

## **Assessment Report**

# Physical Sciences

University of Tartu

Tallinn University of Technology

2016

## Contents

INTRODUCTION .....	3
GENERAL FINDINGS AND RECOMMENDATIONS .....	4
1. ASSESSMENT REPORT OF SPG AT THE UNIVERSITY OF TARTU .....	8
1.1. INTRODUCTION .....	8
1.2. GENERAL FINDINGS AND RECOMMENDATIONS AT THE STUDY PROGRAMME GROUP LEVEL.....	8
1.3. STRENGTHS AND AREAS FOR IMPROVEMENT OF STUDY PROGRAMMES BY ASSESSMENT AREAS .....	9
1.3.1. GEOGRAPHY (BSc, MSc).....	9
1.3.2. GEOLOGY (BSc, MSc), GEOLOGY AND ENVIRONMENTAL TECHNOLOGY (BSc).....	16
1.3.3. CHEMISTRY (BSc, MSc) .....	22
1.3.4. PHYSICS (BSc, MSc), MATERIALS SCIENCE (BSc, MSc) .....	31
2. ASSESSMENT REPORT OF SPG AT TALLINN UNIVERSITY OF TECHNOLOGY .....	37
2.1. INTRODUCTION .....	37
2.2. GENERAL FINDINGS AND RECOMMENDATIONS AT STUDY PROGRAMME GROUP LEVEL .....	37
2.3. STRENGTHS AND AREAS FOR IMPROVEMENT OF STUDY PROGRAMMES BY ASSESSMENT AREAS .....	38
2.3.1. EARTH SCIENCE AND GEOTECHNOLOGY (BSc, MSc).....	38
2.3.2. ENGINEERING PHYSICS (BSc, MSc).....	44
2.3.3. APPLIED CHEMISTRY AND BIOTECHNOLOGY (BSc, MSc) .....	50

## Introduction

Quality assessment of a study programme group involves the assessment of the conformity of study programmes and the studies and development activities that take place on their basis to legislation, national and international standards and developmental directions, with the purpose of providing recommendations to improve the quality of studies.

The goal of quality assessment of a study programme group is to support the internal evaluation and self-development of the institution of higher education. Quality assessment of study programme groups is not followed by sanctions: expert assessments should be considered as recommendations.

Quality assessment of a study programme group takes place at least once every seven years based on the regulation approved by EKKA Quality Assessment Council for Higher Education [Quality Assessment of Study Programme Groups in the First and Second Cycles of Higher Education](#).

The aim of the assessment team was the evaluation of the Study Programme Group (SPG) of Physical Sciences in two higher education institutions: the University of Tartu and Tallinn University of Technology.

The team was asked to assess the conformity of the study programmes belonging to the study programme group and the instruction provided on the basis thereof to legislation and to national and international standards and/or recommendations, including the assessment of the level of the corresponding theoretical and practical instruction, the research and pedagogical qualification of the teaching staff and research staff, and the sufficiency of resources for the provision of instruction.

The following persons formed the assessment team:

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The assessment process was coordinated by Hillar Bauman (EKKA).

After the preparation phase, the work of the assessment team in Estonia started on Monday 2 May 2016, with an introduction to the Higher Education System as well as the assessment procedure by EKKA, the Estonian Quality Assurance Organization for Higher and Vocational Education. The members of the team agreed the overall questions and areas to discuss with each group at the two institutions that were subject to the assessment process. The distribution of tasks between the members of the assessment team was organized and the detailed schedule of the site visits agreed.

During the following days, meetings were held with the representatives of the University of Tartu (Tuesday 3 and Wednesday 4 May) and Tallinn University of Technology (Thursday 5 and Friday 6 May). In all cases, the schedule for discussion on site for each of the various study programmes only allowed for short time slots to be available for team members to exchange information and discuss conclusions and implications for further questions.

On Saturday 7 May, the team held an all-day meeting, during which the structure of the final report was agreed and the findings of team meetings were compiled into a first draft of the assessment report. This work was executed in a cooperative way and the members of the team intensively discussed their individual views on the relevant topics.

In the following two sections, the assessment team summarizes its general findings, conclusions and recommendations that are relevant across the whole SPG. In so doing, the team provides an external and objective perspective on the programmes and the contexts within which they are delivered. Ultimately, the intention is to provide constructive comment and critique which may form the basis upon which improvements in the quality of the programmes may be achieved. In formulating its recommendations, however, the assessment team has not evaluated the financial feasibility associated with their implementation.

## **General findings and recommendations**

### Opportunities and challenges in the physical sciences

The physical sciences underlie many aspects of modern life, and can be regarded as vital parts of the economic infrastructure of Estonia. Hence the programmes in this study programme group are important for producing graduates at all levels who can teach in high schools, work in technical enterprises including universities and government establishments, and undertake research that can support such enterprises. Such programmes are offered in Estonia only at the University of Tartu and Tallinn University of Technology, each of which provides programmes in the broad areas of chemistry, physics and earth sciences. Recruitment to most of these programmes has fallen markedly because of the reduction in the size of the age cohort entering higher education, although the team learned that this is now levelling off. Most of the programmes also suffer from high drop-out rates, for reasons that are not always under their control.

Failure of any of the programmes would seriously reduce the supply of skilled people into the economy, yet their continuation cannot be assured – indeed, the geo-ecology programme at the University of Tallinn closed recently

because student numbers had fallen too far. The team has therefore made recommendations in this report that are intended not only to help improve the quality of the programmes but also to enable them to survive and flourish.

#### Teaching in Estonian and in English

These programmes are needed to ensure the survival of higher education in their disciplines in the Estonian language, a responsibility felt especially strongly by the University of Tartu as the national university. In both universities the programme staff meet this responsibility by writing, adapting or translating university textbooks that enable them to offer BSc programmes in Estonian. The team sees this as a **strength** and as a major contribution, given that there is no significant commercial market for such books.

However, in order to function as professional scientists in these fields, graduates must also have a command of the *de facto* language of science, which is English. Students are already fluent in conversational English, but they need to become fluent in scientific English in their chosen field. The team **recommends** that this should be achieved by offering all MSc programmes entirely in English, a change that is already underway piecemeal. Students and employers would strongly welcome this. It would also facilitate outward mobility of students and inward mobility of international students and lecturers, as the EKKA standards expect.

#### Cooperation between universities

The team sees a need for cognate programmes at the University of Tartu and Tallinn University of Technology to cooperate actively to help each other survive while maintaining their distinct missions. There is already some collaboration in the physical sciences, but rivalry and competition are also evident. The team does not expect these to cease, but it **recommends** that the programmes should share their resources and design their curricula so that they overlap in core areas but not in the specialist pathways and electives they offer (which could also be made available to each other's students). At each institution, many of the programmes are going through a period of change, so now would be a good time to put such cooperation into practice. The team notes that there are already a few joint UT/TUT master's programmes in other disciplines.

#### Programme structures

Because of low student numbers, the programmes enjoy very favourable student:staff ratios. Facilities are generally good, staff are well-qualified and approachable, and students who met the team were generally articulate and happy. These are all positive factors for student and staff mobility.

Nevertheless, most of the programmes need to make themselves as attractive as possible in order to continue to recruit and retain students in competition with other programmes. In discussions with teaching staff the team found that senior staff were reluctant to change from traditional approaches in which programmes begin with fundamental topics such as mathematics that underpin their disciplines but are not appreciated as relevant by the students who join the programme. Senior staff mostly did not seem aware of newer student-centred approaches to teaching and learning, either, and were content for the later years of the curriculum simply to reflect the research

interests of the chairs and laboratories they lead, which do not necessarily lead to a well-balanced programme. The team therefore **recommends** that the programmes should be revised to give students a lively introduction to their chosen discipline from the start, after which the need for the underpinning topics may seem more obvious and palatable.

In both universities there are active moves to consolidate physical science programmes and related programmes into broad BSc programmes. The team welcomes these moves, which will make more efficient use of staff time while allowing students to defer specialization to the MSc level and so make a better-informed choice. The team believes that it is important for the new programmes to be designed as integrated wholes rather than as the sum of contributions from the contributing institutes and departments, and that to achieve this, programme managers will need have a more prominent role. Accordingly, the team **recommends** that programme managers should be given authority as programme directors to lead the curriculum and direct the operations of their programmes.

There are also examples of successful mergers of research institutes both in the universities and outside that have strengthened physical science degree programmes. The team believes that other such mergers are possible and **recommends** that they should be encouraged.

#### Quality of teaching

As far as enhancing the quality of teaching on the physical science programmes is concerned, both universities offer introductory courses in pedagogy. These are required for PhD students, who are in turn required to do some teaching. This is a **strength** in helping to produce the next generation of university teachers. However, the courses are optional for other teaching staff. Some do take the courses, but not all do, and this misses an opportunity to enhance teaching quality more widely. The team **recommends** that all staff who teach should be required to take the basic courses in pedagogy provided for PhD students.

It also seemed to the team that the basic courses, and the updating seminars that are available, have not provided teaching staff with a good grounding in areas such as strategic programme planning and curriculum design informed by the principles of constructive alignment in relation to intended learning outcomes – for example, staff planning one new programme were going to discuss the intended learning outcomes only *after* agreeing what to teach. The team also heard little about assessment. The team **recommends** that the new-style programme directors it proposes should be required to take courses in programme design.

In respect of staff development more generally, the team considered that there should be more mobility within Estonia and internationally, with more encouragement to take sabbatical leave.

#### Interaction with stakeholders

The programmes all seek feedback from students on their courses, with some degree of coercion. However, there appears to be no systematic feedback to students to show that prompt action has been taken in response to their feedback, a process that is known to improve response rates and the quality

of comments in other countries. There also appear to be no systematic surveys of programmes as a whole. The team **recommends** that students should routinely be given a response to their feedback on each course. The team also **recommends** that students should be surveyed each year on their experience of the programme as a whole, including how well their courses fit together and how well their academic and personal needs are supported.

Systematic contact with alumni and with employers appears to be weak. In the self-evaluations and in meetings with staff, the team was told that in a country as small as Estonia teaching staff remain in contact with alumni and basically know everyone in the field. This may well be true for alumni and employers engaged in research and development, often in the universities themselves. However, in discussion with students, alumni and employers, the team formed the view that staff tend to ignore students who follow less traditional career paths, especially BSc graduates, even when they are employed in a scientific or technical capacity. The team **recommends** that alumni and employers should be surveyed systematically on how well the programmes fit students for employment.

#### Contribution from research

All the programmes are associated with significant research activity, with which students are encouraged to engage from the first year of the BSc, before they undertake research as part of their BSc and MSc work. This is an undoubted **strength** of the programmes, but it does have some less positive consequences. The progression from BSc to MSc to PhD and quite often to an academic position is widely understood as the norm, so that the BSc is not always designed or considered as a fully rounded exit qualification suitable for those who leave for employment or for a different MSc programme at this stage (as the Bologna reforms envisage they may).

Researchers support the programme by providing this research training and in many cases by teaching courses, so that funding for research and researchers supports teaching. The team was told that the relative proportions of direct funding for teaching and indirect funding from research monies were not readily obtainable, with estimates ranging from 20% to 80% direct funding. There is no 'right' proportion, but teaching that is heavily dependent on research funding is vulnerable if that funding falls markedly, and whatever the proportion, it is hard to budget for teaching when the true costs are not known. The team **recommends** that accounting methods should be developed to show the true cost of teaching the BSc and MSc programmes and how far it depends on research funds.

Given that teaching is significantly dependent on research funding, then if cognate programmes are to collaborate as recommended earlier, they might want to support their teaching through some collaborative research grant applications for expensive but essential general-purpose equipment. However, the team was told that joint grant applications are not possible. If the team understands the situation correctly, then it believes that some solution to this problem needs to be found. The team therefore **recommends** that funding should be made available for general-purpose equipment needed for research and advanced teaching either by allowing joint research grant applications or by some targeted mechanism.

# 1. Assessment report of SPG at the University of Tartu

## 1.1. Introduction

Study programme group	<i>Physical Sciences</i>
Higher education institution	University of Tartu (UT)
Study programmes	Geography (BSc, MSc) Geology (BSc, MSc); Geology and Environmental Technology (BSc) Chemistry (BSc, MSc) Physics (BSc, MSc) Materials Science (BSc, MSc)

The University of Tartu (UT) was founded in 1632, and has developed as the national university of the Republic of Estonia, with a mission to advance science and culture, to provide the possibilities for the acquisition of higher education based on the development of science and technology in the fields of humanities, social, medical and natural sciences, and to provide public services based on teaching and research.

There are 11 study programmes (Chemistry BSc and MSc; Geography BSc and MSc; Geology BSc and MSc; Geology and Environmental Technology BSc; Materials Science BSc and MSc; Physics BSc and MSc) belonging to the group of Physical Sciences in the University of Tartu. They belong to the Faculty of Science and Technology, and the courses are delivered mainly by staff of the Institute of Ecology and Earth Sciences, the Institute of Chemistry and the Institute of Physics.

## 1.2. General findings and recommendations at the study programme group level

The University has a clear strategic view of the need to develop teaching and public engagement with the physical sciences, including students writing Wikipedia articles in Estonian about scientific topics. There is evident support for internationalization and for fostering good teaching by means that include awards for staff and research in teaching and learning.

Less positively, senior staff who met the team seemed to be rather inward-looking. They felt that UT had little to learn from outside and that traditional ways of organizing academic matters remained the best. This affected their

approach to teaching and their attitude towards changes resulting from the Bologna reforms.

Nevertheless, staff were committed to helping students to succeed. A particular **strength** of the programmes is the way in which senior students act as mentors to help induct students into the University and the programme; as tutors to help them academically in the first year; and as teaching assistants to supplement the instruction given by teaching staff. Students benefit from excellent sports facilities and some new and refurbished buildings, although they told the team that there is not enough general social space.

## 1.3. Strengths and areas for improvement of study programmes by assessment areas

### 1.3.1. Geography (BSc, MSc)

#### Study programme and study programme development

##### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

##### Comments

The well-established BSc and MSc programmes have been run by the Department of Geography within the Institute of Ecology and Earth Sciences since 2001. The Centre for Migration and the Laboratory for Geoinformatics contribute to teaching and joint research projects. The programmes compare very well with other similar programmes of high standard internationally and the structure and content of courses are well designed to support achievement of the stated objectives and learning outcomes, with a suitable balance between theory and practical training. The Department has good interactions with employers, who are very positive about the strong theoretical components of the programmes and about the balance struck between theory and practice, as are students who met the team; the Department takes account of employer feedback to revise individual courses and the programme as a whole. The BSc programme includes a field class in

Prague to run for the first time in the summer of 2016, and there is potential for more field work in human geography or joint human and physical geography. In the MSc curriculum there are four specializations, but Geoinformatics is by far the most popular. The teaching is generally research-led, drawing on the expertise of staff.

However, the self-evaluation report and discussions with staff identified potential overlap between courses that needs to be addressed in a systematic way. The BSc programme also needs to include more geographical content in the obligatory base generic courses in Economics, Chemistry and Mathematics, including examples of their relevance to geographical concepts and issues. Students would also benefit from an overview of what geography is about, with a focus on modern applications. All this could motivate and inspire students about the discipline and help reduce dropout. More geographical foundation teaching in the first year would also support courses taught in later years. Nevertheless, there is very good foundation teaching in key subjects.

In both programmes, some elective courses are taught in English with the help of visiting international staff. An MSc programme taught entirely in English could recruit international students and hence increase overall student numbers. Students are also interested in studying abroad through the Erasmus programme and exchange agreements with other universities. There is scope to increase uptake of Erasmus exchanges through better advertising and providing guidance for prospective students, possibly with the involvement of returning and incoming Erasmus students. It would be helpful to review courses offered abroad to identify courses that correspond with compulsory or core courses at UT, perhaps by one person acting as an Erasmus tutor.

The programme council meets twice a year and discusses a range of issues pertaining to the development of the programme, including student evaluations and feedback, employability and overlaps between courses. There is also an annual staff away day (with an overnight stay) where these issues are discussed in a more informal setting. However, formal involvement of employers and students in these meetings could enhance their value.

### Strengths

- Research-led teaching
- Very good foundation teaching in key subjects
- Links with employers and collaboration in the design and delivery of practical courses
- Visiting international staff who are involved in the design and teaching of elective courses in English
- A collegial atmosphere among teaching staff fostered by away days and informal meetings

### Areas of improvement and recommendations

- The Department should ensure that there is enough geographical foundation teaching in the first year to motivate students and to support courses taught in later years
- The Department should review the curriculum to eliminate any remaining overlaps between courses
- It is recommended to teach the MSc entirely in English
- The Department should encourage more students to take up Erasmus exchanges
- The Department should consider increasing the number of international field classes
- The Department should consider enhancing its away days and informal meetings by some involvement of students and employers

## Resources

### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).
- ✓ Resource development is sustainable.

### Comments

There are very well-designed labs and state-of-the-art equipment ranging over areas from computing to drones, photogrammetry and DNA testing, as well as software including all proprietary GIS and specialized packages. All teaching staff who met the team were very enthusiastic about the use of e-learning tools and new educational technologies, and there is extensive use of Moodle.

There seems to be a sufficient supply of textbooks and other teaching aids, including projection facilities and e-books. Access to international journal articles and books is very good. Mechanisms to ensure sufficient supply of textbooks and other teaching aids include an annual request for new books by the library to which the Department responds. In addition, teaching staff have been involved in the design and production of a Geography textbook in Estonian (which was shown to the team during the visit and seemed very well designed with many supportive illustrations in colour). This textbook included examples of student work with appropriate credit given to them.

Most of the equipment and resources seemed to have been acquired through research funding. The Department has an excellent track record of attracting external research funding, but equipment maintenance costs can be high and apparently have to be covered by the departmental budget. Longer-term planning would help to ensure that resource development is sustainable and that resources will be adequate in the event of changing circumstances. There is also potential to use the equipment through collaboration with industry and

sub-contracting to generate funding that could be used for maintenance and for student support. Having said that, the resources for staff and students seem to be very good. However, there are too few spaces for students to socialize and to undertake individual learning and group work. There are some spaces, but some of these are in great need of refurbishment.

### Strengths

- Excellent equipment available for teaching
- Very good access to international journal articles and books
- The textbook in Estonian developed in the department that includes examples of student work
- A proactive approach to ensure there are sufficient up-to-date textbooks and other teaching aids

### Areas of improvement and recommendations

- The Department should explore using its equipment in collaboration with industry to generate funding
- The Department should refurbish and possibly expand social and study spaces for students

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.
- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

The team's observation of a laboratory class and comments made in discussions with students and staff show that the process of teaching and learning in both programmes supports the students' individual and social development. There is a collegial atmosphere and overall all staff seem to be very approachable to the students. Modern teaching methods and tools are used in teaching, and there is strong support for the development of digital culture and enthusiasm amongst staff about the use of new educational technologies. Practical and theoretical studies seem to be well interconnected, for example through the extensive use of laboratories for teaching and the introduction of a new international field class. In addition, the very good

organization and content of practical training support achievement of the stated programme learning outcomes.

As expected, in the MSc programme there is more personal contact with academic staff via individual supervision and small group teaching, which enhances student motivation and the overall learning experience. Students who met the team reported that this is also happening to some extent in the BSc programme and confirmed that teaching staff are generally very approachable. Some of the employer representatives who met the team would like to see more teamwork and similar transferable and social skills training within the study programme.

Students report that the formative feedback given on their coursework and overall academic performance on the MSc programme overall is very detailed and helpful. On the BSc programme the detail of the feedback varies, but teaching staff are very approachable when there is a need for further discussion.

### Strengths

- A very good balance between theory and practice
- Flexible teaching processes and up-to-date methods

### Areas of improvement and recommendations

- The Department should reflect on comments from employers about teamwork and transferable skills
- The Department should consider how well its teaching and learning foster learning mobility

## **Teaching staff**

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

Overall, the staff are well-qualified. Most of them seem to have been undergraduate or postgraduate students in the department and therefore are familiar with the courses and teaching processes. A considerable number of the staff have a very strong research track record and they aim to conduct

research-led teaching as much as possible. The teaching staff are also in a very good position to offer thesis supervision that can lead to high quality and original student work. However, it appears that students do not always find it easy to obtain sufficient clear information on staff research interests and expertise. This makes it harder to develop thesis projects, choose supervisors, etc.

There also seem to be very impressive and useful links with employers and the industry that are used to provide work placement and internship opportunities to students as appropriate.

General student feedback on academic staff is very good. The Faculty polls students on the most valued teachers, and according to the 2015 poll the Department was represented among the top teachers, with a number selected for the 'Best Teacher' award. There also seem to be significant efforts to take on board student feedback about teaching and learning, both formal and informal, which shows that some lecturers obtain very low student evaluation scores and may need to update their material. It seems that this mostly applies to less experienced lecturers; this may therefore be expected and is countered by mentoring of more junior staff.

During the visit the team met international visiting Marie Curie and Fulbright scholars with an impressive profile who are involved in both research and teaching in the department, including co-convening courses in English. As noted in discussions with staff, students and employer representatives, there seems to be excellent collaboration between the Department and external partners. Employer representatives are also involved in teaching and supervision of student projects (with a strong practical component).

Suitable training is provided centrally for any interested staff who need to update or extend their knowledge of new educational technologies. Although this training is centrally administered it can also be tailored to departmental needs and it was apparent from our visit that this is strongly encouraged in the Department. However, it appears that there is not much take-up of University grants that support teacher training. More junior staff are mentored informally as already mentioned, while more senior staff are reviewed and mentored by the University Council. It was not clear that teaching performance plays any significant role in staff promotions, which sends the message that teaching is not important compared with research and so does not motivate good teaching.

The Department has good international exchange links with partners abroad, but the team formed the impression that this is not fully exploited. The same also applies to the use of sabbatical leave, which could be combined with spending time abroad.

### Strengths

- Plenty of academic staff with strong teaching and research track records
- Very good provision of practical experience
- Good collaboration with external partners

### Areas of improvement and recommendations

- The Department should provide more detailed information for students on staff research interests and expertise
- The Department should make more use of University grants to support teacher training
- The Department should mentor staff more formally, especially more junior staff
- Teaching quality should be recognized in staff promotion
- The Department should encourage more use of sabbatical leave

## Students

### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

### Comments

Throughout the visit the team met students who seemed to be very motivated and capable. They play an active role in curriculum development, especially via the programme council and discussions with staff. They are also involved in societies such as the European Geographers, and take an active part in conferences, summer schools and other departmental events. From the team's discussions with relevant people it seemed that alumni and employers are very pleased with the professional preparation and social competencies of graduates.

Geography suffers from high dropout, whether at the request of the student or by failure to graduate in time. In addition to financial difficulties, a key reason that was highlighted is that high school students lack knowledge about the discipline of Geography, so there is a need to manage their expectations better. Modifying the curriculum to convey more of the nature and attraction of modern geography has already been mentioned, but more engagement with high schools could help to ensure that students know what Geography is about at degree level. In their first year students are helped by senior students acting as mentors. The team asked employer representatives whether students who are sought by employers eventually abandon their studies to take employment, but overall employers strongly encourage students to complete their studies.

Some students are involved in the department's Erasmus exchange programme. All students who met the team seemed positive about the possibility of spending part of their studies abroad, but (as discussed earlier) there seems to be a need to make students more aware of the advantages of

international mobility and to co-ordinate selection of courses abroad better to ensure recognition of the credits and grades at UT. Some of the employer representatives said that they would welcome programmes taught in English that would attract international students who could then potentially stay and work in Estonia.

#### Strengths

- Overall high levels of satisfaction with the programmes and their graduates
- Very good cooperation with employers

#### Areas of improvement and recommendations

- The Department should engage with high schools to ensure that students are aware of what Geography is about at higher education level
- The Department should explore further ways of reducing dropout through more financial and academic support for students
- The Department should consider surveying employers more systematically to build on the existing strong cooperation
- The Department should develop more Erasmus opportunities, supported by programmes taught in English

### 1.3.2. Geology (BSc, MSc), Geology and Environmental Technology (BSc)

#### **Study programme and study programme development**

##### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

##### Comments

The new interdisciplinary Geology and Environmental Technology programme started less than a year ago in 2015–16, with input from employers from private and government enterprises and companies. The change was made because of a decline in the number of students in the two earlier BSc

programmes. Among students, the new programme has turned out to be popular, and 21 new students were accepted into the programme in 2015. Teachers estimate that only about three students have dropped out during the first year of operation, which is a positive sign for future years. Otherwise it is too early to assess the operation and the learning results of the new programme.

The self-evaluation report gives only rather general data from student feedback and evaluations, whereas more detailed statistics would be helpful. Student feedback on the programmes from 2011–14 indicated that they were satisfied with their education (but there were generally low numbers of responses).

The MSc programme in geology suffers from a low number of students, and only 5 new students started their studies in 2015–16. This small number is a serious threat for the future of the programme, and major efforts are required in order to recruit more students. The description of the programme in the self-evaluation report is much less detailed than for the BSc, with little indication of how it is constructed apart from a list of courses in the appendix. The structure and content of the programme seem to be largely comparable to other similar programmes in Europe, but MSc programmes are now normally taught in English, particularly in smaller countries.

Sustainable development seems to be largely absent from the programmes, and MSc students would like to have more variation in lecture topics. There is also no mention of any scheme for student internships with Estonian companies and agencies.

Given the excellent teaching environment and up-to-date laboratory facilities discussed later, the programme could easily attract international students: for example, in Sweden more than 50% of students at the master's level are international. However, to achieve this, the MSc courses need to be offered in English. In discussions with teachers, students and employers, this suggestion received wide support. The change could also have a positive impact on the recruitment of domestic students. The University website gives generally good information in English on the programmes in Geology and Environmental Technology, even though they are not currently offered in English.

The self-evaluation report makes no comments and reflections on how the BSc programme in Geology and Environmental technology and the MSc in Geology compare with the geology programmes at Tallinn University of Technology. However, some joint lecturing and use of the TUT field station are mentioned.

All study programmes have a programme council, which includes student and employer representatives. However, the council appears to be a relatively passive institution that meets only a couple of times per year. The structure and operation of the study programme could be made more coherent if the programme council had greater authority.

### Strengths

- The new BSc programme in Geology and Environmental Technology is a well justified, broadly-based offering in the spirit of the Bologna

agreement that gives Estonian students an integrated education in Geology or in Environmental Technology

- The MSc programme in Geology offers many possibilities for problem-based practical learning in laboratories and field courses, with active interaction between the teachers and students

#### Areas for improvement and recommendations

- It is recommended that the MSc programme should be offered in English
- The programme council should be given more authority to direct the structure and operations of the programme

### **Resources**

#### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).
- ✓ Resource development is sustainable.

#### Comments

The available facilities for lectures and laboratories are good and modern, offering an excellent foundation for teaching and research that is generally taken care of by laboratory technicians. Apparently the laboratories do not have separate teaching budgets, but teaching-related costs are generally paid for by a system that transfers running costs from the laboratories to external funding for research projects. This includes maintenance and repair of research equipment used for teaching. The team considers that budgeting would be less uncertain if the programmes were allocated budgets from which they paid the costs related to laboratory teaching; this might mean an explicit levy on research projects for infrastructure costs.

Study programmes and the departments are not responsible for costs related to the use of lecture rooms, which fall on the Institute of Geology. This may lead to poor planning and uneconomical use of lecture rooms.

There is easy access to the University's Natural History Museum collections and exhibits. The content of the geological collections is fully searchable on the internet and to a large extent it contains digitized images, which can be used by students and researchers.

The facilities benefit from active cooperation with the Institute of Chemistry. The instruments are mostly new, and they cover the general analytical needs in geoscience research and teaching. The level of instrumentation exceeds that in average European universities.

As already noted, there is some collaboration with the geology programmes at Tallinn University of Technology. More formal collaborations and interactions would make it easier to obtain funding for the more expensive common teaching and research equipment

The available geological databases in Estonia are already quite excellent and useful, but too little information is in English. If these were written in English (at least at the MSc level) and made available on-line, they would form a useful resource.

### Strengths

- Modern state-of-the-art and well-supported geological and geochemical laboratories
- Easy access to the UT Natural History Museum collections and exhibits

### Areas for improvement and recommendations

- Study programmes should be allocated budgets from which they pay the costs related to laboratory teaching
- More formal collaborations and interactions should be established with the programmes at TUT
- MSc theses should be written in English and made available on-line

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.
- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

The self-evaluation report says little about methods of teaching, learning and assessment. The Moodle system is used by some teaching staff. The quality of teaching is monitored through an electronic feedback system. In rare cases of very low quality teaching, the head of the Institute takes measures to replace the lecturer. For routine feedback, students seem to prefer direct contact.

On the MSc programme, the small number of MSc students leads to effective teaching in small groups. There is active interaction between the teachers and students that allows hands-on learning in the field and laboratories. However, students would like to have more variation in lecture topics.

As already noted, dropout was a serious issue during the operation of the previous Geology BSc programme. Teachers suggested two separate reasons: some students are disappointed because they have no previous knowledge of geology as a discipline, and others find the chemistry requirements beyond them. Dropout from the new BSc programme needs to be carefully monitored, especially the performance of the students in the chemistry courses. If problems appear, tutoring and other measures to support the students should be taken.

### Strengths

- Effective small-group teaching, with active interaction between teachers and students and hands-on learning in the field and laboratories

### Areas for improvement and recommendations

- Dropout from the new Geology BSc programme should be carefully monitored and prompt remedial action taken if necessary

## **Teaching staff**

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

The university budget supports 2.5 professors, who are in charge of the MSc programme in Geology and the geological part of the BSc programme. Teaching is also given by PhD students as a requirement of their programme. The teaching staff are well qualified and include some externally funded researchers, some of them with a significant teaching load. Overall, the programme has access to internationally renowned active and productive geology researchers.

The number of teachers supported by the budget is rather small to cover the wide field of earth sciences, especially at the MSc level. The shortage of teaching staff will become evident if the number of students grows from the current low values, especially on the MSc programme. One option to be considered would include stronger cooperation and profiling with the Tallinn University of Technology. Another possibility could be to collect stronger earth science teaching staff from earth science teachers in other departments of the

Institute of Ecology and Earth Sciences under a common earth science umbrella. Teachers from industry or government agencies would also increase the relevance of the teaching and improve contacts with the future employers of the students. Students and alumni would also prefer more international teachers.

The existing teachers appear dedicated and participate in pedagogical training courses. They apply new teaching techniques and use Moodle as a platform for teaching and course material.

### Strengths

- The staff are well-qualified, active, and interested in teaching

### Areas for improvement and recommendations

- The programme should increase the number of available teaching staff and range of expertise through (i) cooperation with the Institute of Ecology, (ii) cooperation with Tallinn University of Technology, (iii) appointing visiting teachers from industry or government agencies, and (iv) appointing international teachers

## **Students**

### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

### Comments

The students on the geology programmes are active and motivated, though they point out that financial support is mostly not sufficient to allow them to study full-time. They seem to have realistic views of their future working life. Most of the students and young alumni who met the team had clear scenarios of employment in consulting companies or in industry. Only one considered academic life as the principal option. The scientifically active teaching staff motivate students and give them personal guidance, particularly in the MSc-programme. The opportunity of face-to-face feedback in this small department is a clear advantage for students.

There is no detailed information on how many graduates from the Geology programmes get jobs within their specializations, but the newly created alumni network will improve this.

### Strengths

- The ready access to teaching staff

### Areas for improvement and recommendations

- A reliable understanding of the job market for graduates should be developed by systematically surveying alumni and employers
- Work placement opportunities for BSc and MSc students should be offered in relation to the Institute's externally funded research programmes

### 1.3.3. Chemistry (BSc, MSc)

#### Study programme and study programme development

##### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

##### Comments

The chemistry programme is among the three largest in the Physical Sciences, with robust bachelor's and master's programmes. The content and structure of the programmes are generally well aligned with their stated objectives and learning outcomes. They are traditionally designed, covering all the expected content areas (while omitting biochemistry), with many interesting electives and specialized courses to attract students at all levels.

Like all programmes at UT, the BSc and MSc chemistry programmes are run by a programme manager and overseen by a programme council consisting of eight to ten members, including two students and an employer. The programme council publicizes its deliberations through the department intranet, but does not formally report to the Institute Council (unless it needs approval for some significant change). Curricula in Estonia conform to the expectations of the European Higher Education Area as embodied in the National Qualifications Framework, and in particular are outcomes-based. At UT curricula are reviewed every three years based on information collected in a standard form by the programme manager. The chemistry curriculum has experienced only minor changes in the last three years. The Strategic Plan 2015 has been launched recently, so there has not been sufficient time to close the loop on the cycle of improvement.

However, in 2016 a new curriculum will bring the chemistry, physics and materials science programmes together in a joint first year, after which students will be able to specialize in one of the three disciplines. This will be more efficient for teaching given the rather small student numbers each programme has after recent declines in admissions, discussed below.

However, within chemistry (and similarly within physics), students comment that there are frequent overlaps between courses, which seem to have been assembled independently to reflect the research interests of the various chairs and laboratories rather than as a coherent set designed collegially to deliver the programme mission. Against this background, it was not clear to the team how well the three components will be integrated in the new joint curriculum. In discussions on the current chemistry programme it frequently seemed that not even the programme manager could answer the team's questions fully, while teaching staff answered only on their own behalf, rather than taking a broader view. The team therefore doubted whether the programme manager for the new joint programme will have sufficient oversight or authority in dealing with two different institutes when trying to optimize the new curriculum.

The BSc programme includes 42 credits of practical experience, including work experience in the form of internships that students mostly find for themselves, often outside the University but also in UT research groups. The programme also aims to prepare graduates to pursue the speciality of Teacher of Chemistry, but it was not clear to the team how the curriculum supports that aim.

The MSc has been revised recently by providing a stronger focus on entrepreneurship as part of professional practice, at students' request. Because the number of students has reduced, the number of elective courses has been reduced (and individual courses may in future be offered only in alternate years of the two-year programme) with the effect of ensuring that students acquire advanced knowledge across all areas of chemistry. This is intended to widen their possible fields of employment, but students who met the team wanted more electives so that they could specialize.

UT operates a formal system of seeking student feedback on their programmes. For students on the chemistry BSc programme the satisfaction has been consistently high (much better than physics and noticeably better than geography and materials science, but noticeably poorer than geology), and survey response rates have been increasing. The satisfaction has been correspondingly high on some of the constituent courses, but for some courses that scored comparatively less well, the reason has been explored and remedial measures have been introduced.

Feedback scores from students on the MSc programme overall have improved in recent years to exceed those for the BSc, but for the latest survey the number of respondents had fallen to only four. Some courses were well received, but others that needed attention have been revised, mostly yielding improved scores. The increase in practically-oriented material is a particular response to this feedback. MSc students take an obligatory course that requires them to receive training in some specialization outside their home laboratories and to report on it to a committee chaired by their thesis advisor.

Feedback from teaching staff is gathered through the programme council and in the Institute of Chemistry Council. Some feedback from employers is gathered, and has led to introducing professional practice into the curriculum. However, employers who met the team said that they had not been asked for their opinions.

### Strengths

- Oversight of the programme by a council including at least two students and an employer
- A focus on entrepreneurship in the MSc programme
- High levels of student satisfaction

### Areas of improvement and recommendations

- As indicated in the self-evaluation report, MSc students should be encouraged to complete surveys so that the response is more representative
- The programme manager for the new joint BSc programme should become director of the programme, with sufficient authority to optimize the new curriculum across the three areas

## **Resources**

### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).
- ✓ Resource development is sustainable.

### Comments

The Institute of Chemistry occupies a relatively new Chemicum building in a campus on the edge of the city. The Chemicum contains the chemistry library and a café that serves hot food, but students reported that it contains too little space for spending time informally between classes, given that they may spend all day on the campus, which is remote from the city centre. There are seating areas on each floor, but these are used by the research groups on those floors and do not facilitate interaction between groups. Lecture rooms are good and very well equipped, with the facility to perform lecture-demonstrations under safe conditions. The costs of the building fall on the Institute.

Practical laboratories are well-designed, but some equipment badly needs updating; safety is well catered for. The team formed the impression that synthesis laboratories were less well supported with even basic instrumentation than those in analytical chemistry in particular (a discipline in which the Institute houses an accredited testing centre). The development of practical skills depends strongly on students starting to develop an involvement in the research of one of the groups in the Institute, often starting as early as the first year of the BSc, although no formal association exists until students select their BSc thesis work. This model reflects the strong research base in the Institute, but the team formed the view that it does not guarantee students a sufficiently broad or consistent grounding in

practical chemistry to serve as a basis for further study or employment outside the Institute. This matter is discussed further below.

MSc students report problems with overcrowding in the research laboratories where they do their thesis work.

UT uses Moodle as its virtual learning environment, and makes study materials widely available through its Study Information System (SIS), which staff and students generally find satisfactory. Updating of computer resources is a continuing task, and teaching staff have been provided with training in the use of new multimedia teaching tools.

To remedy a lack of suitable teaching materials, some staff have written textbooks in Estonian, the usual language of instruction. Some staff have also produced Estonian-language materials based on standard foreign-language materials. Students report that textbooks are generally available and teaching staff report that up to now requests for new textbooks have been successful. Teaching materials written by staff are also made available online.

The Institute contributes significantly to the programmes in geology and in materials science.

### Strengths

- Very good lecture rooms
- Well-designed basic teaching laboratories

### Areas of improvement and recommendations

- More space should be provided for individual and group study and relaxation, as noted in the self-evaluation document and confirmed by students
- Equipment in laboratories should be updated urgently, as noted in the self-evaluation document, preferably as part of an internally-funded rolling programme of replacement that does not rely on successful research grant applications
- Teaching laboratories for synthetic chemistry should be given higher priority, with more instrumentation to provide hands-on experience with GC and IR in the introductory organic laboratories.

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.
- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

The self-evaluation report says rather little about teaching and learning, especially in relation to learning outcomes. The team learned that this reflected the general position across the University until recently, but that now a more systematic approach is being taken.

All PhD students are required to take courses in teaching and learning methods, and they do significant amounts of teaching, but in chemistry they do not normally lecture. Many such students become members of teaching staff, but it appears that although teaching staff recruited from elsewhere are offered the training, they are not required to take it. Similarly, updating on modern teaching and learning techniques is available, and some staff choose to take part. Some teaching staff are using more technology in their courses, shifting instruction towards problem-based learning, and offering hybrid courses that mix online and face-to-face learning, as students tend to expect. The team formed the impression that more senior members of teaching staff tended to adopt traditional methods of teaching, learning and assessment, without necessarily justifying their approaches convincingly in terms of the learning outcomes paradigm.

In relation to assessment, guidance is available on how marks should relate to the achievement of course learning outcomes, but the team found no widespread understanding among teaching staff of how to design assessment to test the level of achievement for each outcome. Students report that formative assessment during a course can take place weekly, once early in the course for diagnostic purposes, half-way through, or not at all, depending on the lecturer. Assessment with suitable feedback during the course would tell students how they are getting on and indicate how they can improve their performance.

Students are given a range of opportunities to learn and develop important softer skills, including academic writing, referencing, working in groups, and making presentations.

Ratings of teaching by the students in chemistry are among the best in the Physical Sciences, with few exceptions. The poorer ratings lead to remedial action, and students gave the team an example where the content of a course had been modified to suit to their needs better. The team was told that Faculty policy is that teachers who score less than 3 out of 5 on feedback must be asked to prepare an improvement plan; if the problem persists they must attend a suitable teaching course, and ultimately their contract may not be renewed.

### Strengths

- High student ratings for courses

### Areas of improvement and recommendations

- Systematic attention should be given to teaching and learning strategies in relation to the achievement of learning outcomes, which are largely ignored in the self-evaluation document

- All teaching staff should be required to take the teaching and learning programme given to PhD students, unless they have taken an equivalent certificated programme elsewhere
- Every course should include formative assessment, at least midway through, so that students can learn how to improve their performance in the final assessment for the course.

## Teaching staff

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

Three-quarters of chemistry teaching staff have a PhD, and only they may teach the obligatory courses for the MSc. Research is very strong and feeds directly into the programme through the electives offered and through the close association of students with a research group for their thesis work at each level. The University is starting to encourage teaching staff to undertake educational research. Visiting lecturers give some courses, and there have been some external co-supervisors. Doctoral students may be supervisors or co-supervisors of MSc students as well as providing instruction in laboratories or seminars. They do so under the supervision of their research supervisor.

Overall, the student rating of their lecturers is very positive for both the BSc and MSc programmes, the main criticism being out-of-date teaching materials and methods. Where lecturers are seen to be performing less well, steps are taken to improve matters, as already noted.

Other support for students is provided in their first year by senior students who act as mentors to help with induction and as tutors for small groups to help students to overcome difficulties with their courses. In later years there are teaching assistants who provide additional seminars and tutoring. There is also an academic affairs specialist who helps students navigate their way through the academic systems of the Institute, Faculty and University.

### Strengths

- The strong research culture that feeds in to the curriculum

- The supplemental support for students provided by mentors, tutors and teaching assistants

#### Areas of improvement and recommendations

- Teaching materials should be kept up to date

### **Students**

#### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

#### Comments

In the academic year 2015–16 the BSc programme admitted 35 students for a total of 87 students. These numbers have declined along with the general national decline in the age-group: in 2012–13 there were 135 undergraduates. Potential students are encouraged to study chemistry by various initiatives with schools. A mobile laboratory or 'science bus' visits schools for demonstrations by chemistry students; school students come into the UT chemistry laboratories; and chemistry staff visit schools to help students prepare for chemistry Olympiads.

In 2015–16 the MSc programme admitted 22 students for a total of 42 students. The total has held up well over recent years despite the fall in graduate numbers, perhaps assisted by more publicity for graduate studies at UT.

The prior level of knowledge among entrants varies quite widely, depending on which high school they attended. Poorly prepared or poorly motivated students struggle to get through the first year, and often decide that the subject is not suitable for them if they cannot cope with the compulsory pre-requisite courses, despite help from teaching staff for them in groups and individually. A more specific problem occurs with students who enter the chemistry programme having failed to secure a place on a medicine programme and continue trying for a place in medicine the next year: if they succeed, they leave the chemistry programme. Thus dropout from the BSc programme is substantial and has been increasing, from 26 in 2011–12 and 22 in 2012–13 to 38 in 2013–14. As long as medicine remains so popular, this problem cannot readily be solved within chemistry, but it could be alleviated if medicine gave preference to first-time applicants in its admissions.

Another issue concerns the large number of students who fail to graduate in the minimum or 'nominal' time, often because they do not finish writing up their graduate thesis in time, or for a variety of personal reasons including financial pressures. In recent years the number who graduate one year late has been greater than those graduating on time. Efforts to counter this have

included emphasizing to students the need to find a supervisor and thesis topic as soon as possible.

Among MSc students, dropout has increased from one to four and five per year. Such small numbers are subject to large variations through individual circumstances (often financial problems), but need to be monitored carefully so that students can be supported as far as possible. The number of MSc students who graduate one year late has been about the same as those graduating on time.

During the three academic years 2011–12 to 2013–14, no chemistry undergraduates undertook any study elsewhere in Estonia, three studied abroad, and there was one international student. Inward mobility into countries with a small language community is always difficult unless students can take courses in a major language; some universities offer courses specifically to attract such students. Similarly, outward mobility usually requires the students to have some non-native language competence.

From 2016–17 all UT master's programmes must include some courses in English and the University intends to move towards providing international master's programmes. In recent years one or two MSc chemistry students have studied abroad, but none elsewhere in Estonia, and there have been no international students.

The team learned that providing courses in English is a sensitive issue, because as the national university UT is expected to be seen as supporting the national language. This is entirely reasonable. However, in the view of the team, support for the language is amply demonstrated by the efforts of teaching staff to provide university chemistry textbooks in Estonian for which there is no real commercial market.

Nevertheless, the national standards for study programmes expect qualified foreign and visiting teaching staff and practitioners to participate in teaching within study programmes, and expect students to study as foreign or visiting students at other Estonian and/or foreign higher education institutions as part of their studies. These cannot realistically be achieved solely in the medium of Estonian. Offering more courses in English would increase the inward mobility of teaching staff and outward mobility of students. It could also increase the inward mobility of international students, which would help to offset the reduction in enrolment of Estonian students. In any case, the *de facto* international language of chemistry is English.

Students who met the team spoke excellent English, as did the staff, so there is no practical obstacle to delivering courses in English. Students in particular would welcome being taught in English and noted that this would also have the benefit of making it easier to have international lecturers on the programme. In the view of the team, it would be a reasonable compromise between the need for chemistry to be taught in Estonian and the need for chemistry to be taught in its international language if teaching on the BSc programme remained entirely in Estonian and teaching on the MSc programme moved entirely to English. This would also facilitate the recruitment of international students.

Employment of graduates and postgraduates is not surveyed systematically, though it is argued that in a small country much is known informally. An

alumni network is being formed that may provide more systematic information. Most graduates progress from BSc to a master's programme and from MSc to PhD, often at UT. Students and staff who met the team confirmed that their intentions for the programme were that it should provide this progression, and ideally further progression from PhD to staff member. There appeared to be little thought for students who graduate and follow a different career path, for whom it was said there is little demand and few job opportunities, though employers indicated to the team that they are not always able to find Estonians trained in the chemistry specialization needed in their industry.

Employers are not surveyed systematically either (which is admittedly difficult), but anecdotal evidence from government agencies indicates broad satisfaction with the knowledge and skills of graduates. Graduates are broadly satisfied with the preparation that their programme provides, but would have welcomed more opportunities to acquire work experience. Employers who met the team said they had not been asked for their views. Between them they employed a significant number of BSc, MSc and PhD graduates, and were realistic about what they might reasonably expect from them at the different levels. However, they would welcome graduates with a broader grounding in the main practical skills. Two referred to problems in recruiting graduates with skills in synthetic organic chemistry, and one of them had eventually recruited PhD graduates from outside Estonia.

In the view of the team, the Institute of Chemistry needs a more reliable view of the job market for its graduates, at all levels, so that it can better meet the national needs for skilled chemists as one might expect of the national university. This may mean offering teaching and training that is not so strongly tied to the research interests of its senior staff, organic synthesis being a case where evidently supply does not meet demand.

#### Strengths

- The active engagement of the department and its students with schools to foster interest in chemistry

#### Areas of improvement and recommendations

- The high drop-out rate from the BSc programme should be counteracted by early detection through better monitoring and more personalized support for students who experience problems
- It is recommended that the MSc programme in Chemistry should move towards being taught entirely in English
- A reliable understanding of the job market for chemistry graduates at all levels should be developed by systematically surveying alumni to follow their employment history, and employers to learn their experience of hiring alumni
- The Institute of Chemistry should review how well its programmes provide the skilled chemists the country needs outside higher education

### 1.3.4. Physics (BSc, MSc), Materials Science (BSc, MSc)

#### Study programme and study programme development

##### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

##### Comments

The Physics and Materials Science programmes are both run by the Institute of Physics (IP): the Physics programme involves five of the departments in the IP (though the work is carried out in 13 specialized laboratories), and the Materials Science programme has two professors. Enrolments are low and dropouts are high, such that only about a third of the students continue their study towards the MSc programme. The low numbers are a concern, since qualified physicists are much needed in Estonia, as employers told the team. The self-assessment report did not mention the physics-based programme at Tallinn University of Technology, although staff said there are a few common courses, for which students do not move. However, it seemed to the team that more coordination between the programmes in the two universities is important to make best use of resources while ensuring that between them the programmes offer a wide coverage of physics. It would be valuable for more students to transfer between the two universities after their BSc as the Bologna process envisages.

The Physics programme is quite traditional and needs to include more modern aspects of physics. More computer programming and computational sciences would better reflect the needs of employers. The Materials Science programme has many chemistry courses and would benefit from including more courses in basic materials science as distinct from physics or chemistry. Students may transfer between the two programmes if they gain suitable extra credit points, and students commented that mobility within UT is very good. The BSc and MSc programmes are taught in Estonian; this is understandable at the BSc level, but in order to make the MSc programmes more attractive to students, especially foreign students, they need to be taught entirely in English as the working language of physics internationally.

As mentioned above under Chemistry, a new joint BSc programme is being introduced that combines chemistry, physics and materials science. This is intended to help to increase the number of students admitted and to decrease the number of dropouts. However, staff who met the team said they feel that

this programme has been imposed on them from above in UT. The team considers that the staff need to be more actively engaged in constructing and integrating the programme as a whole rather than just adding different courses together. This is especially important given that students already complain about a lack of coordination between courses and some overlap between courses, which staff said at MSc level mostly reflect the lecturer's specialization. Students also commented that there have been frequent changes of programme manager.

#### Areas of improvement and recommendations

- The Physics programme should include more modern aspects of physics, computer programming and computational sciences, and these should continue in the physics component of the new joint BSc programme
- The Materials Science programme should include more courses in basic materials science and these should continue in the materials science component of the new joint BSc programme
- The new joint BSc programme should be constructed as an integrated whole with the active engagement of the teaching staff
- It is recommended that the MSc programmes should be taught entirely in English
- The Institute of Physics should explore more ways of coordinating the programmes with the engineering physics programme at Tallinn University of Technology

### **Resources**

#### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).
- ✓ Resource development is sustainable.

#### Comments

The IP has a pleasant and efficient modern building and teaching facilities. The laboratories are well equipped with modern instrumentation. The maintenance and operation costs of the various instruments are not insignificant and these costs are paid from the research budget. This may limit the students' access to the instruments so that they do not get enough hands-on experience of using the different instruments. Allocating an additional budget for the students' use of instruments would ensure adequate training on this equipment.

The programme has e-learning support which seems to be frequently used by the students.

### Strengths

- The excellent teaching and learning environment

### Areas of improvement and recommendations

- Additional funds should be allocated to ensure that students receive adequate hands-on training on the various instruments

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.
- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

Approaches to teaching and learning are mostly conventional, and where e-learning is used, it does not usually require active engagement by the students. Instead, students referred to some lecturers teaching by what they called 'PowerPoint karaoke'. Modern approaches to teaching and learning were hardly mentioned in the self-evaluation report or by teaching staff, and nor was assessment, which is particularly important in the learning outcomes approach. The use of formative feedback is very variable, though staff say they are readily approachable by students who have problems.

There is rather little opportunity for students to work and learn in groups and teams or to develop skills in making presentations, all valued by employers, though students said some lecturers were 'brilliant' with group work and discussions. Students also reported that some poor lecturers had been replaced. The team considered that the lack of emphasis on generic soft skills reflects a curriculum seen primarily as a set of largely independent courses, with not even the programme manager having a broad overview of the programme as a whole that could inform a more coherent approach.

### Strengths

- Some approachable and inspiring teaching staff

### Areas of improvement and recommendations

- The programmes should introduce more modern approaches to curriculum design, teaching, learning and assessment

- Every course should include formative assessment, at least midway through, so that students can learn how to improve their performance in the final assessment for the course.
- The programmes should provide more opportunities for students to learn and practise soft skills such as working in groups and developing presentation skills

## Teaching staff

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

The IP benefits from highly competent and motivated staff, who are all active in research. The various departments have extensive cooperation with several international groups and several collaborations with industry. Because student numbers are so low, the student:staff ratio is notably low, and offers excellent opportunities for the students to interact closely with the staff. However, students indicate that these opportunities are not always put to best use.

In order to counter the high dropout rate in the first year, the IP offers study-support services, and tutoring by senior students (as in chemistry). However, it appears that training in pedagogy is compulsory only for PhD students who teach as a requirement of their programme. Other teaching staff are not required to take the course, though some may do, and students indicate that some teaching staff lack skills in modern approaches to teaching. The high proportion of staff who are graduates of UT limits their experience of other approaches to teaching and learning. This would be enhanced by more interchange with Tallinn University of Technology, as already mentioned, and by more international mobility, especially of younger staff.

International lecturers contribute to the programmes occasionally. Students welcome this and would welcome more participation by international students.

### Strengths

- Qualified research-active staff with wide international and several industrial collaborations

### Areas of improvement and recommendations

- Teaching skills should be increased by requiring all teaching staff to undertake training in pedagogy
- The mobility of staff members should be increased in Estonia and internationally

## Students

### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

### Comments

The programmes suffer from a low intake of students and a high rate of dropout, often to IT. The Physics programme has had a lower degree of student satisfaction than the Materials Science programme, and compares poorly with other programmes in the Faculty, so there is much room for improvement. It was generally not clear to the team or to students who met the team what changes were being made in response to the feedback so that satisfaction rates improve. Students who met the team reported that they had organized a physics society to get changes made such as providing more teaching aids, and that some response was noticeable.

As already noted, the Physics programme benefits from a very low student:staff ratio that is not always best used to benefit students. Although the Materials Science programme has fewer teachers, they have better interactions with the students.

Teaching staff said physics students acquired problem-solving skills relevant to employment. The BSc programme was not designed to develop these skills, but in the MSc programmes there are elements that develop soft skills such as making presentations. Less than half of BSc physics graduates go on to do the MSc, so they evidently get jobs, but the staff said this was 'a mystery' to them as there is no physics industry in Estonia. However, employers told the team that some large international physics-based companies do have production plants in Estonia, just no R&D activity. Employers who met the team also reported that they do recruit BSc graduates, who often continue on an MSc programme while working. In materials science, more students go directly from BSc to MSc.

Overall, the team formed the impression that the Institute of Physics does not focus on preparing students for careers outside academic life, and so is not clear about its overall teaching mission, especially for the BSc. Teaching staff told the team that the system of a three-year BSc followed by a two-year MSc was 'problematic'. Under the Bologna process, the BSc is intended as an exit qualification for employment as well as an entry qualification to an MSc, not

necessarily at the same university. Indeed, many of the students who met the team had career intentions outside university life.

Strengths

- Commitment of students to enhancement through tutoring and forming a physics society

Areas of improvement and recommendations

- Interaction between staff and students should be increased
- More effective action should be taken in response to poor feedback from students and should be reported back to them
- The Institute of Physics should systematically gather information about the destinations of its BSc graduates, and should consider how well the curriculum prepares these graduates for employment.

## 2. Assessment report of SPG at Tallinn University of Technology

### 2.1. Introduction

Study programme group	<i>Physical Sciences</i>
Higher education institution	Tallinn University of Technology (TUT)
Study programmes	Earth Science and Geotechnology (BSc, MSc) Engineering Physics (BSc, MSc) Applied Chemistry and Biotechnology (BSc, MSc)

In Estonian society TUT is recognized as an internationally high-ranked research university, providing quality research-based education, accountable for the new generation of engineers, for the spirit and quality of engineering culture in Estonia, and for promoting sustainable development of society and growth of national welfare by innovative services.

To realize its role, TUT provides opportunities for acquisition of higher education in line with developments of science and technology in all cycles in the areas of natural and exact sciences, engineering, manufacturing and technology, social sciences and in related areas.

The history of TUT dates back to 17 September 1918 when the Estonian Engineering Society opened an engineering school called Special Engineering Courses. Qualification as a university was granted to Tallinn University of Technology in 1936.

The Physical Sciences study programme group is situated under the Faculty of Science.

### 2.2. General findings and recommendations at study programme group level

The University has a clear strategic approach towards the physical sciences. Faculties and programmes are being merged and consolidated, as detailed later in this report, and student numbers will be grown through recruiting more international students. As a technological university, TUT recognizes a mission to offer programmes in applied physical sciences that complement the more fundamental and theoretical programmes offered at the University of Tartu; the University of Tallinn now offers no programmes in this study

programme group. The programmes operate in excellent buildings that have been developed over the last 10–15 years.

A special feature that is a **strength** of TUT is the MEKTORY, a building imaginatively designed to help to develop and support entrepreneurial thinking among staff and students, and the public. It is becoming well known since it opened three years ago, but some students who met the team were not aware of it, even though they were interested in developing their own ideas. The team **recommends** that TUT should publicize the MEKTORY better among physical science students.

TUT also has a Careers Centre that acts as an intermediary for internship offers and communication between the faculties, students and enterprises, and the Estonian Student and Employer Information Portal is accessible free of charge for all users. However, students who met the team said the Centre was helpful only for general commercial employment, while employers said they were more likely to approach relevant academic staff for names of potential recruits, who are then more likely to be those known to be more active in research. The team concluded that the needs of students seeking employment outside research and development (especially those on the BSc programmes) were not being well met, and neither were the needs of smaller employers. It **recommends** that the Careers Centre should be more proactive in matching the employment needs of all students in the physical sciences with those of small as well as large employers.

At present, councils draw their membership from a narrow base. The team **recommends** that all councils should have at least two student representatives.

## 2.3. Strengths and areas for improvement of study programmes by assessment areas

### 2.3.1. Earth Science and Geotechnology (BSc, MSc)

#### Study programme and study programme development

##### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

### Comments

The BSc and MSc in Earth Science and Geotechnology are new study programmes, launched as recently as in September 2015, that combine Oceanography and Meteorology, Geology, and Geotechnology. The programmes are strongly applied and represent good steps in the right direction, but their real performance can only be realistically evaluated at a later date. However, based on admission statistics, the BSc programme suffers from a serious lack of students, and the number of dropouts from the previous programmes is rather high.

The announced merger of the Institute of Geology and the Department of Mining at TUT will have a major impact on the further development of the programme. In particular, it can be expected to improve the programme by increasing the proportion of applied courses, which it may be hoped will increase student numbers and make the graduates more attractive to the employers. The planned merger could lead to more field activities and increased teaching of engineering skills, which students would welcome.

The team found that, generally speaking, teaching at both BSc and MSc level is more practical and applied in approach than in the cognate programmes at the University of Tartu. The self-evaluation report would have been more valuable for TUT as well as for the team if it had contained some comments and reflections on how the TUT programmes compare with those at UT (like other programmes), but the geology programmes at UT are not mentioned even once in the text.

The present programme leads to strong specialization from the beginning of the BSc studies. However, once students have chosen their specialization, they are not able to change their chosen line of study later for their MSc studies, whereas mobility between BSc and MSc programmes is one of the objectives of the Bologna reforms. A broader curriculum at the bachelor level would be a way to increase the number of students able to switch specialization at MSc level.

From the team's meetings with students and employers it seems that courses in applied geology should be expanded, in particular concerning local raw materials exploration and mining companies. There is one course on environmental protection and sustainable development, but sustainability could be a natural part of more courses. Although cooperation with the industry partners and future employers already exists, this important aspect could usefully be further emphasized and clarified. The programme with internships for students with various Estonian companies and agencies is a step in the right direction.

Both programmes are basically taught in Estonian, the BSc entirely and the MSc almost entirely. While it is important to retain the capacity to teach these subjects in Estonian at BSc level, teaching the MSc in English would undoubtedly increase the number of students and produce a more international teaching environment. Those who met the team at all levels generally supported this, and we understand that it will be effectuated as soon as possible. There would also be value in exploring joint MSc programmes with other universities in order to increase the number of international students coming to Estonia and the number of Estonian students going abroad

for part of their MSc studies. Even before establishing the MSc taught in English, it would be good to have information about it in English on the TUT website.

The financing for the teaching activities on the programmes is very unclear, such that it is presently not possible to get information on the teaching budget per course or per teacher. Research in Estonia is presently largely project-based, and individual researchers (as well as the laboratories) are generally supported by personal research grants, while the notional income from teaching the BSc and MSc programmes is at best unclear. It seems that in effect personal research grants largely finance the teaching and laboratory activities. It is difficult to see how this situation is sustainable in the longer term unless the funding for the teaching activities is clarified to produce separate teaching and research budgets that can operate down to the level of courses, teachers, and laboratory usage levels.

The team found the administration of the programmes unclear. It is possible that having one person in charge for the BSc programme and another for the MSc programme could make the administration clearer and more effective.

### Strengths

- BSc and MSc programmes that provide applied and integrated geotechnological teaching across geology, oceanography and meteorology, combining the teaching power of separate institutes into a single programme
- Generally good contacts and interactions at all levels with employers, who appear to be generally satisfied with the graduates

### Areas for improvement and recommendations

- The BSc curriculum should be broadened so that more students can change specialization at MSc level
- More courses should cover aspects of sustainability
- It is recommended that the MSc programme should be taught entirely in English, and the possibility of joint MSc programmes with other universities should be investigated
- The funding for the teaching activities within the programmes should be clarified by separating teaching and research budgets
- Responsibility for the administration of the programmes should be clarified, perhaps by having different persons in charge for the BSc and MSc programmes

## **Resources**

### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).

✓ Resource development is sustainable.

### Comments

The study programme has at its disposal all the resources of the research institutes, while the available facilities on TUT campus for lectures and labs are good and modern, including state-of-the-art geological and geochemical laboratories. The newly renovated field station and research vessel are unique and very important facilities and the field station is used jointly also by the University of Tartu, which could be a starting point for more extensive collaboration. Such collaboration could lead to more effective use of the limited resources available and could make it easier to obtain joint funding for more expensive common teaching and research equipment. However, academic staff told the team that researchers at UT and TUT may not apply for joint research projects, although TUT says that while there are no official restrictions, sometimes it is hard to reach common understanding. Whether this restriction is real or perceived, the team believes that it should be removed or circumvented.

TUT also has the largest geological collection in Estonia, which it is obviously a unique and essential resource for both teaching and research. The content of the geological collections is fully searchable on the internet and it also to a large extent contains digitized images, which can be used by students and researchers. The available databases are excellent, but are not completely in English. TUT also houses the Laboratory of Marine Ecology of The Marine Systems Institute. However, the running costs for these resources are largely financed by individual research grants, as already noted. This could present future problems if the flow of research grants is interrupted in any area that is key for teaching.

### Strengths

- Excellent laboratory and fieldwork facilities, and access to the largest geological collection in Estonia

### Areas of improvement and recommendations

- Where possible, attempts should be made to establish more collaborations and interactions with the cognate programmes at the University of Tartu, in order to make more effective use of the limited resources available
- Any real or perceived restriction on joint applications for research funding between TUT and UT should be removed or circumvented
- The amount of information in English in the available geological databases should be increased

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.

- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

The self-evaluation report says rather little about teaching, learning and assessment. University policy on pedagogic training makes it voluntary for teaching staff to attend formal pedagogic courses, but it is obligatory for PhD students, who must teach as part of their programme. It appears that excellence in teaching has little influence on promotion, and there is no programme to recognize staff excellence in teaching.

The Study Information System (SIS) and Moodle resources appear to be helpful for students to organize their studies and for the University to help students with their progress. Although the internship programme is important in helping students to develop practical skills, it was not clear how students are trained in writing and presenting.

It is important for the future development of the programme to evaluate the feedback collected from students and employers. Hitherto, student feedback has to a large extent been received orally, but to get reliable and useful feedback, it should be collected confidentially and anonymously. This has started in the current academic year, with students required to give feedback on at least four courses in each semester; anonymity of the respondents is ensured, and the results are presented in aggregate form only. A survey in 2014 indicated that the students were generally satisfied with their education and this also became clear when the team met students. However, students would like more international lecturers and more e-learning.

### Strengths

- Study Information System and Moodle resources that are actively used and appreciated at all levels

### Areas of improvement and recommendations

- Formal pedagogic training should be obligatory for all teaching staff, both new and already established

## **Teaching staff**

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.

- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

The programmes benefit from competent and active teaching staff including professors, lecturers and PhD students. The Earth Science teaching staff are generally internationally renowned active and productive researchers with a high production of scientific papers and strong involvement in international projects. However, the self-evaluation report notes that certain teachers have an unfairly high teaching load. There are also few teachers from industry, who would increase contacts with the future employers of students, and few internationally recruited staff, whether on continuing contracts or as visitors.

### Strengths

- A good mix of professors, lecturers and PhD students involved in teaching
- Teaching staff who are generally internationally renowned active and productive researchers

### Areas of improvement and recommendations

- More teaching staff should be recruited internationally and as adjunct teachers from industry
- The excessive teaching load on certain teachers should be addressed

## **Students**

### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

### Comments

Too few students apply to the BSc programme and dropouts are common. Students are generally admitted based on their final exam grades at secondary schools. Selection of students is one way to avoid dropouts, and perhaps the weight of mathematics could be increased to get more mathematically oriented students. More active student counselling could also reduce dropout. The team also felt that the existing system of student scholarships and government loans fails to give students a sufficiently high

and stable income, so that they must take jobs and are then more likely to drop out.

The students are generally satisfied with their education; they welcome the practical training and would like more. They also quickly become involved in research projects. They report that they can easily and informally contact staff, who readily offer advice.

It is too early to evaluate the success of the new BSc and MSc programmes, but the self-evaluation report notes that the numbers are very low, particularly on the BSc programme. A broader BSc curriculum as proposed earlier could be easier to market and could possibly attract more students. Teaching the MSc programme in English as also proposed earlier could help to increase numbers, but marketing would require more information to be provided in English.

Although there is no detailed information on how many of the graduates from the previous programmes have secured jobs within their specializations, employers, staff and students who met the team gave the impression that most graduates have been able to find employment.

#### Strengths

- Scientifically active teaching staff who are readily approachable and can motivate and give personal guidance to students, particularly in the MSc-programme
- Students who readily get involved in research projects

#### Areas of improvement and recommendations

- To reduce dropouts, attention should be given to the recruitment and selection of students and to more active counselling for students on the programmes

## 2.3.2. Engineering Physics (BSc, MSc)

### **Study programme and study programme development**

#### Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market and feasibility analyses), and professional standards; and the best quality is being sought.
- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

#### Comments

The Engineering Physics programme started in 1991, and has gone through various versions that at different times have involved specializations in applied mathematics, applied mechanics, applied physics, medical physics and earth sciences. In the current BSc programme there are specializations in applied mathematics, applied mechanics and applied physics. Since there is no BSc programme in medical physics but many BSc students go on to take the separate MSc in Biomedical Engineering and Medical Physics in the Institute of Biomedical Engineering, some topics in medical physics remain in the Engineering Physics curriculum. The MSc curriculum comprises only engineering physics, though students may elect to take more mathematics, more physics or more mechanics as special studies and correspondingly write their theses in their chosen field.

The study programmes follow the general lines of similar programmes in other countries. The BSc programme offers a basic education in physics in a classical way that gives students a solid foundation of physics. The main difference is that the programme has a general studies module, obligatory in Estonia, which in addition to foreign languages has courses in informatics, environmental protection, law, philosophy, economics, and ergonomics. Students found some of these boring.

However, the mission of the programme is not exactly clear. It seems that the objective is to offer a broadly based educational programme in applied mathematics and physics relevant to engineering-related fields. However, the team was told that the title Engineering Physics is not well understood by applicants but was adopted because of a wish to differentiate itself from the more theoretical programmes at the University of Tartu. A prevailing remnant of history seems to limit collaboration between TUT and the University of Tartu, the only two universities in Estonia that provide physical science programmes. National coordination and collaboration between the two universities is urgently needed to meet the national demand for graduates, and to facilitate student mobility and study paths between the two universities.

The programme has a somewhat interdisciplinary nature, and since the Department of Physics is very small, most of the teachers on the Engineering Physics programme are part time, being primarily associated with other departments. In the opinion of the team this dilutes the focus of the programme.

Because the Engineering Physics BSc suffers from low admissions and high dropout at different stages of the programme, there is a shortage of students. Academic staff who met the team blamed poor preparation in schools and the poor attitude of many students, but did not appear to consider that the programme might also be insufficiently student-centred in content or teaching methods. The present introductory laboratory work is very traditional and needs to be replaced by more appealing experiments and modern instrumentation. The curriculum would benefit by introducing more technology-related topics such as magnetism, spintronics, acoustics and modern optics. Students and employers who met the team said there was a great need to introduce computer programming and computational methods into the programme, the current informatics courses being insufficient.

To counter the low student numbers, a revised BSc programme is being launched, without formal specializations but with possibilities for students to choose more mathematics, more physics or more mechanics. This should be helpful in increasing the number of students with a more serious interest in physics, but needs to be supported by the modernization just described. The appeal of the programme could also be increased by changing the title to 'engineering science' or 'applied physics' to represent its scope better. The programme produces graduates who are useful in many areas of science, engineering, industry and public services, and it would be good to increase the supply.

Both the BSc and the MSc are taught in Estonian. Students and employers who met the team would welcome teaching the MSc entirely in English, which would provide students with the necessary transition to the use of English for technology, and could increase student recruitment from overseas. It would also facilitate inward and outward mobility among students and academic staff.

The Head of Curricula and the Study Council of the Faculty carry out regular supervision of the study programmes. Information about possible problems and necessary improvements is obtained from feedback from students and lecturers. In addition to such feedback, general feedback from students on their study programmes is organized every semester by the TUT Office of Academic Affairs.

#### Strengths

- Graduates who are useful in many areas of science, engineering, industry and public services

#### Areas of improvement and recommendations

- The programme should include more modern technology-related topics
- The programme should include computer programming and computational methods
- The laboratory classes should introduce more appealing experiments using modern instrumentation
- The Department should consider changing the title of the programme to represent its scope better
- The planned new BSc programme should be designed as a broad-based offering in modern mathematical, computational and physical subjects
- It is recommended that the MSc programme should be taught entirely in English

### **Resources**

#### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student

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| numbers, etc.).<br>✓ Resource development is sustainable. |
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### Comments

TUT has a standard budget structure for revenues and expenditures. The Department receives about 80% of its budget from teaching activities.

The Institute is hosted in a fine building with a pleasant ambience. However, the student laboratories that the team saw need more modern instrumentation. In addition, the laboratories could be better coupled to the existing research facilities, for example in such areas as semiconductors and solar-cell materials.

TUT provides the infrastructure for teaching and learning (classrooms, ICT, and learning materials). The Library orders textbooks and other material according to requests from the Department. Teaching materials such as slides, lecture notes, and laboratory instructions are available for students on the internet through departmental homepages. Lecture notes and materials prepared by lecturers partly compensate for a shortage of expensive textbooks and other learning materials. The infrastructure is in general good and valued by the students, and overall, the resources support the achievement of the objectives of the study programmes.

### Strengths

- The Institute building that provides a pleasant environment for working and studying

### Areas of improvement and recommendations

- New student laboratory exercises should be developed with modern instrumentation and new experiments

## **Teaching and learning**

### Standards

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| <ul style="list-style-type: none"><li>✓ The process of teaching and learning supports learners' individual and social development.</li><li>✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.</li><li>✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.</li><li>✓ Practical and theoretical studies are interconnected.</li><li>✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.</li><li>✓ The process of teaching and learning supports learning mobility.</li><li>✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.</li></ul> |
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### Comments

The Departments regularly discuss teaching issues at their meetings. The issues include concerns of students regarding the organization of studies, supervision of theses, possibilities to participate in seminars, in working groups and research projects, and reports of research projects of the Departments. Nevertheless, the team formed the impression that teaching and learning methodology is not much discussed. The lack of a student-centred approach has already been noted, and active e-learning did not seem to be common. There appears to be rather little learning in small groups, student seminars and problem-solving classes, and other approaches such as the flipped classroom seem to be absent. There do not appear to be systematic measures to identify and support students who are experiencing difficulties with their studies, even though this should help to decrease the high dropout rate.

The Department has a person responsible for organising all study processes and administration. Possible academic fraud is an important issue, especially in writing the final thesis. During the first seminar introducing thesis writing, the issue is discussed and students are informed about dealing properly with external references. The Department also has a supervisor responsible for organizing internships in research groups. Students report on their internship in a presentation.

Supervision of course work and term papers is carried out by the respective lecturers. Both BSc and MSc programmes end with a thesis, and a detailed schedule for thesis preparation has been adopted. At the beginning of each semester there is a workshop dealing with thesis requirements, and possible supervisors and topics are presented. Supervision of the final thesis is professor-based, but a defence committee is commonly used, with different outside members for BSc and MSc thesis committees. For the BSc thesis no reviewer outside of TUT is required, but an external reviewer is required for the MSc thesis.

In collaboration with MEKTORY, the Departments participating in the programme have introduced a project framework approach, the target of which is to achieve closer cooperation with companies.

### Strengths

- The low student:staff ratio

### Areas of improvement and recommendations

- E-learning methods and flipped-classroom approaches should be more vigorously developed
- More small-group work should be introduced
- Measures should be implemented to identify and support students who are experiencing difficulties with their studies

## **Teaching staff**

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.

- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

TUT has regulations that determine the necessary qualifications for academic staff. The Departmental Councils also discuss questions concerning hiring academic staff as well as the needs for improving study programmes. The teaching staff in Engineering Physics have adequate qualifications to achieve the objectives and learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning. Visiting teachers and researchers also participate in educational activities, and professors supervise the work of part-time lecturers by advising them and visiting their lectures. The subjects covered in the programmes are supported by the research activities of the academic staff, who have a track record of securing domestic and international (EU level) research grants.

Members of teaching staff are engaged in professional and teaching-skills development; however, the overall commitment of the teaching staff could be stronger. Representatives participate in TUT level competitions for grants to develop existing subjects or to create new subjects. The study consultant supports teaching staff in organizing the study processes, and there is a newly appointed and enthusiastic programme manager. Full-time teaching staff participate regularly in teaching skills seminars, organized by the TUT Study Department. These seminars deal with questions of organization of studies, student feedback, and recruitment of new students. Moreover, information on study programmes and PR issues are discussed, but again modern approaches to teaching and learning seem to be missing.

Overall student assessment of teaching skills of the teaching staff is positive. Any criticisms are discussed at Departmental meetings.

### Strengths

- Positive student evaluation of teaching staff

### Areas of improvement and recommendations

- The commitment and engagement of the teaching staff should be strengthened
- More international teaching staff should be recruited for the programme

### **Students**

Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.  
Alumni and their employers are pleased with their professional preparation and social competencies.

Comments

The number of students has been decreasing during the last three years, which is the general trend in Estonia because of the low birth rate. Engineering Physics has difficulties in filling the student intake quota in competition with other programmes, but the students who actually choose Engineering Physics are in demand in Master's studies of other specialities, such as medical physics and various technology specializations.

The team was told that students in high school are not well aware of what engineering physics is. Students from the programme go into high schools to increase awareness, and current students also volunteer to have high school students shadow them.

As already noted, the drop-out rate is high, especially among students whose first choice was not the BSc programme. There do not appear to be systematic efforts to improve motivation and retention of students who are experiencing difficulties in their studies.

There is little student mobility inwards or outwards. This would be facilitated if the MSc were taught entirely in English, as recommended earlier.

The graduates from this programme are quite few, and are highly appreciated in the Estonian labour market. Employers told the team that the programme provides a good foundation in physical sciences (though there is scope for improvement).

Strengths

- Graduates of the programme who are in high demand

Areas of improvement and recommendations

- The programme should be marketed better among Estonian high-school students
- The national and international mobility of students should be increased

### 2.3.3. Applied Chemistry and Biotechnology (BSc, MSc)

#### **Study programme and study programme development**

Standards

- ✓ The launch or development of the study programme is based on the Standard of Higher Education and other legislation, development plans, analyses (including labour market

and feasibility analyses), and professional standards; and the best quality is being sought.

- ✓ The structure and content of modules and courses in a study programme support achievement of the objectives and designed learning outcomes of the study programme.
- ✓ Different parts of the study programme form a coherent whole.
- ✓ The study programme includes practical training, the content and scope of which are based on the planned learning outcomes of the study programme.
- ✓ The study programme development takes into account feedback from students, employers, alumni and other stakeholders.

### Comments

The Applied Chemistry and Biotechnology programme was established in 2002, and has been revised a number of times since then. The BSc and MSc programmes aim to train specialists with a broad education in sciences who are able to solve problems using science-based methodologies and to apply their knowledge to various fields of chemistry and biotechnology in private enterprises, laboratories and government organizations. The MSc programme further aims to enable students to practice and present independent research, with opportunities to apply their knowledge in a real working situation. The Department is the only chemistry-based technology-driven programme in Estonia. Both the BSc and MSc curricula are mapped against the intended learning outcomes, as currently taught.

The BSc and MSc are regarded as consecutive study programmes, and nearly all MSc students the team met had completed their BSc at TUT. All doctoral candidates the team met had completed both their BSc and MSc at TUT. Although some bachelor's graduates move into employment rather than proceeding to the masters' programme, and some master's students move into employment rather than proceeding to the doctoral programme, still there seems to be an expectation that the programmes form a continuum, and in particular that the BSc and MSc need not stand as independent programmes. This is a rather insulated view that fails to consider the needs of all students. Students and the programme itself would benefit from the cross-fertilization that comes from students attending a different campus for their graduate work from where they received their undergraduate degree.

Among the revisions, in 2014 a version of the BSc programme was adopted that allows more freedom of choice for the students, leading to two basic sub-courses, one corresponding to each half of the degree title. The revision updated and improved a number of courses to make them more manageable and to help prepare students for BSc and MSc thesis work. It also offered students more choice of electives. The MSc revision also served to offer students more choice of direction in their studies, with updating of various courses and inclusion of courses better oriented towards professional practice in the widest sense. Students still pointed out to the team the paucity of available electives.

The Department observes that more cooperation with private and public organizations is needed to promote the programme and enable more students to find internships, which are required for the degree. Students and teaching staff both have indicated that the students must find their own internship, in spite of the existence of the TUT Career Centre. The team was told that finding an internship is considered as part of the study process that improves students' career management skills, and the role of the Career Centre is

apparently to provide assistance in developing relevant skills rather than to find internships.

The University has a standard student questionnaire that seeks answers on a five-point scale but the Department criticizes it as very superficial, and hence in need of supplementary qualitative feedback. The questionnaire has been voluntary, but will be mandatory in the future. The Department also refers to an initiative from the students and also alumni to create a report about the management and development of the programmes, content and subjects of the courses. The most recent student report in 2014–15 covered every BSc programme.

Other than individual teaching staff efforts, it seems that until the present academic year the department has not routinely gathered feedback from stakeholders, such as students and employers, and used it to develop the programme.

Enrolment in the programme has been declining somewhat. In the past the BSc entering class size has been around 40, but it is now closer to 20 students annually, and 30 was said to be the optimum number.

One outcome of an upcoming structural reorganization in the sciences at TUT is that, starting in the academic year 2017–18, a single BSc programme will be formed, combining current programmes from Applied Chemistry and Biotechnology, Food Technology, and Gene Technology. This will allow for common introductory courses, and assure a critical mass of students prior to their specialized courses.

There is currently no formal programme council, but the team was told that one will be formed as the new curriculum is organized. The student voice on such a group is needed. A broadly representative programme council for the Faculty of Science was formed in the current academic year, and the team learned that from 2017/18 there will be a programme council for the study programme. The team was not told why this has to be delayed for a whole year.

#### Strengths

- The regularly updated and revised curriculum that tries to reduce overlaps between courses and to improve the offerings for the students

#### Areas of improvement and recommendations

- The BSc should be designed to stand on its own as a three-year programme that can lead to employment or a suitable MSc, with the MSc designed also to be inviting to students from outside TUT.
- The programme council for the department should be formed for 2016/17 rather than waiting until 2017/18 as currently planned.
- The department should work closely with the Career Office on campus to develop a more systematic way to let students know of practical internships outside of TUT.
- Students in the first practical organic chemistry course should be exposed to some of the standard modern instrumentation, to include in particular characterization by gas chromatography and infrared

spectrophotometry; although the team was told that GC and IR spectrometers are available in the organic chemistry laboratory, it did not see any when it visited.

## Resources

### Standards

- ✓ Resources (teaching and learning environments, teaching materials, teaching aids and equipment, premises, financial resources) support the achievement of objectives in the study programme.
- ✓ There is a sufficient supply of textbooks and other teaching aids and they are available.
- ✓ Adequacy of resources is ensured for changing circumstances (change in student numbers, etc.).
- ✓ Resource development is sustainable.

### Comments

The Department provides access to a range of advanced equipment and software in a building completed in 2004. The physical facilities seen by the team appeared nicely appointed and well maintained. The analytical instrumentation looks particularly strong. BSc and MSc students can also work on projects in the research labs that expose them to additional high-end equipment. However, the team observed that standard international safety protocol was not being followed in some laboratories. Solvent cabinets were grey rather than the bright yellow that is required in many countries, and although the team understands that this is not required in Estonia it is desirable to expose students to broader international standards. Many students were not wearing eye protection, and although the team was told that this applies only to work with computers and analytical instruments that require fine tuning and do not spill dangerous chemicals, nevertheless experience elsewhere shows that allowing such exceptions is hard to monitor and fails to take account of hazards caused by other workers in the laboratory, so that best practice is to require eye protection to be worn at all times in all laboratories.

Encouraged by a Ministry initiative, departmental staff have been engaged in producing textbooks and translations of textbooks in Estonian, mainly but not entirely at BSc level. However, students complained in written feedback to the department that the library holds too few copies of some essential texts. This has apparently been remedied recently, because students who met the team confirmed the availability of the books in the library.

The Department cites as an area for improvement keeping laboratories up to date within limited financial resources, and suggest that this weakness can be eliminated by applying for research funds to update the laboratories. The University allocates funds separately to the Dean for teaching and research. In turn the department staff determine how to use the funds. The team was unable to see financial information that clarifies how teaching and research funding are allocated and spent.

A new modern instrument can be placed in a research lab, and then students can be trained to use it on a rotating basis. Using research staff and instrumentation is an efficient use of equipment, although its usable lifetime

may be diminished by student use and it is not an efficient use of staff time. There is probably no way to avoid this situation for certain expensive instruments, but this should not substitute for training every student on a standard piece of equipment in the teaching laboratories.

### Strengths

- Coordinated efforts of the teaching and research staff to expose students to instrumentation in the teaching and research laboratories

### Areas of improvement and recommendations

- All persons in laboratories should be required to wear proper personal protective gear as a matter of uncompromised policy.

## **Teaching and learning**

### Standards

- ✓ The process of teaching and learning supports learners' individual and social development.
- ✓ The process of teaching and learning is flexible, takes into account the specifics of the form of study and facilitates the achievement of planned learning outcomes.
- ✓ Teaching methods and tools used in teaching are modern, effective and support the development of digital culture.
- ✓ Practical and theoretical studies are interconnected.
- ✓ The organisation and the content of practical training support achievement of planned learning outcomes and meet the needs of the stakeholders.
- ✓ The process of teaching and learning supports learning mobility.
- ✓ Assessment of learning outcomes is appropriate, transparent and objective, and supports the development of learners.

### Comments

The Department is seeking to make most of its study materials accessible from its website: while some lecturers are using the University's e-learning platform Moodle, others are creating their own web pages, and students complain about materials spread over different sites. However, the Department notes that many activities essential to the subject are not suited to e-learning. Students appreciate online materials, but recognize they do not substitute for standard teacher-student interaction.

Some students drop out of the programme because they have difficulty in mathematics or physics. These may be talented, creative students who need some assistance getting started in their university career, especially if the programme was not their first choice. While teaching staff uniformly said they would help such students one-on-one, research shows that poorly-prepared students respond better to other students. TUT does not seem to have a peer tutor or mentor programme to try keeping such students in the program.

Considerable stress is placed on learning in research laboratories, and students are expected to present results of a real research project in their BSc final thesis. This prepares and motivates them for continuing to the MSc programme. A number of BSc and MSc students have won awards in the national student research competition. However, students would like more internships to be available for them to conduct practical work outside the University. The Department notes the need to adopt a more systematic

approach to finding partner organizations to offer internships. The Department also observes that offering courses that do not require attendance at lectures is an area for improvement.

As noted later, student mobility is negligible. The BSc curriculum does not support learning mobility, either in or outside the country, but the plan to teach MSc programmes in English from next academic year is excellent: the programme would serve to attract paying students from other countries, which is an important step in providing Estonian students international exposure. It will attract students from other countries, and will make TUT more attractive to visiting lecturers and researchers. Sending Estonian students abroad for part of a programme should also pay dividends when they arrive back home.

PhD students are required to teach as part of their curriculum. They participate (mandatorily) in the annual seminars and training for instructors to promote the use of technology in the classroom.

The current SIS-based method of evaluating teaching is not considered satisfactory. Working with the Student Union to revamp the process and add qualitative feedback has been mentioned as a future plan. Students were unable to provide an example of when their feedback led to improvements in the programme. This may well have happened, so the Department should close the loop on this feedback by making students aware of how important their input is. This will also motivate students to provide more thoughtful feedback.

### Strengths

- Having all PhD students trained to teach, and then expecting them to gain teaching experience

### Areas of improvement and recommendations

- The MSc programme should be taught entirely in English.
- The Department should routinely let students know what changes are being made in response to their feedback

## **Teaching staff**

### Standards

- ✓ There is teaching staff with adequate qualifications to achieve the objectives and planned learning outcomes of the study programme, and to ensure quality and sustainability of the teaching and learning.
- ✓ Overall student assessment on teaching skills of the teaching staff is positive.
- ✓ The teaching staff collaborate in the fields of teaching and research within the higher education institution and with partners outside of the higher education institution (practitioners in their fields, employers, and staff members at other Estonian or foreign higher education institutions).
- ✓ Recognised foreign and visiting members of the teaching staff and practitioners participate in teaching the study programme.
- ✓ The teaching staff is routinely engaged in professional and teaching-skills development.
- ✓ Assessment of the work by members of the teaching staff (including staff evaluation) takes into account the quality of their teaching as well as of their research, development and creative work, including development of their teaching skills, and their international mobility.

### Comments

Most staff are also doing research, many with partners outside the University. This is a good model for the students, and provides them with connections useful for projects and employment.

There are a total of 15 faculty in the professorial ranks, plus a number of researchers and lecturers who teach. The student/staff ratio is low, allowing personal interactions, and additional students could be accommodated.

Teaching staff are offered courses on teaching methodology (including the use of new technology), while PhD students are required to take such courses and to teach in laboratories or undergraduate seminars. The Department argues that this creates a pipeline for possible new teaching staff. Attendance at these workshops is voluntary for permanent teaching staff.

Some teaching staff receive poor evaluations from students because they do not adopt the latest advances in teaching methods. In very rare cases, teaching staff who have repeated bad ratings are asked to explain the outcome and register for a pedagogy course.

Particularly through Erasmus links, a number of foreign academics give lectures in the Department. Students reportedly would like more of these, and the Department notes this as an area for improvement.

### Strengths

- A dedicated teaching staff, with some enthusiastic and talented young members
- Some teaching staff who have a particularly good relationship with employers obtain feedback that is beneficial in modifying some courses

### Areas of improvement and recommendations

- All teaching staff should be required to take a course in pedagogy
- More lectures should be given by visiting foreign academics

## **Students**

### Standards

- ✓ Student places are filled with motivated and capable students.
- ✓ The dropout rate is low; the proportion of students graduating within the standard period of study is large.
- ✓ Students are motivated to learn and their satisfaction with the content, form and methods of their studies is high.
- ✓ As part of their studies, students attend other Estonian and/or foreign higher education institutions as visiting or international students.
- ✓ Employment rate of alumni is high.
- ✓ Alumni and their employers are pleased with their professional preparation and social competencies.

### Comments

For 2015–16 there are 92 students on the BSc programme, following a steady fall from 130 in 2010–11, and 43 students on the MSc programme, which has held steady in numbers for the last three years. The Applied Chemistry and Biotechnology curriculum is listed as a priority programme in the Smart Specialization area and as a result scholarships are provided for 30% of all BSc and MSc students; there are also performance-based scholarships for most others.

The Department says there is a very strong student community that provides thorough feedback, and the team received copies of 200-page reports about all BSc programmes that had been assembled by student representatives and supplied to the Vice-Dean. The students on the Applied Chemistry and Biotechnology programme who met the team did not feel affinity with the student representatives, nor with their annual reports. Rather, students indicated they often completed the evaluations in the department SIS and provided feedback on specific courses when the instructor asked. However, the students did not believe they had ever been asked for feedback about the programme as a whole, and since they do not serve on any of the staff education committees, they lack an avenue for their voice to be heard.

For the BSc programme the dropout rate has remained at or below 20% in recent years. For the MSc the dropout rate was steady at around 15% until last year, when only one person dropped out. The University has set reducing dropouts as an important key performance indicator for the programmes. In response the Department intends to develop ways of measuring programme quality in terms of outcomes. Just under 60% of students admitted to the BSc graduate on time, but this does not seem consistent with the statement in the self-evaluation report that “Most of the students graduate within the nominal time”, which it cites as a strength of the programme.

The Department recognizes that there is insufficient information for students on studying abroad, and suggest this should be publicized on the Institute’s website.

Graduates work in scientific centres, government or private laboratories, some of them working outside chemistry and biochemistry, including as entrepreneurs. Estonia may be a small country, but there are also many jobs in science that are not known to students as possible careers. The Department itself comments that some alumni work in IT, having presumably benefited from this aspect of their studies even if they did not appreciate it at the time. This recognizes that some alumni find employment outside research and development, or even in occupations not related to chemistry, but such alumni tended to be overlooked by academic staff who discussed employment with the team.

Alumni and employers who met the team said strong positive things about the programme, but they also gave some constructive feedback that had not been solicited from them by the Department. Some employers provide their views informally through personal and social contacts with academic staff.

As mentioned in previous categories, students would like more internships, and better communication about the availability of internships especially outside the University laboratories. They do not find the Careers Office helpful in this respect.

Strengths

- The initiative taken by students to gather and analyse feedback on the programmes in the Faculty of Science

Areas of improvement and recommendations

- The Department should conduct exit surveys for students who leave the programme, in order to identify reasons for the drop out and therefore suggest some possible interventions to reduce the rate
- The Department should survey alumni and employers on a regular basis to establish their needs and how best the programme can meet them
- The Department should make a concentrated effort to publicize and encourage student mobility, possibly with one of the teaching staff acting as a liaison to the International Office
- The Department or the Careers Office should urgently provide students help to set up their internships