EuroTeQ as an Alliance to Promote European Engineering Education

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Abstract: The ongoing technical progress needs in deepening the partnership of engineering educational institutions. The EuroTeQ University Alliance, created by six leading European universities of science and technology, represents one of the first responses to this challenge. The paper is dedicated to assessing the strengths and weaknesses of the EuroTeQ platform. The EuroTeQ student cohort is compared here with the international student team studied at the host university for three years and the European Erasmus+ one-semester student team. A discipline "Robotics" of six credit points for the bachelor degree came into the focus of this study. An active learning approach was applied as the basic educational methodology. As a result of multilateral analysis and observations, several directions for further development of the EuroTeQ Alliance are proposed.

1 INTRODUCTION

As the educational landscape of Europe is becoming more and more diverse, contemporary society needs to respond to this alteration in a timely manner. Higher education calls for transnational university alliances that could link the knowledge space with research, innovation and service. These alliances aim to increase the institutional cooperation, to deepen its intensity, and to expand effectiveness. They have to open the ways towards the future, to strengthen European values, and to increase the competitiveness and weight of higher education. To accelerate the steps forward, the alliances are asked to support various cooperation models, involve partners from different types of institutions, and cover broad geographic areas across Europe.

EuroTeQ, a union of European engineering universities (EuroTeQ, 2022), is the flagship of such alliances. It is designed to promote high-quality European higher education and adopt a challenge-based approach whereby students, faculty and external partners could collaborate in interdisciplinary teams to solve the big challenges facing Europe today. The European Union considers this alliance as part of the European Universities initiative (European Universities initiative, 2021). This is one of the European Commission projects designed for three years. About five million euros has been allocated there through Erasmus+ (Erasmus+, 2022) and two million euros through Horizon 2020 (Horizon, 2020) European educational programmes.

The EuroTeQ alliance involves six universities, namely Technical University of Munich (TUM) in Germany, as a coordinator, École Polytechnique (L'X) in France, Research and entrepreneurial Technical University of Denmark (DTU) in Kongens Lyngby near Copenhagen, Czech Technical University (CTU) in Prague, the Eindhoven University of Technology (TU/e) in Netherlands, and Tallinn University of Technology (TalTech) in Estonia. The third-party partners from École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland and the Israeli Technion Institute of Technology in Haifa support the alliance and contribute to its activity. EuroTeQ has also 45 associated partners from society and industry.

Students from TUM, TU/e, DTU, L'X, CTU, TalTech, EPFL and Technion self-enrol in EuroTeQ targeting to receive either a certificate of achievement or the diploma supplement upon completion and to

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experience virtual and/or physical mobility at all levels of study. To navigate there, the student-centred course catalogue was jointly designed and delivered across inter-university campuses. In 2022, the catalogue involved above 100 disciplines. The rules for transferring obtained grades vary depending on the institution grading systems.

In the first two years, EuroTeQ has become very popular among the students and staff. Practically, all well-known social media support this alliance. EuroTeQ Engineering University page in LinkedIn has near 800 followers. Something similar can be observed at #euroteq in Facebook and TikTok, @EuroTeQ in Twitter and Instagram.

EuroTeQ spring 2023 statistics is impressive. 69 students have enrolled in 95 subjects. 18 young people chose more than one subject. 15 learners selected subjects from different universities simultaneously and some students chose disciplines from the same university. Many students are currently on a waiting list since the subjects they selected have a limit of participants and there turned out to be more applicants than places.

Nevertheless, quite many challenges have been discovered related to EuroTeQ. This study focuses on the impact of EuroTeQ participation on engineering students with diverse educational backgrounds, skills, and language proficiency. The purpose is to determine an extent of EuroTeQ effectiveness and to identify possible ways in achieving success in academic performance and knowledge acquisition. To clarify the reasons for failures and dissatisfaction of students and staff, various teams of applicants are compared with each other during the analysis of the past training period.

The following research questions were stated here:

- how big is a dropdown rate of EuroTeQ students and what are its reasons?
- what forms of study mainly prefer EuroTeQ enrolees and which of them they usually ignore?
- how great are the time costs for participation in the EuroTeQ study?
- what could be concluded about the study success of the EuroTeQ participants compared to other students?

In the next sections of the paper, related studies are referenced, materials and methods are explained including students and disciplines, learning environment and educational format. Then, the results of the analysis are displayed followed by discussion and conclusions.

2 RELATED STUDY

As shown in (Wu, 2013), open cources have many benefits for society, as they make higher education a public good, allowing anyone to enroll and providing an opportunity to freely communicate with other learners and faculty on a global scale. They expand the possibilities of instructors to experiment with pedagogical methods and systematize data on learners behavior, motivation, team interaction, and student habits. According to (MOOC, 2022), online courses ensure many affordable and flexible paths to obtain new skills, advance career, and increase a scale of quality competences. Millions of people around the globe enrol in open institutions aiming to develop and change their career.

However, despite their potential to support education, such organisations as MOOCs and SPOCs have serious concerns (Guo, 2017), mainly related to dropout, since only a very small percentage of their enrolled learners complete the study. As follows from (Onah, 2014; Feng, 2019; Goel, 2020; Bugueño-Córdova, 2022; Schmieden, 2022), MOOC completion rates are very low, somewhere from 3 to 30%.

Among the reasons of the notable dropout, such possible challenges are usually listed as:

- unordered learning environment,
- low digital literacy of participants,
- requirements for participants to self-regulate and set their own goals,
- lack of time for course participation,
- language and translation restrictions,
- difficulties for instructors to control online learning,
- accessibility limitations for users, especially for people from poor socio-economic regions and areas with bad Internet access.

It was demonstrated in the preceding authors' studies that the difference in the experience and skills of learners involved in the common educational environment becomes a source of enthusiasm for some and discontent for others. This work extends to the EuroTeQ platform the previous findings in student mobility (Vodovozov, 2020), active learning (Vodovozov, 2021) and blended methodology (Vodovozov, 2022) taking into account new student groups and activities.

3 MATERIALS AND METHODS

3.1 Students and Disciplines

Three teams of enrolees are compared in this research, namely the home TalTech students, the Erasmus+ mobility students, and the EuroTeQ students, a total of 77 participants. A discipline "Robotics" (ATR0030) for the BSc degree of six credit points in the European Credit Transfer and Accumulation System (ECTS) came into the focus of this study. English was used as a non-native instruction language for all participants. Spring and autumn 2022 semesters are covered together.

The home team is represented by the international students from Georgia, Ukraine, Iran, Afghanistan, and several African countries enrolled to complete a full cycle of undergraduate learning in TalTech. This cohort studies "Robotics" as a mandatory discipline in the chosen "Integrated Engineering" specialty. On the other side, European Erasmus+ and EuroTeQ learners chose "Robotics" as an elective course of their specialization. For the home and Erasmus+ students, "Robotics" represents the part of their curricula and directly affected the results of their educational performance. For EuroTeQ students, this is an additional burden that does not have a direct impact on their academic records. It is noteworthy that trainees with various backgrounds, skills, and levels of knowledge were united in a common learning cohort and created a multifaceted collective, which is fairly typical for modern engineering society (Vodovozov, 2020).

3.2 Learning Environment

A notable feature of the approach under consideration is that the educational landscape was organized in such a way that the course has been composed of two parts, namely the mandatory part and the elective part. Bearing in mind differences in work experience, skills and knowledge, such a division is considered quite justified.

The first part aimed at providing students with the necessary knowledge base and professional experience. In general, it was mandatory to perform a minimum number of laboratory works and computer exercises, as well as to pass a theoretical exam.

The second part was designed to expand and deepen this compulsory base to meet the specific needs, habits, or requests of participants. This elective part presumed active learning, which means that it was focused on student's desire to educate themselves encouraging them to take responsibility for their own learning (Vodovozov, 2021). All elective activities were composed of multiple training events, such as practices and polls in the particular topics, with appropriate learning forms, outcomes, and durations.

All students in this educational environment could participate online or in-person in lectures, student presentations, and computer exercises, as well as in practical laboratory works on real equipment. To this aim, those who studied in the class and online were supervised by the staff in such a way that, although to varying degrees, but to maximize both in-person and online knowledge understanding and acquisition.

Individually selected assessment methods served as an integral part of this environment. The assessment system presumed both formative and summative forms, and learners could select one or another possibility. The sum of bonuses received for solving elective tasks was considered as the expected examination grade (formative assessment). However, instead of the bonus, participants could take a usual written exam (summative assessment).

Table 1 demonstrates the study forms and assessment methods applied.

Table 1: Study forms and assessment methods.

Compulsory study	Elective study
Laboratory practice	
In-person defence of exercises	Supervised exercises, and self-made computer exercises
	Participation in class lectures, on-lecture discussions and fast-track polls
	Self-learning via Internet, textbooks, and e-books
	Student presentations
	Online quizzing
Summative exam-based assessment	Formative bonus-based assessment

3.3 Educational Format

Weekly lectures were delivered in class and broadcast simultaneously via Echo™ along with slideshows and video clips in the institutional learning management system Moodle™, therefore home and Erasmus+ students could choose between in-person classes, online participation, or simply skip them. Attendee of live classes could also participate in fast-track polls and solve on-lecture tasks with bonus collecting. They could also discuss possible responses and get to know about correct solutions, whereas the EuroTeQ team members had only two options, namely either to attend online or to skip lectures.

To increase the grade and to get the primary research and publication experience, interested students were invited to develop and demonstrate the authored PowerPoint™ presentations also broadcasted online. All such presentations are usually included in an international workshop "Amazing Robotics" supported by Estonia section of IEEE education society. Before uploading, the presenters were advised to evaluate their files themself by summing up the points in the specially developed grading criteria:

- the presentation has a pre-recorded audio format with pictures and text of good quality, including a list of references and web links;
- the presentation clearly focuses on the chosen topic; the robot place in the general topology classification is given; an application area and examples, companies, and their models are presented; the history of development, perspectives, advantages, and disadvantages are listed;
- technical and technological data are given, including payload, speed, mass, power, number of bodies and their names, number and types of joints, coordinate systems, sensors and actuators, control and programming tools;
- the student makes a presentation to the audience, answers the questions, and asks the questions to other speakers.

Since the speech themes were agreed before presentations, the speakers fulfilled part of the exam requirements and helped others with learning. Student audio-files were stored in the Moodle™ repository with the appropriate copyright attributes and open access for all site visitors.

Lectures were accompanied by online quizzes that students could answer at will. Each right answer boosted the respondent's bonus while the wrong one reduced it. After the deadline, the answers were automatically graded and quiz results were posted along with the correct solutions.

Computer exercises might be produced either in the schoolroom or independently following by in-person defence and reporting. Exercises involved also an elective section, which solution also brought bonuses. Such popular and widespread software as MATLAB™ helped students to better understand the main topics of the discipline despite the difference in experience and programming skills.

Laboratory practice was performed as a team activity followed by role sharing, individual tasks, and personal reports.

Unlike the TalTech and Erasmus+ students, the educational format of the EuroTeQ participants had some restrictions. Laboratory works were carried out for them not on a regular basis, but in the form of a special week-long laboratory session, to which they were invited by the TalTech administration at the end of the semester. The EuroTeQ students had the only online lectures and broadcast live computer classes. Supervised exercises were replaced by weekly consultations conducted via Microsoft Teams™.

Unfortunately, as the schedules of many universities participated in the EuroTeQ were not agreed, it was impossible to avoid problems with timetables of classes. It is even more disappointing that for the same reason some EuroTeQ students could not travel to TalTech for participation in the laboratory session. And this is despite the fact that traveling to another country accompanied by live contact with the staff is the most attractive side of the EuroTeQ project.

4 RESULTS

Figure 1 shows the enrolment and dropout rates of students. As can be seen from these diagrams, the EuroTeQ team makes up an insignificant part of the group, although it attracts attention with a significant dropout.

In Fig. 2, the EuroTeQ team is compared to the TalTech and Erasmus+ teams in terms of the chosen forms of study.

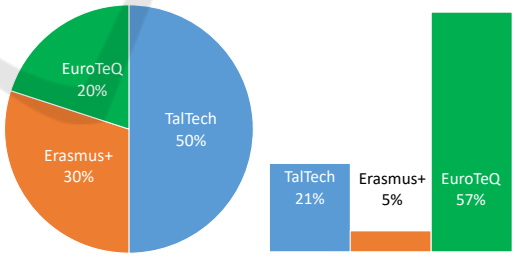

Figure 1: Enrolment (left) and dropout (right) rates of students.

According to this diagram, the attitude of EuroTeQ participants to study can be considered to some extent different from the attitude of TalTech and Erasmus+ members. EuroTeQ learners pay less attention to such elective activities as student presentations or additional exercises, but they seem to be more motivated in quizzes and web consultations.

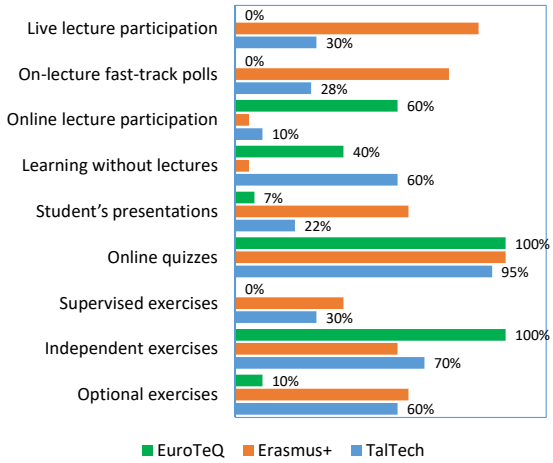

Figure 2: The share of students participated in elective forms of study.

To attract attention to lectures, the students were involved in on-lecture talks, surveys and polls participation in which could boost the bonus amount collected in the scope of formative assessment. Those who took part via Internet, including EuroTeQ students, acted as outside bystanders of these options. Nevertheless, all students always received lecture slides and manuals for further and deeper study the subject.

The same applies to exercises. Students who visited supervised classes, as a rule, followed the directions of the trainer on how to systematically carry out their work. They also had the opportunity to ask questions and get help directly from instructors in solving their issues. Oppositely, in the case of self-completion of homeworks, these benefits were lacking or delayed, but the strong students could move faster and pick their own methods in task solving. With any approach, tutorials with detailed exercises and work instructions were always available to everyone.

In order to understand the "cost" of elective activities in a course designed for 156 hours (six ECTS credits), including 64 hours of classroom lessons, it was estimated the time spent on study by the students participated in these events. Quizzing time has been obtained directly from Moodle™ statistics. Exercise time was also counted by Moodle™ as the time intervals between the start and completion of tasks. The time spent on creating presentations was calculated by the students themselves. Figure 3 shows the approximated fractions of time between different forms of elective study.

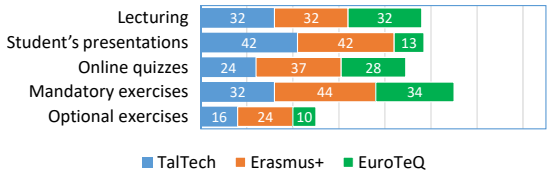

Figure 3: The distribution of academic hours that an average participant devoted to elective learning.

During the data processing for Figure 3, it turned out that the team members can be divided into three categories, namely those who dedicated to learning more than 70% of the nominal study time, those who spent less than 10% of the available time, and the leftovers. Figure 4 demonstrates such a distribution.

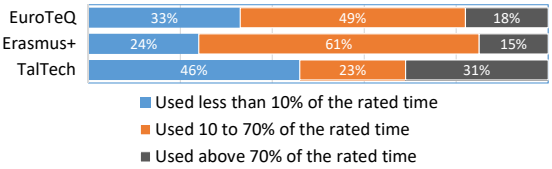

Figure 4: The ratios of time spent on study by an average learner.

It is impressive here that EuroTeQ students have spent considerable time for elective study, which, unlike their competitors, they had to snatch from the main classes at their universities.

Though most of students chose various options, only a part of them received a score above 2 on a 5-point grading system.

Figure 5 illustrates the proportion of learners who not only tried, but also succeeded in elective activities. Regrettably, EuroTeQ is not among the leaders in this category.

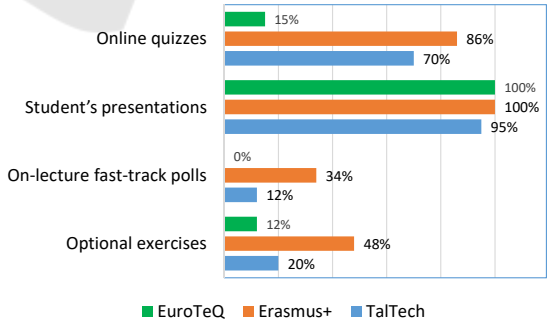

Figure 5: The share of successful students among the elective activity participants.

Despite the fact that the absolute majority of learners were satisfied with the bonuses they earned and accepted them as final grades, some had to go through an exam in the form of a summative

assessment. This applies to those who did not participate in elective study or who were not satisfied with too low formative assessment results. Figure 6 compares the results of the formative assessment with the final grades. Of course, all EuroTeQ students used their bonuses because they could not attend the in-person exams.

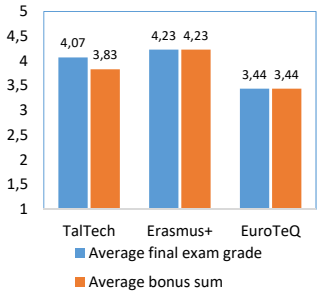

Figure 6: Comparison of the results of the formative assessment with the final grades.

5 DISCUSSION

A comparison of the presented results shows a clear distinction in learning outcomes and study approaches between students belonging to different teams. The best results are achieved by Erasmus+ students, which cannot be said about EuroTeQ participants. The same applies to a completion rate.

It can be assumed that the first reason for this lies in the students' goals.

There is no doubt that the main objective of the average TalTech student is to get the highest examination grade, as a successful completion of the BCs degree is a prerequisite for building his/her career, in particular, for admission to a MSc and then PhD degree or choosing a prestigious profession. To achieve this goal, most TalTech students voluntarily turn to elective activities regardless of their specialty, form of study and mental abilities, since all the options offered are of great importance for refund and open up many ways to achieve maximal grades. In this regard, Erasmus+ students who have come to TalTech for one or two semesters from leading European universities have a better chance for success, as they can fully devote themselves to their studies without being distracted by family and side earnings. As for the EuroTeQ learners, this is an additional workload for them, which does not directly affect their current BSc degree and, if it bears fruit, then only in the future.

In this regard, much depends on the abilities and working capacity of the EuroTeQ students. First, unlike the rest of the participants in their group, they have to study mainly in absentia, without direct contact with teachers, and search for a lot of information online. Second, they get into a new educational environment in which they must adapt quickly. Third, they should find extra time to learn along with their mandatory institutional and traditional domestic duties. Fourth, they have to combine the schedule of their university with the timetable of TalTech that, as a rule, do not coincide.

There are also problems with an alien qualification system. The European Qualifications Framework (EQF), created as a joint knowledge base for educational institutions, faces a number of challenges. A study (Pappa, 2021) conducted within the EuroTeQ project framework revealed many differences in the implementation of EQF in the educational programs of six universities. Based on these findings, some implications and proposals for the comparability of national engineering education systems are currently being discussed.

As a result, a high dropout rate and low academic performance become the same EuroTeQ challenges that MOOC and SPOC suffer from. On the other side, EuroTeQ has every reason and enough tools to minimize these issues.

1. The six leading European universities represent a fairly small and very powerful union capable of studies organizing at the highest possible level.
2. Also, there should not be a big problem with the coordination of timetables.
3. Students are encouraged to consult with their home universities on how to achieve recognition of the facts presented in the EuroTeQ course catalogue.
4. As all students are different and not all of them require elective study, a home university could conduct preliminary consultations and selection among those wishing to receive additional education.
5. It would be useful to improve the advertising campaign. Applicants should be provided with information about the courses with a clear indication of the assessment system, dropout rate, laboratory works and classes, as well as with videos, photos, etc. Virtual Open Days could bring invaluable help in this process.
6. It is promising to introduce various types of questionnaires and application forms for pre-registration.
7. It is also a need in establishing a delay between pre-enrolment and real enrolment, which would help the applicant to evaluate the upcoming

amount of work, the learning environment, the quality of teaching, and other factors before making a final decision on admission.

6 CONCLUSION

The EuroTeQ University Alliance is a good example of an in-depth partnership of engineering educational institutions. The analysis carried out in this study revealed some strengths and weaknesses of this platform. The EuroTeQ student team was compared with foreign students studied at TalTech for three years and European Erasmus+ one-semester team of students. As a result, several directions for further development of EuroTeQ are proposed. Among them, a need in consulting students on the course catalogue usage is shown. Coordination of timetables is offered. Every home university could conduct preliminary consultations and selection among those wishing to receive additional education. It is demonstrated the usefulness of improving the advertising campaign aiming to provide applicants with information about the courses, assessment system, average dropout rates, laboratory works and classes, virtual Open Days, etc. Finally, it is promising to introduce questionnaires and application forms for pre-registration. It is also offered establishing a delay between the pre-enrolment and the real enrolment.

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