programme, EACH, from its inception until today. The evaluation is divided into four parts, covering the relevance of the programme, its design and implementation, the partners and their cooperation, and the impact and dissemination of the programme. Finally, we have summarized some strong and a few points for improvement, and outlined opportunities for the future. We hope this report will contribute to making an already successful programme even better.

The EACH Advisory Council, December 7, 2017

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## Relevance of the Programme

Analytical Chemistry dominates more jobs of chemists and chemical engineers than any other chemical sub-discipline, both in Europe and in Northern America (Salzer et al. 2015). This situation is observed since a couple of decades, but the profile of academic education did not yet follow this development in the job world. Other deficits among graduates concern a lack of entrepreneurial attitude as well as a lack of information about the wide field of industrial research. All these issues are tackled by the innovative EACH programme.

Modern techniques of Analytical Chemistry cover an extremely wide area, from remote sensing in the upper atmosphere, via process analysis in industrial mass processes to single-molecule detection in biological systems. No single institution is able to cover all this challenge in their educational programmes. For this task, a consortium of closely cooperating, renowned partners with complementary expertise is required. The EACH programme is based on such a partnership. It is a unique programme worldwide, a role model for integration of educational and non-academic institutions within the European Higher Education Area and an excellent example for its worldwide attractiveness.

The high educational and scientific standard of the EACH programme attracted excellent students from around the globe. These students are very much interested in the learning mobility incorporated in this Joint Master Degree (JMD) programme. The programme structure takes into account distinct differences in the educational background of the accepted students by offering a common first year at the same place for all students. This strategy harmonizes the knowledge level of all students and the same time extends their intercultural horizon. Together with the top-level teaching of fundamentals in Analytical Chemistry, this first year is an important cornerstone of the academic programme and the related learning outcomes.

In 2017, recruiters for most EU countries report problems finding qualified chemists and chemical engineers. This holds even for Greece, Spain and Portugal. The lack of qualified personnel is further aggravated by the too narrow specialization of current graduates. Teaching units in Analytical Chemistry are usually very small and focused on just one technique, their graduates only gathered experience in a correspondingly narrow part of Analytical Chemistry. The EACH programme leaves this unfortunate situation behind them. This programme offers the most comprehensive range of education in Analytical Chemistry, apparently world-wide.

An important component of the first year of the EACH programme is occupied by metrology. Metrology lays the foundation for any kind of measurement and its evaluation, both in basic research and in industrial applications. This component is one of the innovative parts of the EACH programme as it is hardly found in university programmes on Analytical Chemistry. This can be documented for the EU when looking to the requests of the graduates of the last 15 years, which skills they acquired by life-long learning. Most often required are courses on hard skills (legislative/regulatory knowledge, e-skills), followed by problem-solving skills, social skills and self-management skills. All these crucial skills are imparted by the EACH programme. As the EACH programme is fully integrated in the usual university life, this programme obviously contributes to university excellence, innovation and competitiveness.

Another innovative element in the EACH programme is the Winter School, which provides added value to the students, to the participating universities, potentially to the participating non-academic players as well. The Winter School provides the students with the opportunity to decide about their specialization during the second year of the EACH programme. At the same time, it helps the academic teachers to develop their further interaction. The Winter School might be used as well to strengthen the cooperation with the non-academic partners of the programme, in particular with respect to offering dedicated internships. These internships are an outstanding part of the EACH programme. This part might even be strengthened in the course of further development of the EACH programme.

Common university education focuses on academic research careers of the graduates. The EACH programme offers in addition foundations for further careers in industry, either industrial research or administration, or for careers in regulatory laboratories. Both industry and regulatory laboratories have a high demand for analytical chemists. Offering these additional and highly demanded branches is a real advantage of the EACH programme and a key component for optimal employability of the students.

A large number of non-academic players are associated partners of the EACH programme. These non-academic partners are very diverse in size, work sector and activity area. The largest non-academic partners are globally active, and they are market-leaders in their field. This will contribute to the excellent employability of the international EACH students. Most of the non-academic public and private partners are SMEs with strong roots in the Baltic region. This regional tie will ensure the distinct impact of the EACH programme on the host regions of the programme and will help to consolidate and to improve the scientific and economic situation both in the region of the host institutions as well as in the countries of origin of the students of EACH.

## Quality of the Programme Design and Implementation

The students take their first year of courses at the University of Tartu (UT), the EACH programme's host institution, with a focus on learning fundamentals of Analytical Chemistry. UT's strong programme in Measurement Science/Metrology makes this an ideal setting for the students to begin the EACH programme. An advantage of having all students start in the same place is to assure a consistent baseline of their Analytical Chemistry knowledge and skills before they proceed to their second-year institutions and more advanced and specialized concepts. Between their first and second years, students complete an internship which provides students with an excellent opportunity to apply their learned knowledge and gain experience in a real-world work setting. This core structure of the EACH programme is very strong.

Students apply for placement in one of the three second-year host universities. Each university is well-equipped to offer specialized programming and adds a practical/applied component to the fundamentals learned during the first year of the program. The completion of thesis research projects also occurs at the second-year university (or affiliated industrial settings). Students cite that a strong reason for joining the EACH programme is because of an opportunity to continue their studies at the second-year universities. Indeed, each of these universities is respected and well-equipped to advance and specialize students' knowledge as they move into the second year of their program.

All students attend an innovative Winter School in between the Fall and Winter semesters of both their first and second years in the EACH programme. The Winter School allows different cohorts/intakes of students to interact and allows the first year students to learn more about the second-year universities from the students who have been placed there for a semester already. Though students indicate a desire to learn of their second-year placements earlier in the programme, this interaction between different intakes is seen as a positive. The Winter School also allow all faculty and students to gather in one place that might be otherwise prohibitive during the hectic academic semesters. According to the data provided, it appears that students have been assigned to their second-year university of choice for the first two cohorts of the programme. The EACH Academic Board seems to be doing a good job in placing the students. However, some students indicate that the process of interviewing and being placed into the second-year university can be stressful or confusing. While such a decision (where they will complete the second year of their Master's program) would naturally make students anxious, interviewing for such opportunities are part of real-world experiences that participants will inevitably face in the future. Students also have a chance to broaden their knowledge by attending seminars given by visiting scholars and participating in Analytical Chemistry exercises/activities. Participants have given the Winter School favorable evaluations, with recurring comments that it should even be lengthier.

Participants say very good things about the International Student Service office at UT. In fact, some comments have suggested that this office be in contact with their counterpart offices at the second-year universities. This office, along with the orientation program at UT appear to integrate the students smoothly into the programme. The programme takes advantage of the content expertise by inviting visiting scholars to interact with the students.

Actually, it is double degrees, not joint degrees.

On average, the programme has slightly exceeded its goal of bringing in 6-7 visiting scholars per year. These types of interaction with international experts should certainly be continued.

Students in the programme take a rigorous two year, 120 ECTS combination of coursework and research credits with traditional grading/assessment metrics. These are similar to other M.Sc. programmes in the EU (with perhaps the EACH programme being a bit more intensive than the average traditional programme). Graduates receive joint degrees (with UT and their second-year university) - giving them the additional recognition of studying at two universities. The thrust of the EACH programme is to assure that graduates are able gain employment. The programme has done a good job of partnering with industrial laboratories and introducing students to socio-economic aspects in Analytical Chemistry. Though the program is too new to have already released the data, it will be interesting to see the employment (or continued education) rate of the first cohort to have completed the programme.

Overall, the quality of the project design is quite strong, and with the exception of only a few issues, the implementation has seemed to be successful. The team should certainly be commended for their successes and efforts in support of the successful EACH programme. Now that the programme has graduated its first cohort, have a second group of second year students, and their third group of first year intake, it will be important for the programme to take a detailed look at how it seems to be progressing.

In June and September 2017, the first intake of students graduated successfully from the EACH programme (See the graduation blogposts at Uppsala, Lyon and Åbo). Just few months later, 14 out of our 17 fresh graduates have already obtained positions! See: <https://each.ut.ee/EACH/the-career-boost-of-the-first-each-graduates/>

This is regrettable, but at the same time this the best option for the 2nd year professors to see the students.

We have now expanded the informational activities about 2nd year universities: There are three separate sessions: (1) with 2nd year professors in Nov; (2) with 2nd year students in Dec and (3) meeting of the whole consortium in the Summer School in Jan. Furthermore, now we have the first graduates who in Autumn 2017 also participated in information exchange and gave very useful information - since they have seen the whole programme from beginning to end.

This is explained in detail at the start of the first study year at UT.

## Quality of the Teams and the Cooperation Arrangements

While the students express satisfaction with the programme, several have indicated that they would have liked more information about the second year sites, and known about their second year school assignment before the Winter School, where they have a chance to meet with second year students. This is a reasonable request. On the other hand, one of the main purposes of the Winter School is to go through the interview and final selection process. Perhaps this could be made more clear to the students. The interviews were a distraction element during the Winter School exercises, both for the supervisors and the students, some of which were more focused on their interview and second year assignment than the exercise. Of course, it could also be said that the exercises provided a welcome distraction, keeping their minds off the interviews and final placement for the second year. If students will be individually interviewed in parallel with the exercises, this should also be clearly communicated in advance to the teachers and supervisors of those exercises in advance.

This now done.

The specializations, or study tracks, in Uppsala and Turku (Åbo) are clearly distinct. Indeed, terms related to “mass spectrometry” (Uppsala) and “electrochemistry” (Turku) are at opposite ends of the Analytical Chemistry spectrum, as drawn from bibliometric analyses (Palmlad and Waaijer 2015). Lyon adds the industrial process aspects, giving the students a wide range of choices for their specialization. Given that three of the four cooperating institutions are based in the Nordic/Baltic region, It may make sense to formally involve more industrial partners from the business areas that dominate in the Nordic regions, such as wood pulp chemistry and biotech/pharmaceuticals.

The financial aid package offered to the students, including tuition, travel, health insurance and monthly allowance, must be considered generous by any standard, especially given the living costs in Estonia. The higher costs in Finland and Sweden have not deterred the students, and Uppsala has been the most popular first-choice of the students for their second year. The students have been able to travel and enjoy their spare time.

The positive feedback from the students on specific teachers and coordinators suggests these are dedicated and motivated to give the students the best possible education and overall experience.

This is a good idea and to some extent it has materialized already: some of the theses defended in 2017 at both UU and AAU involved industrial partners from teh Nordic area and in some cases the work was done entirely at the industry..

## Impact and Dissemination

Information about EACH is easy to find on the Internet. The website <http://each.ut.ee/EACH/> contains relevant information about the programme for current and prospective students alike. The content, including the FAQ, is current and frequently updated. As a consequence of the EACH programme, the website of the master degree in Lyon (<http://master-analyse-controle.univ-lyon1.fr/>) has also been converted into English (<http://master-analytical-chemistry.univ-lyon1.fr/>). This new website is more than a translated document and has enhanced the international development of Lyon's master degree. The website also includes a specific part dedicated to EACH programme. Information about the EACH programme in Uppsala is also available on a dedicated webpage (<http://www.uu.se/en/admissions/master/selma/program/?pInr=EACH&pKod=TKE2M>). At Åbo Akademi University the programme is mentioned as an international master's degree programme taught in English (<http://www.abo.fi/ansok/master>) with links to the main EACH website and the Laboratory of Analytical Chemistry involved in Turku.

The impact on Lyon's master's degree has been particularly important. Historically, lectures were given in French and only few hours were dedicated to English language instruction. When the EACH programme was funded, teachers in Lyon started to translate all teaching documents into English. Since 2016, all lectures associated with the Industrial Analysis modules are given in English and, as some modules are shared with other Analytical Chemistry study tracks, more students in Lyon benefit from this internationalization.

In Uppsala, the programme has further extended the internationalization of Analytical Chemistry education and fostered networking and cross-disciplinary collaborations. The high quality of the EACH students has also resulted in a positive trend in the national Master level students.

We were not able to find any peer-reviewed publications about the EACH programme itself, but did find two papers published so far in 2017 explicitly acknowledging the EACH programme, one on vacuum ultraviolet detectors from the group of Professor Jérôme Randon in Lyon (Liu et al. 2017) and one on antibody-drug conjugates by an EACH student and Professor Jonas Bergquist in Uppsala (Neupane and Bergquist 2017). We encourage all supervisors, especially at the second year universities, to acknowledge the programme whenever a publication comes out of the internship or thesis of an EACH student, as publication in a respected, peer-reviewed journal indicates high quality of the supervision and the student's work.

Follow-up studies of alumni with respect to career and professional status should be conducted in the not too distant future. Comparison with analytical chemists and chemists generally, as recently surveyed (Salzer et al. 2015) will be a good indicator of the impact and efficiency of the master's programme.

## SWOT Analysis

The 2nd year selection process has been one of the most carefully elaborated processes in this consortium. This process is actually very labor-intensive for the consortium. It would be much easier to assign all students to 2nd year universities during admission. We are, however, firmly convinced that assigning students to the 2nd year university after they have studied the first semester at UT serves first of all the interests of students. Before starting their studies they generally have quite incomplete picture of the subject of analytical chemistry and therefore are not in position to make an informed choice of the 2nd year university. As a result, very often happens that during the winter school student expresses a completely different preference compared to what he/she expressed upon admission. In all three intakes all students have got their first choice for the second year university.

**Strengths:** The programme is successful, as measured by the students themselves. A common first year of courses allows the students to select an academic or industrial focus for their second year. That the programme prepares graduates for a career in Analytical Chemistry in academia, regulatory laboratory or industry should be emphasized. The social interactions in the very diverse student body is very strong, as those of us who were present observed during the most recent Winter School. This prepares graduates for working in a diverse company and communicating in English with other non-native speakers. The project design and quality of the project team are strong and there appears to be a real socio-economic need for this programme. By any metric, the programme seems to have gotten off to a very successful implementation.

The feedback has already improved, as Lyon teachers become more experienced in teaching in English.

**Weaknesses:** In past evaluations, some students have expressed disappointment with the second year selection process, in particular not knowing their assigned second year before the Winter School, where there is an opportunity to meet with students from the second year institutions. However, all students got their first choice for the second year institution in 2017. Several students also mentioned the level of English in the instruction at one of the second year universities (Lyon?) could be better. Teachers in an international M. Sc. programme such as EACH must have sufficient English proficiency as well as knowledge on the subject. Students also seem to desire more practical laboratory work in their first year- and this request seems reasonable in-line with the overall objectives of the programme.

**Opportunities:** As a relatively new programme, it is understandable established collaborations and contacts are relied upon. However, for the students, it may be beneficial to involve, as associate partners, at least one representative of each major area of chemical industry in Sweden and Finland (e.g. pulp and paper, biotech/pharmaceuticals, paints and dyes). Academically, Uppsala University is well-renowned in Analytical Chemistry, and numerous spin-offs, particularly in protein analysis (several of which are now part of GE Healthcare) are still active in Uppsala. Involving these would create an opportunity for the students who want learn about advanced analytical techniques and apply them in an industrial setting. Further, it might be beneficial to leverage, when possible, even more participation from the previously lesser involved associated partners and form continued interactions with the visiting scholars whom have previously visited and have a deeper appreciation/understanding of the programme. This would expose the students to additional aspects, applications and roles of analytical chemists around the world.

**Threats:** The programme coordinators have obviously been successful in acquiring funding and assisting the students in finding internships. The width of the programme, preparing students equally for a PhD and academic career as for a career in industry, can be seen as a strength, but there are other M. Sc. programmes which are focused from the beginning, and these may attract the most confident of students. And since the programme is so focused on graduates gaining employment, it will be important to see data, as the programme matures, related to employment (or continued education) rates.

The wish of the students is well known to us and has already been taken into account: as of this study year lab component has been introduced into two more 1st year courses.

We see it as a strength. And the programme contains numerous features to make it competitive against competitors (study at two universities, excellent choice of specialization possibilities, ...). Furthermore, once the student specializes – the second year studies can be highly focused.

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