

# EACH Evaluation Report 2020

**In this report** we have evaluated the design, implementation and continued progress of the EU-funded Erasmus Mundus Excellence in Analytical Chemistry Joint Master Programme, EACH, from 2017 until November 2020. As in 2017, the evaluation is divided into four parts, covering the relevance of the programme, its design, implementation and continued development, the partners and their cooperation, and the impact and dissemination of the programme. We have also looked at the specific impact of the COVID-19 pandemic and how the partners have responded. Finally, we summarize the strengths of the programme and suggest a few things that could be improved, outlining future opportunities. We sincerely hope our report will contribute to sustaining and improving an already highly successful programme.

The EACH Advisory Council, November 17, 2020

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## Coping with COVID

2020 has been a very special year and the SARS-CoV-2/COVID-19 pandemic caused exceptional challenges to higher education efforts world-wide. Below we outline some of these challenges, with emphasis on those particularly difficult for an international programme such as EACH.

We understand that each partner handled the situation according to the local rules and regulations, always prioritizing the safety and wellbeing of the students and instructors. At the same time, the partners worked separately and together to ensure the quality of the programme by providing online lectures, while being flexible on teaching times and locations. The changes to the programme as well as local regulations have been communicated to the students continuously. Scholarships have been extended for students who need longer to complete their studies due to COVID-19.

Teaching in Tartu went completely remote on March 16 and remained so until May 17. From the 18th, in-person teaching with a maximum group size of 10 people was again permitted. The schedule was adjusted accordingly, with lectures during the online-only period and focusing on the core laboratory course May 18 to June 11, finishing on time for the students' internships.

The second-year institutions faced a similar situation and moved most lectures online. For the thesis work, Åbo and Uppsala labs remained open and the students were able to work on their thesis projects according to schedule. Lyon was in full lockdown for most of the spring and labs started to gradually open in May-June. Therefore most of the UCBL students had to reschedule their work, performing literature studies during lockdown and experimental work in the summer.

By the beginning of Jan 2021 all first-year EACH students have arrived to Tartu.

The current academic year started as previously planned at all partner universities. In Tartu, all EACH lectures in the first semester were held online as some of the students had not yet been able to travel. The plan is to finish with the lectures by the end of the year, so that the students can focus on the lab coursework in 2021. By the beginning of November 2020, half (8 out of 16) first-year students are physically in Tartu. The partner is providing special assistance to those students not yet in Estonia and who are currently struggling to travel to Estonia (including living in different time zones).

The second-year universities have adopted a hybrid teaching model, being aware the situation can change quickly. Local restrictions were recently imposed in Uppsala, for example. Uppsala students have had continued access to the laboratories for course and thesis work. At UCBL, thesis projects have been moved to Q2-Q3 2021. All second-year students managed to travel from Estonia to their second-year locations. Though some internships had to be cancelled, suitable alternatives were quickly found and 16 out of 17 students managed to finish their internship during the summer. The defenses of theses at UU, AAU, and UCBL took place online as planned June 8, August 17 and September 3, and were attended by members of the Advisory Council. One student from Uppsala and one from

Extension (and stipend) was granted to the student who did not finish the internship in summer and by now the student has successfully graduated from the programme.

Lyon had to prolong their studies due to travel restrictions and lockdown respectively. However, both are expected to finish this year. ←

UU student defended his thesis on Nov 25, 2020. The student at UCBL has extended her study period until Aug 31, 2021.

The programme has also incorporated aspects of COVID-19 in the training, with at least one student working on a rapid testing method for SARS-CoV-2 at AAU. We understand that the previous experience with and infrastructure for online teaching within EACH were immensely helpful in moving additional lectures online.

In conclusion, we are very impressed with how the EACH programme and all partners responded to the COVID-19 pandemic, caring for the students and rescheduling and shifting courses online to maintain the quality of the programme under exceptional circumstances.

## Relevance of the Programme

The EACH programme is a unique educational programme worldwide, a role model for integration of educational and non-academic institutions within the European Higher Education Area and an excellent example for the worldwide attractiveness of this area. The modules of the EACH programme are complementary in their content, thus enabling the universities to apply their specific strengths. Students appreciate the common start at the same university and the mandatory mobility in the second year. Around 70% of the learning objectives of EACH are achieved by collaborative efforts of the partner universities. Joint rules on supervision, presentation and assessment of master's theses ensure seamless transition between universities and modules. Almost half of all theses are carried out at companies. 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 metrology. This component is one of the innovative parts of the EACH programme as it is hardly found in university programmes on analytical chemistry. A very strong point of the EACH programme is the emphasis on the development of problem-solving skills, social skills and self-management skills. The EACH programme is built upon four fully recognised master's programmes and degrees incorporated within the partner institutions' degree offers. The programme ends with a double degree. Students prefer national certificates over joint certificates. ←

Yes, two surveys have demonstrated this.

Analytical chemistry dominates more jobs of chemists and chemical engineers than any other chemical sub-discipline, both in Europe and in Northern America [1]. This situation has been observed for a couple of decades, but the profile of academic education did not yet follow this development in the job world. Employability of graduates of the EACH programme has turned out to be very high. Good competence of analytical chemists is critically important for industry, trade, healthcare, and environment. Expensive high-quality education in analytical chemistry is ensured by the EACH programme. A large number of non-academic players are associated partners of the EACH programme. These non-academic partners are

Yes, this is clearly demonstrated by the surveys that we are routinely conducting among graduates (87% of the graduates have found a new position within 12 months from graduation), see <https://each.ut.ee/EACH/career-outlook/> for the summary and information on different intakes.

very diverse in size, work sector and activity area. This will contribute to the excellent employability of the international EACH students.

Learning outcomes of the EACH programme belong to three categories: some can be achieved during courses in the first common year, some at one of the II year universities, but the majority (more than 70%) are achievable only by following one of the three study tracks – studying in the I and II year university and participating in the internship. Industry and laboratories play an important role in providing students with knowledge and skills, as well as influencing the learning outcomes. The EU is now the world leader in research and education in aspects of quality and in metrology in analytical chemistry. The EACH programme provides both strong fundamental components and emerging topics as well as socio-economic and metrology-quality related aspects. 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 gives the students the opportunity to decide about their specialisation during the second year of the EACH programme. At the same time, it helps the academic teachers to develop their further interaction.

The high educational and scientific standard of the EACH programme continues to attract excellent students from around the globe. The programme structure takes into account distinct differences in the educational background of the accepted students. EACH universities state that international education experience and that internationalisation in these universities has distinctly profited by their involvement in EACH. International students in all partner universities attend the same classes with local students. Integrating local language courses into the programme has proven to be very efficient. Of the registered EACH students, more than 90% report that the programme fulfilled their expectations, all students continue to recommend the EACH programme.

## Quality of the Programme Design and Implementation

The past few years have been successful for the EACH programme. The structure of the program represents a strength. The students take their first year of courses at the University of Tartu (UT) 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. 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.

EACH programme students attend Winter School between the Fall and Winter semesters of both their first and second years in the 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. Students also have a chance to broaden their knowledge by attending seminars

given by visiting or local scholars and participating in analytical chemistry exercises/activities. During the Winter School, students apply for placement in one of the three second-year host universities.

Each second-year host university is well-equipped to offer specialised 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 partners). 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. Again, this structure (first-year, Winter School, and second-year) of the EACH programme is a strength.

Yes, there is always room for improvement and improvements (often based on students feedback) are introduced to courses on a regular basis.

Students reported satisfaction with the instruction in the programme. Course selection and instructor quality were applauded (though it seems that some unidentified courses could be improved). As was the case in the last Advisory Council evaluation, students expressed a desire for more practical experiences. The 2018 and 2019 student evaluations still showed a desire for more practical work. However, it should be noted that the 2020 student evaluations did not seem to mention this as much. So perhaps, improvements in this regard have been made. Especially since the potential to engage in practical learning was mentioned as a factor that drew students to the EACH programme, a continued focus on increasing practical experiences is advised.

Indeed, more practical work possibilities are provided now than there were in the past.

While it is important to introduce analytical chemistry students to new technologies that are seeing expanding application, as well as socio-economic aspects of analytical chemistry, fundamentals should be more strongly emphasized, especially those that employers and future colleagues would expect the EACH graduates to master. For example, in the spring of 2020, one member of the Advisory Council attended the final thesis presentations of eight EACH students in Uppsala. While in general the scientific quality of theses was high and the students enthusiastically presented their projects, only one (!) out of the eight students knew how to correctly report the precision and uncertainty of their measurements, with several students using many excess significant digits without any notion of uncertainty. This is an essential part of reporting analytical measurements that would be expected to be covered in the first year of the program. We know it also has been on the syllabus, but it is obviously something that needs stronger emphasis. It is something that definitely should 'be on the test'.

The Winter School is generally rated highly by students. The 2020 Winter School was evaluated quite highly by students (and this shows an area of improvement). Students appreciated the organization of the Winter School and found the lectures and practicals to be of value (a good model for future Winter School offerings). Most notably, students have more recently expressed content with the second-year institute selection process. This was an area of student concern (and naturally, a process that can cause some anxiety to students) in the last Advisory Council report. Improvements in this process, and the balance in placements among the second-year institutes, is nice to see.

Significant digits and precision: this is an eternal battle. This issue is specifically addressed at UT at least in 4 (!) courses and still sometimes such mistakes percolate into the final thesis. In particular, a special session is held with students (in the framework of the Master's seminar) at UT where it is explained, how to present scientific data (figures, tables, etc etc), in presentations and in theses. But this happens in the 1st year and as we see, may sometimes be forgotten by the end of the 2nd year.

We have decided to additionally introduce similar sessions every spring, closer to the thesis, specifically for the 2nd year students (online, so all can participate).

Students in the programme take a rigorous two year, 120 ECTS combination of coursework and research credits. 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). 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. Overall, the quality of the EACH programme is quite strong, and with the exception of only a few issues, it has run successfully. The team should certainly be commended for their successes and efforts in support of the programme. It will be great to track the EACH programme as it continues into the future.

## Quality of the Teams and the Cooperation Arrangements

The students are generally and broadly satisfied with the EACH programme, as clearly indicated by the fact they stated they would recommend it to others. The information provided to students has improved since 2017. The quality and dedication of the teams and their cooperation have been proven in the face of the current pandemic. It is one thing to outline cooperation in a proposal, another to show it when “the rubber meets the road”. The EACH partners have really come through, and the students are fortunate to follow a programme whose organizers care both about the level and quality of the training as well as the wellbeing of the students.

The specializations at second-year universities are distinct. We are happy to see that at least in the 2017 and 2019 intakes, the students’ preferences for second-year location were more balanced, with Åbo now close to matching Uppsala and Lyon. Åbo (Turku) is strong on sensors and electrochemistry, Uppsala on mass spectrometry, and Lyon on industrial processes and quality control, giving the students a wide range of choices for their specialization. In our 2017 evaluation, we noted that given that three of the four cooperating institutions are based in the Nordic and Baltic region, there should be an opportunity to involve more industrial partners from these regions from regionally strong areas such as wood and pulp chemistry, pharmaceuticals and biotechnology. We understand that such efforts may not have been prioritized in 2020, but encourage the organizers to pursue this in the future.

Some new associated partners have been attracted from this region.

The financial aid package offered to the students, including tuition, travel, health insurance and monthly allowance, remains generous by any standard, especially given the living costs in Estonia. The higher costs in Finland and Sweden have not deterred the students from applying there. Additional support was provided in 2020 for those students who needed to extend their stay due to COVID-19. The positive feedback from the students on instructors and coordinators suggests these are dedicated and motivated to give the students the best possible education and overall experience, something that was really shown during 2020.

## Impact and Dissemination

Information about EACH is easy to find on the Internet. The main website contains more information about the programme and testimonies from past students. The content is current and frequently updated. This aspect of the programme was already good in 2017, and has been improved further in 2020.

The impact of the programme in Lyon continues to improve as more and more of the teaching is offered in English, to the benefit of non-EACH students and instructors alike. In Uppsala, the programme continues to extend the internationalization of analytical chemistry education and foster cross-disciplinary collaborations. The thesis projects are well-embedded in ongoing research lines.

The Advisory Council was pleased to see the experience and success of the programme disseminated by the organizers in a 2019 article “EACH (Excellence in Analytical Chemistry), an Erasmus Mundus Joint Programme: progress and success” published in *Analytical and Bioanalytical Chemistry* [1]. Once the pandemic is over, we would encourage the same authors to summarize and disseminate their experiences and how they adapted to the particular challenges caused by COVID-19 to an international, multi-site, programme such as EACH in a suitable journal, either within the field of analytical chemistry or a journal for higher education. We believe this may be useful to similarly structured programmes in other fields.

 This is a good idea!

## SWOT Analysis

**Strengths:** The programme is successful by any metric. The hard work of the organizers and instructors ensures a high quality of training on relevant topics and technologies. A common first year of courses provides the base from which students select either an academic or industrial focus for their second year. The programme thus prepares students for a career either in academia/higher education, regulatory laboratories or industry. An international and diverse student body provides for a positive experience. The quality and dedication of the team are strong, as proven in 2020. The organizers have listened to feedback from the students and the Advisory Council and made adjustments and improvements accordingly. The programme is definitely in the forefront of higher education in analytical chemistry, in Europe.

**Weaknesses:** As mentioned above, the Advisory Council did on at least one occasion observe weaknesses in the students' understanding of basic analytical chemistry principles, such as how to report measurement precision and uncertainty, even though these are emphasized in the first year of the programme. An even stronger coordination between

See the response above.

course elements, courses and first- and second-year institutions may improve application and retention of the fundamental principles of metrology.

**Opportunities:** The partners have established a well-working collaboration, where each have clearly defined roles. Though Lyon specializes on teaching analytical chemistry in industrial contexts, we still argue it would be beneficial for the students and host nations alike to involve representatives of each major area of chemical industry in Sweden and Finland (e.g. pulp and paper, biotech/pharmaceuticals, paints and dyes).

See the response above.

**Threats:** Few foresaw the threat posed to the programme by a respiratory virus resulting in widespread and extended lockdowns, travel restrictions and limits on in-person gatherings. However, the coordinators responded admirably to the unexpected events of 2020. In general, the programme coordinators have been successful in acquiring continued funding for all aspects of the programme. Impressively most of the coordinators and teachers remain with the programme. This provides “institutional memory”, ensuring continuity and quality. The EACH programme is actively driven by the main coordinator at each partner university. Though none of these are near retirement, as far as known to the Advisory Council, other changes, such as promotion, can result in a coordinator no longer able to continue in their role. For long-term sustainability, the program would need, in addition to continued funding, a contingency plan for each partner in the case the current coordinator leaves. As a field, analytical chemistry only increases in relevance and societal importance, as are the technologies and topics covered by the programme.

This is a very relevant comment. We will work on this.

## References

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