Faculty of
Science & Technology

UNIVERSITEIT TWENTE.

Programme-specific appendix to the programme part of the students' charter, including the education and examination regulations of the Nanotechnology (NT) Master's Programme

(art. 7.13 and 7.59 WHW)

Contents

Preamble

a. The rules in this appendix apply to the full-time master's programme Nanotechnology (No. 60028).
b. Together with the Common Part this programme-specific appendix forms the programme section of the student charter for the master's programme Nanotechnology of the faculty Science and Technology at the University of Twente.
c. In case of conflict between the Dutch and English versions of this appendix, the Dutch version is legally binding.
d. The programme is subject to the legislation of the Dutch Higher Education and Research Act (WHW).

Reference: TNW17057/bb/ae/vdh
Date: 20 July 2017

Article 1 Programme Mission, Profile and Objective

The discipline of nanotechnology aims to design and develop functional materials, structures and systems by manipulating or measuring materials at the nanometre length scale and to use new phenomena and properties on this length scale. Research and development in this field concerns the manipulation of nano-scale structures and their integration in larger components, systems and architectures.

The Nanotechnology programme aims to train students at an internationally recognized high academic master level, to be pro-active researchers, designers and engineers who are able to develop, propagate and apply innovative knowledge in the field of nanotechnology.

The Nanotechnology programme offers students a curriculum that allows them to acquire skills in nanotechnology and to further develop their knowledge, skills and insight in the various sub-areas of nanotechnology. The final level aims to provide graduates with sufficient competencies to be able to act at a high academic level and in a professional and independent manner. Graduates will be able to successfully enter a variety of professional fields, such as scientific research, process and product development, and professional training in nanotechnology or related disciplines.

The Nanotechnology master's programme focuses on the design, manufacture and characterization of functional nanomaterials, nanodevices and systems. The subjects are closely related to the research subjects of the various groups that are part of the research institute MESA+ Institute for Nanotechnology.

Article 2 Programme Aims

The programme aims have been outlined on the basis of the 3TU Academic Competencies, better known as the Meijers Criteria (or the ACQA[1] criteria). These criteria have been approved by the NVAO[2] and these criteria provide a very good framework in which the general targets of an academic master's programme are systematically arranged and which also allow the inclusion of specific aspects of the programme.

A technical academic graduate is characterized by means of seven areas of competence (see Fig. 1), arranged into three groups:

(a) domain of the programme
(b) academic method of thinking and acting
(c) context in which scientific research is conducted

Each area of competence consists of a combination of knowledge, skills and attitude.

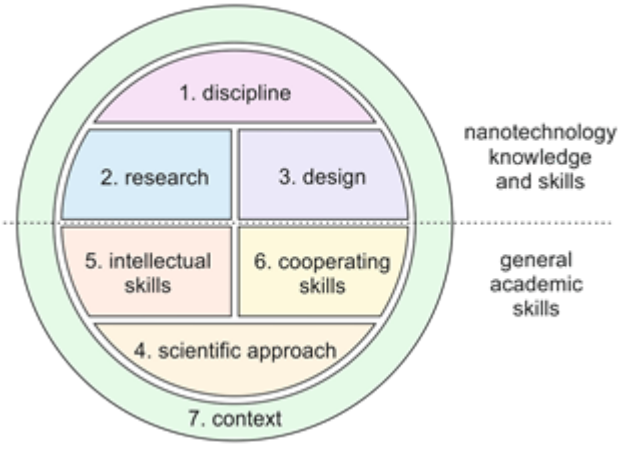

Figure 1 Seven areas of competence on the basis of the Meijers Criteria.

[1] ACQA: Academic Competences and Quality Assurance.

[2] Accreditation Organization of the Netherlands and Flanders (NVAO).

The graduate:

1. has knowledge of one or more scientific disciplines.
2. is a skilled researcher.
3. is a competent designer.
4. uses a scientific approach.
5. has basic intellectual skills.
6. is an able collaborator and communicator.
7. takes the current and social context into account.

These seven areas of competence for a general technical academic master are further elaborated on to define the programme aims for the MSc Nanotechnology. With each programme aim, the focus is on knowledge (k), skills (s) or attitude (a).

The M-NT graduate:

1. Has thorough knowledge of a sub-area of nanotechnology.
An M-NT graduate is versed in current scientific knowledge and has the competence to extend this knowledge by means of (independent) study.

1a	Has a thorough understanding of the basic knowledge of the relevant disciplines and is versed in the areas of the disciplines that are in the forefront of the knowledge of nanotechnology and underlying disciplines, such as (nano)physics, (nano)chemistry, (nano)devices and materials science (latest theories, methods, techniques and topical questions). [ks]
1b	Actively looks for structure and connections in the relevant disciplines [ksa]
1c	Has the knowledge, skills and attitude to independently, in the context of more advanced ideas or applications in nanotechnology: - develop theories and models, - interpret texts, problems, data and results, - conduct experiments, and collect and simulate data, - make decisions based on the data and the modelling. [ksa]
1d	Has experimental skills in areas of relevant disciplines, such as - nanotechnology: the manufacture of nanomaterials, qualitative and quantitative characterization of chemical and physical properties, including working in a cleanroom. - in one of the research areas: nanomaterials, bionanotechnology, nanofluidics, nano-optics, nanoelectronics, nanodevices, nanomedicine. [ksa]
1e.	Has the ICT skill to create and edit text, data and models. [ksa]
1f.	Is aware of the presuppositions of standard methods and their importance; is able to reflect on these methods and presuppositions; is able to challenge them; is able to propose changes and is able to assess their impact. [ksa]
1g.	Is able to independently identify gaps in their knowledge, and to enhance and extend their knowledge through study. [ksa]

2. Is able to conduct research in one or more sub-areas of nanotechnology.
An M-NT graduate has the competence to acquire new scientific knowledge through research. Research here means: developing knowledge and new insights in a targeted and methodical manner.

2a.	Is aware of the complex nature of the research methodology in nanotechnology. [ksa]
2b.	Is able to independently conduct research at master level, and to - analyse research issues of a complex nature in nanotechnology, - make use of the relevant knowledge base, - define research targets and, if relevant, define suitable hypotheses, - define a research plan, including the required theoretical and experimental steps, assumptions and methods, - carry out the various activities of the research plan, - analyse and evaluate the research results in relation to the defined problem, - assess the scientific value of the research results, - defend these results against others. [ksa]

2c.	Is perceptive and has the creativity and the ability to discover specific connections and new viewpoints and to use these new viewpoints for new applications. [ksa]
2d.	Is able to work at different levels of abstraction and selects the appropriate level for the process stage of the research problem. [ksa]
2e.	Is able to assess the scientific merit of research in nanotechnology, to systematically collect such research, and to analyse and process it. [ksa]
2f.	Is able to and has the attitude to involve other disciplines in their research as and when necessary. [ksa]
2g.	Is able to handle changeability of the research process due to external circumstances or progressive insights. Is able to adjust this process accordingly. [ksa]
2h.	Is able to contribute independently to the development of scientific knowledge of one or more sub-areas of nanotechnology. [ks]

3. Is skilled in designing in one or more sub-areas of nanotechnology.

Apart from conducting research, many M-NT graduates will also create designs. This concerns in particular the design of measuring installations, methods, materials or systems that are required for research, but also the design of processes for nanomanufacturing and for the production of nanotechnology products. Designing is a synthetic activity that aims at the realization of new or changed artefacts or systems, with the objective of creating value in conformity with pre-defined requirements and wishes.

3a.	Is able to independently design at master level, and to: - analyse complex design issues in connection with measuring installations, methods, materials or systems. - integrate the relevant knowledge base in a design. - formulate design requirements, objectives and conditions, and takes into account safety, environmental and economic aspects, and describes and translates these requirements into quantitative design parameters. - formulate a design plan on a general and detailed level, including the steps, assumptions and methods. - analyse and evaluate a design and decision steps in a systematic manner with respect to the defined requirements. - make a technical and economic analysis of the selected design. - defend these results against others. [ksa]
3b.	Is able to systematically collect, analyse and process relevant design information from literature, patents, databases and websites, and is able to identify missing information. [ks]
3c.	Is creative and has synthetic skills with respect to design problems. [ksa]
3d.	Is able to work at different levels of abstraction and selects the appropriate level for the process stage of the design problem. [ksa]
3e.	Is able to handle changeability of the design process due to external circumstances or progressive insights. Is able to adjust this process accordingly. [ksa]
3f.	Is able to and has the attitude to involve other disciplines in their design as and when necessary. [ksa]
3g.	Is able to phrase new research questions on the basis of a design problem. [ks]

4. Takes a scientific approach.

An M-NT graduate uses a systematic approach, characterized by the development and use of theories, models and consistent interpretations; has a critical attitude and has insight into the nature of nanoscience and nanotechnology.

4a.	Is able to identify and take in relevant developments. [ksa]
4b.	Uses a systematic approach, characterized by the development and use of theories, models and consistent interpretations and is able to subject these to a critical assessment in the area of their final master's assignment. [ksa]
4c.	Is in possession of extensive skills in using, developing and validating models; is able to make a considered choice between modelling methods. [ksa]

4d.	Has insight in the nature of science and technology (purpose, methods, differences and similarities between scientific disciplines, nature of laws, theories, explanations, role of the experiment, objectivity, etc.) and is familiar with current discussions. [k]
4e.	Has insight in scientific practice (research system, relationship with clients, publications system, importance of integrity, etc.) and is familiar with current discussions on the subject. [k]
4f.	Is able to adequately document the research results and design, with the purpose to contribute to the development of knowledge within and outside the discipline, and is able to publish the results. [ksa]

5. Has intellectual skills.

An M-NT graduate is competent in reasoning, reflecting and forming an opinion. These are skills that are trained and improved in the context of nanotechnology, and that are generally applicable, afterwards.

5a.	Is able to critically and independently reflect on his/her own thinking, decision making, and acting and is able to make adjustments. [ksa]
5b.	Can reflect on their strong and weak points in connection with research, design, organization and teaching/advising activities, and can make adjustments on the basis of this. [ks]
5c.	Is able to reason logically within nanotechnology and is able to recognize modes of reasoning (induction, deduction, analogy, etc.); is able to recognize fallacies, and is able to apply the modes of reasoning. [ksa]
5d.	Is able to ask adequate questions and takes a critical, but constructive attitude when analysing and resolving complex problems in nanotechnology. [ks]
5e.	Is able to achieve a substantiated opinion in case of incomplete of irrelevant data or inaccuracies, taking into consideration the manner in which the data was created. [ks]
5f.	Is able to express a point of view in a scientific argument in nanotechnology and is able to make a critical judgement. [ksa]

6. Is an able collaborator and communicator.

An M-NT graduate has the ability to collaborate with and work for others. This calls for adequate interaction, a sense of responsibility, as well as good communication with colleagues and non-colleagues. He/she is also able to participate in a scientific or public debate in the English language.

6a.	Is able to communicate in written and spoken English on research and solutions for problems with colleagues, non-colleagues and other stakeholders. [ksa]
6b.	Is able to understand written scientific literature and text books, discussions and debates in the English language. [ksa]
6c.	Characterized by professional behaviour. This means: drive, reliability, honesty, involvement, accuracy, perseverance and independence as well as respecting others, irrespective of their age, social or economic status, education, culture, beliefs, gender, race or sexual orientation. [ksa]
6d.	Is able to perform project-based work: is pragmatic and has a sense of responsibility; is able to deal with limited sources; is able to deal with risks; is able to compromise. [ksa]
6e.	Is able to work within an interdisciplinary team with a high level of diversity. [ks]
6f.	Has insight in and can handle team roles and social dynamics and is able to take on the role of team leader. [ks]

7. Takes the current and social context into account.

Nanoscience and nanotechnology do not exist in isolation; they exist in a current and social context. Points of view and methods have their origin in society and, in time, decisions made will have consequences for society. An M-NT graduate is aware of this and has the competence to integrate these insights in their scientific work.

7a.	Is aware of social, environmental, sustainability and safety aspects of nanotechnology; is able to analyse and understand these aspects and integrates elements of them in his/her scientific work. [ksa]

7b.	Is able to analyse the social consequences (economic, social, cultural) of new developments in nanotechnology, to discuss the subject with colleagues, non-colleagues, and to integrate the consequences in his/her scientific work. [ksa]
7c.	Is able to analyse the ethical and normative aspects of the consequences and the assumptions of scientific thought and actions within nanotechnology, to discuss the subject with colleagues, non-colleagues (in research, design and applications), and to integrate this in his/her scientific work. [ksa]
7d.	Has an eye for the various roles of professionals in society: researcher, designer, manager, adviser/teacher. [ksa]

Article 3 Admission Board

1. An admission board is appointed by the dean of the Faculty of Science and Technology for the admission of students to the master's programme.
2. The Executive Board has delegated the authority to accept or reject students for the master's programme (S&C/387.191/lk) to the board mentioned under section 1.
3. The admission board consists of at least two members:
   a. the Programme Director,
   b. in case of foreign students, a professor or member of the chair in which the student may graduate, and the Internationalization Coordinator;
   c. in case of students with a qualification in higher professional education, the higher professional education coordinator;

   The admission board is chaired by the Programme Director.
   If the chair deems it necessary, the programme coordinator, the secretary of the Board of Examiners and/or the study adviser can join the admission board.

Article 4 Admission to the Programme

1. Admission to the programme is granted to:
   a. Students in possession of a degree in Electric Engineering, Chemical Engineering, Applied Physics, Physics or Chemistry from a Dutch university or a bachelor's degree in Advanced Technology, or ATLAS from the University of Twente, subject to the condition that their education included sufficient attention to quantum mechanics, solid state physics or inorganic materials science, organic materials science and spectroscopy. This assessment is made by the admission board.
   b. Other students who meet at least one of the following requirements:
      - The student is in possession of a bachelor's degree or equivalent in a study programme which, in the opinion of the admission board, enables the candidate to complete the master's programme within the defined period.
      - The student is in possession of a master's degree or equivalent in a study programme which, in the opinion of the admission board, enables the candidate to complete the master's programme within the defined period.
      - If the student has no qualification in the above sense, but does have an education and/or additional experience which, as a whole, is regarded by the admission board as equivalent to one of the above degrees and the board is of the opinion that this education and experience enable the candidate to complete the master's programme within the defined period, the admission board may decide to admit the candidate.

   The admission board issues a proof of admission to the programme if the conditions under section a or b are met.
2. During assessment of the application for admission to the master's programme, the admission board can demand that some subjects must be passed before the proof of admission to the master's programme can be issued.
3. When a proof of admission to the master's programme is issued, the admission board may decide to grant exemption for particular parts of the programme, with exception of the final master's assignment.
4. The decision of the admission board in section 3 of this article requires the approval of the Board of Examiners.
5. Students in possession of a degree for the bachelor's programme Advanced Technology, ATLAS, Electrical Engineering or Chemical Engineering of the University of Twente can be admitted to the

regular master's programme if they successfully passed the modules Science (15 EC, 201500058, B3 programme AT) and Materials Engineering (15 EC, 201400158, B2 programme AT) or Chemistry and Materials Technology (15 EC, B2 programme ST) in their bachelor's programme.

6. Students with a qualification in higher professional education (HBO) may be admitted to the master's programme after they have completed a transfer programme of 30 EC.
   a. The transfer programme consists for about one-third of mathematics. The remaining subjects are BSc modules from Applied Physics and Advanced Technology. The package is put together by the Programme Board. More detailed information on the transfer programme can be found on the website of the department (www.utwente.nl/nt).
   b. Students must complete the transfer programme within a period of 1 year and will be given 2 opportunities to take the exam.
   c. After completion of the transfer programme, the student is admitted to the Nanotechnology master's programme..
   d. Instead of the transfer programme mentioned above, students of the University of Applied Sciences can also attend a transfer minor (Kies-Op-Maat minor) of 30 EC during their higher professional education. This minor must at least consist of all mathematics subjects and the combination of subjects must be approved by the Programme Board.

7. Subject to specific conditions, master students of foreign universities who have reached an advanced stage of their Nanotechnology master's programme may be admitted to the Condensed Master Programme of the Nanotechnology master's programme (Article 6 of the programme-specific appendix).
   a. The Condensed Master Programme consists of at least 70 EC.
   b. Only students who have been granted an exemption for 50 EC by the Board of Examiners of the Nanotechnology master's programme are admitted to this programme.
   c. Students are only admitted to the Condensed Master Programme if the student's specific programme, including the exemptions to be granted, is approved by the Board of Examiners of the Nanotechnology master's programme.

8. Students with a previous education at a foreign institution must demonstrably have sufficient language skills in spoken and written English. A requirement for their admittance to the programme may be a sufficient score in a recognized test. This means a total score of 6.5 or higher for the IELTS test, or a score of 90 or higher for the Internet-based TOEFL test[3]. Students in possession of a bachelor's degree from a country where English is the main language in higher education[4] are exempt from this requirement.

Article 5 Regular Master's Programme

The master's programme consists of two years. The first 3 quarters of the first year consist of subjects and the fourth quarter consists of an internship & job orientation project. The remaining (compulsory) subject and the final master's assignments take place in the second year. The total study workload is at least 120 EC.

The following compulsory subjects are offered in the first year (55 EC):

- Fabrication of nanostructures (7,5 EC, 201600042)
- Characterization of nanostructures (7,5 EC, 201600043)
- Nanoscience (5 EC, 193400050)
- Nano-Lab: Fabrication & Characterization (5 EC, 201600041)
- Nanotechnology design project (10 EC, 201600044)
- The internship & job orientation project is with an external company or external research institute/university (20 EC, 193409509)

The second year consists of the compulsory subject (40 EC):

- The final master's assignment is supervised by a professor of one of the nanotechnology research groups participating in MESA+ (40 EC).

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[3] IELTS: International English Language Testing System; TOEFL: Testing of English as a Foreign Language; see the UT website on admittance to the master's programme's: https://www.utwente.nl/en/education/master/admission-requirements/international-degree.

[4] The list of countries can be found at https://www.utwente.nl/en/education/master/admission-requirements/international-degree/countries/.

The final master's assignment is assessed with two grades:

- One for the scientific and technological aspects (193409100, 20 EC), consisting of the problem analyses (familiarizing oneself with a field of study, evaluation of the context, and formulating the research questions and approach), the realization (the theoretical and experimental approach and realization), and the results analysis (analysis of the results and their relevance);
- One for the general aspect of the reporting (193409200, 20 EC). The general aspects consist of independence, commitment, collaboration, originality and creativity. Reporting consists of the oral reporting (presentation and discussion of the research) and the written report (the final master's assignment report).

The final report of the final master's assignment must be written in English and the colloquium must also be in English.

Approval of the final master's assignment by the Board of Examiners must be requested in time by means of the form 'MSc final project contract and course list Nanotechnology' (no later than 1 month before the start of the assignment). The final master's assignment must be of a nanotechnical nature. The student must indicate the nanotechnical aspects of the assignment in the proposal.

For the purpose of monitoring progress, the student must draw up a mid-term evaluation, in which the acquisition of information, the problem analysis, progress and the direction of the final master's assignment are reported. This report will be discussed with the master assignment committee.

The other 25 EC consist of optional subjects.15 EC must consist of three of the following subjects from three categories:
Solid State Matter:

- Nanooptics/photonics (5 EC, 193400131, 1A)
- Nano-electronics (5 EC, 193400141, 1B)
- AMM Inorganic Materials Science (5 EC, 193700040, 2A)

(Bio)molecular Matter:

- Bionanotechnology (5 EC, 193400111, 2A)
- Nanomedicine (5 EC, 201200220, 1B)
- (Bio)molecular Chemistry & Technology (5 EC, 193700020, 1A)

Soft Matter & Systems

- Lab on a Chip (5 EC, 201600046, 1B)
- Nanofluidics (5 EC, 193400121, 2A)
- Soft & Biological matter (5 EC, 201300135, 1A) or Colloid & Interfaces (5 EC, 193735060, 1A)

The other 5-15 EC are optional and can be used for one of the above subjects or subjects from other master programme's (also non-technical subjects) at the University of Twente.

a. The combination of subjects requires the approval of the supervising professor and the Board of Examiners.
b. For international students, there is a compulsory module Introduction Nanoscience (2 EC, 201600045). This is only intended as an introduction to the subject Nanoscience (193400050).
c. International students and students of the University of Applied Sciences also have to follow a workshop regarding academic skills.

The programme outlined in this article applies to cohort 2016/2017 and later.
The programme applicable to cohorts 2015/2016 and earlier is outlined in the programme-specific appendix to OER TNW150105/mb/vdh, dated 20/08/2015, supplemented by a transition regulation drawn up by the Board of Examiners.

Article 6 Condensed Master Programme

A student's specific programme, including any exemptions to be granted, must be approved beforehand by the Board of Examiners. The following rules apply:

1. The Condensed Master Programme consists of at least 70 EC, consisting of 40 EC for subjects and 30 EC for the master's assignment.
2. Students admitted to the Condensed Master Programme may be granted exemption for some of the compulsory subjects.

This is an overview of the Condensed Master Programme:

- Fabrication of nanostructures (7,5 EC, 201600042)
- Characterization of nanostructures (7,5 EC, 201600043)
- Nanoscience (5 EC, 193400050)
- Nano-Lab: Fabrication & Characterization (5 EC, 201600041)
- The final master's assignment is supervised by a professor of one of the nanotechnology research groups participating in MESA+ (30 EC)

and 15 EC from the following subjects:

Solid State Matter:

- Nanooptics/photonics (5 EC, 193400131)
- Nanoelectronics (5 EC, 193400141)
- AMM Inorganic Materials Science (5 EC, 193700040)

(Bio)molecular Matter:

- Bionanotechnology (5 EC, 193400111)
- Nanomedicine (5 EC, 201200220)
- (Bio)molecular Chemistry & Technology (5 EC, 193700020)

Soft Matter & Systems

- Lab on a Chip (5 EC, 191211120)
- Nanofluidics (5 EC, 193400121)
- Soft & Biological matter (5 EC, 201300135) or Colloid & Interfaces (5 EC, 193735060)

Article 7 Transition Regulation

1. In the event of a change to the programme included in the article 5 or 6 of this appendix, or of a change to one of the other articles included in the general part of this programme-specific appendix, a transition regulation will be defined and announced by the Programme Director.
2. Article 8.4 of the general part states the conditions to be met by a transition regulation.
3. The transition regulation will be published on the website of the Nanotechnology programme.

Article 8 Safety

Working in a laboratory is subject to safety requirements. Students must acquaint themselves with these rules[5] and abide by them.

Article 9 Sequence of Study Units

1. Prior to starting a programme unit, the student must meet the knowledge requirements of the programme unit.
2. The student can only start the internship & job orientation project when he/she has successfully completed at least 30 EC of the master's programme.
3. The student can only start the final master's assignment when he/she has successfully completed at least 50 EC of the master's programme (including the internship & job orientation project).
4. Prior to the examination on the final master's assignment, the student must have successfully completed all other programme units.
5. The Board of Examiners is authorized to grant exemption from the conditions in sections 1 to 4 of this article if strict application of those terms would result in an unreasonable delay in study progress. The student can submit a request to this end to the Board of Examiners.

Article 10 Free Programme

Contrary to the provisions in article 5 or 6 of this appendix, the student can request the permission of the Board of Examiners to attend a free programme in the sense of Art. 7.3d of the legislation. The Board of Examiners will assess whether the programme is suitable within the domain of the faculty, is consistent, and has sufficient merit in terms of the final education targets of the faculty.

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5 See the rules on occupational health and safety and the environment, at http://www.tnw.utwente.nl/intra/diensten/amh/ .

Article 11 Student Counselling

1. The task of the study adviser is to individually advise students on all aspects of their studies, and to inform the Programme Director on the study progress of the students.
2. The professor of the selected faculty for graduation assigns a supervisor.

Article 12 Quality Assurance and Evaluation

1. The programme management is responsible for the evaluation of the programme.

2. The execution of the evaluation of the education of the master's programme Nanotechnology takes place using PDCA procedures by the coordinator Quality Assurance of the Science & Technology faculty/Science & Technology cluster and the programme director/ programme coordinator.

3. The following evaluation tools are used:
    a. Panel meetings with students;
    b. Web surveys of the master's courses[6];
    c. Web survey of the master's final project.

4. The results of the internal quality assurance activities will be published in the following manner:
    a. Summary of the web surveys and response of the lecturer regarding the evaluation will be sent to the programme committee;
    b. Summary of web surveys and the response of the lecturer will be placed in the Blackboard organization 'Quality Assurance and Evaluation Nanotechnology' which is accessible for all students and lecturers of the master's programme Nanotechnology.

5. To evaluate the curriculum and the master's programme in its entirety the following internal and external evaluations are used:
    a. All information obtained using the tools which are mentioned in 12.3;
    b. The National Student Survey (NSE)[7];
    c. The National Alumni Survey (NAE)[8].

    The programme management will respond to the evaluations, and provide a written reaction focusing on plans for improvement.

6. The programme management and the programme committee decide on which actions need to been taken on course level or curriculum level in order to improve the programme. These actions will be recorded in an 'Action List Quality Assurance and Evaluation'.

7. Every year the programme management writes an improvement plan, based on the internal and external evaluations and new insights.
    a. The improvement plan will be discussed with the programme committee;
    b. The improvement plan will be included in the faculty's annual report;
    c. The faculty's annual report will be discussed with the university's executive board by the dean of the faculty and the portfolio holder for education during the autumn meetings.

Article 13 Effectuation and Changes

These regulations will come into effect on 1 September 2017 and replace the regulations dated 1 October 2016.

Established by the Dean of the Faculty, after advice from the Faculty Council and the Programme Committee.

Enschede, 20 July 2017.

6 Not all courses are evaluated using a web survey every year.

7 The NSE is taken every year.

8 The NAE is taken every two years.