

Assessment report  
Limited Framework Programme Assessment

**Bachelor Technische Wiskunde**

University of Groningen

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## 1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Bachelor Applied Mathematics (formal CROHO name: Bachelor Technische Wiskunde) programme of University of Groningen. The programme was assessed according to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

The panel welcomes the programme objectives to educate students in all required fields within the mathematics discipline and in knowing how to apply mathematics knowledge and skills in various areas. The objectives also appropriately cover the research skills and academic skills.

The panel understands and supports the considerations to offer programmes, both in mathematics and in applied mathematics. The panel, however, advises to make the distinctions between the programmes more clear, especially to inform prospective students.

The panel considers the Domain-Specific Framework of Reference to be an appropriate description of the mathematics discipline and of the standards and requirements graduates of both bachelor and master programmes have to meet. The panel welcomes the efforts of the joint Mathematics programmes in the Netherlands to have drafted this Framework. The objectives and intended learning outcomes of this programme meet the Framework and, therefore, correspond to international standards set for the discipline.

The panel welcomes that students are offered a wide range of programmes they may be admitted to.

The intended learning outcomes of the programme correspond to the programme objectives, are very comprehensive and have been very well elaborated. They are conform to the bachelor level.

The intake numbers of the programme are satisfactory. The panel approves of the entry requirements and the admission procedures of the programme. Prospective students are adequately informed about the programme and beginning students are accommodated well in making the transfer from secondary school to university education.

The curriculum of the programme matches the intended learning outcomes. The panel considers the curriculum to be very solid, covering both the foundations of the mathematics discipline and the applications of mathematics. The panel is pleased that, among others, complex analysis is addressed in the curriculum. The way students are trained in research skills, academic skills and modelling is appreciated. The panel suggests to reinforce the training in programming skills in the curriculum. Although the course Mathematics: History, Ethics and Professional Issues is welcomed, the panel advises to strengthen the subjects of history of mathematics and ethics in the curriculum. The panel is pleased to hear the Faculty will recruit an expert on ethics and scientific integrity to lecture in the programme.

The panel regards the lecturers in the programme to be good researchers and committed and skilled teachers. The panel notes the lecturers to be very approachable and to be prepared to assist students actively. As the performances of the teaching assistants vary to some extent, the panel proposes to intensify their training. The internet surveys of students' views on lecturers' performances may result in non-representative results. The panel suggests to rethink these surveys. As the lecturers' work load is rather high, the panel greets the plans to recruit extra staff in the near future. The panel suggests to emphasise the educational capabilities of candidates in the staff members recruitment processes.

The educational concept and study methods are in line with the programme's characteristics. The combined lectures, tutorials and projects allow students to obtain the knowledge and insights required and to acquire the skills needed. The students-to-staff ratio is relatively high but will decrease with the recruitment of extra staff members. The panel is positive about the study guidance in the programme. The panel considers the programme to be feasible. The buildings and the material facilities of the programme are up to standard. The panel advises to monitor drop-out rates and student success rates for the programme. In addition, the panel proposes to hold exit interviews with students on their reasons to leave the programme.

The programme examination and assessment regulations are appropriate. The panel is positive about the responsibilities and activities of the Board of Examiners. The panel appreciates the measures taken by the programme to ensure the quality of examinations and assessments. The panel advises to avoid the involvement of teaching assistants in peer-reviewing draft examinations.

The examination methods selected in the courses are approved by the panel, as they match the course contents. The panel appreciates the diversity in examination methods adopted in the courses. The panel is positive about the homework assignments being limited to 30 % or 40 % of the final course grade to counter any effects of free-riding. The course examinations are assessed reliably, teaching assistants being guided by examiners and answer keys being used.

The Bachelor Project supervision is organised effectively. The assessment of the projects is conducted reliably. The panel, however, advises to add more extensive arguments to substantiate the assessments of the Bachelor Projects.

The examinations of the courses are of adequate level. The panel supports the grades awarded to the Bachelor Projects. The panel considers the assessments and the grading for these projects to be very strict and definitely not too lenient. No Bachelor Projects were found to be unsatisfactory.

The panel appreciates the labour market orientation activities in the programme. The panel is positive about the involvement of the External Advisory Board in aligning the programme to professional field requirements.

The panel is convinced that the programme graduates have reached the intended learning outcomes. Programme graduates are admitted to a wide range of master programmes, which gives evidence of the learning outcomes achieved.

The panel that conducted the assessment of the Bachelor Applied Mathematics programme of University of Groningen assesses this programme to meet the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, judging the programme to be *satisfactory*. Therefore, the panel recommends NVAO to accredit this programme.

Rotterdam, 27 September 2019

Prof. dr. ir. O.J. Boxma  
(panel chair)

drs. W. Vercouteren  
(panel secretary)

## 2. Assessment process

The evaluation agency Certiked VBI received the request by University of Groningen to support the limited framework programme assessment process for the Bachelor Applied Mathematics programme of this University. The objective of the programme assessment process was to assess whether the programme conforms to the standards of the limited framework, as laid down in the NVAO Assessment framework for the higher education accreditation system of the Netherlands, published on 20 December 2016 (Staatscourant nr. 69458).

Management of the programmes in the assessment cluster WO Wiskunde convened to discuss the assessment panel composition and to draft the list of candidates. The panel composition for this assessment has been based upon these considerations.

Having conferred with University of Groningen programme management, Certiked invited candidate panel members to sit on the assessment panel. The panel members agreed to do so. The panel composition was as follows:

- Prof. dr. ir. O.J. Boxma, full professor Stochastic Operations Research, Eindhoven University of Technology (panel chair);
- Prof. dr. R.H. Kaenders, full professor Mathematics and its Education, University of Bonn, Germany (panel member);
- Prof. dr. D. van Straten, full professor Algebraic Geometry, Johannes Gutenberg University Mainz, Germany (panel member);
- Dr. ir. H.J. Prins, manager Research & Development, Maritime Research Institute the Netherlands (panel member);
- S.R. den Breeijen MSc, recently graduated student Master Mathematics, Radboud University Nijmegen (student member).

On behalf of Certiked, drs. W. Vercouteren served as the process coordinator and secretary in the assessment process.

All panel members and the secretary confirmed in writing being impartial with regard to the programme to be assessed and observing the rules of confidentiality. Having obtained the authorisation by the University, Certiked requested the approval of NVAO of the proposed panel to conduct the assessment. NVAO have given their approval.

To prepare the assessment process, the process coordinator convened with management of the programme to discuss the planning of the activities in preparation of the site visit. The site visit schedule was also discussed. In addition, the outline of the self-assessment report and the subjects to be addressed in this report were part of the discussion.

In the course of the process preparing for the site visit, programme management and the Certiked process coordinator had contact to fine-tune the process. The activities prior to the site visit have been performed as planned. Programme management approved the site visit schedule.

Well in advance of the site visit date, programme management sent the list of final projects of graduates of the programme of the most recent years. Acting on behalf of the assessment panel, the process coordinator selected the theses of fifteen graduates. The grade distribution in the selection was conform to the grade distribution in the list, sent by programme management.

The panel chair and the panel members were sent in time the self-assessment report of the programme, including appendices. In the self-assessment report, the student chapter was included. In addition, the expert panel members were forwarded a number of theses of the programme graduates, these theses being part of the selection made by the process coordinator.

Before the site visit date, the assessment panel chair and the process coordinator met to discuss the self-assessment report to be provided by programme management, the procedures regarding the assessment process and the site visit schedule. In this meeting, the profile of panel chairs of NVAO was discussed as well. The panel chair was comprehensively informed about the competencies, listed in the profile.

Being informed by the process coordinator, all panel members sent in their preliminary findings, based on the self-assessment report and the final projects studied, and a number of questions to be put to the programme representatives on the day of the site visit. The panel secretary summarised this information, compiling a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

Shortly before the site visit date, the panel met to go over the preliminary findings concerning the quality of the programme. During this meeting, the preliminary findings of the panel members, including those about the theses were discussed. The procedures to be adopted during the site visit, including the questions to be put to the programme representatives on the basis of the list compiled, were discussed as well.

On 28 June 2019 and 1 July 2019, the panel conducted the site visit on the University of Groningen campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with Faculty representatives, programme management, Board of Examiners members, lecturers and final projects examiners, and students and alumni.

In a closed session near the end of the site visit, the panel considered every one of the findings, weighed the considerations and arrived at conclusions with regard to the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the considerations and conclusions to programme representatives.

Clearly separated from the process of the programme assessment, the assessment panel members and programme representatives met to conduct the development dialogue, with the objective to discuss future developments of the programme.

The assessment draft report was finalised by the secretary, having taken into account the findings and considerations of the panel. The draft report was sent to the panel members, who studied it and made a number of changes. Thereupon, the secretary edited the final report. This report was presented to programme management to be corrected for factual inaccuracies. Programme management were given two weeks to respond.

Having been corrected for these factual inaccuracies, the Certiked bureau sent the report to the University Board to accompany their request for re-accreditation of this programme.

### 3. Programme administrative information

Name programme in CROHO: B Technische Wiskunde (international name: B Applied Mathematics)  
Orientation, level programme: Academic Bachelor  
Grade: BSc  
Number of credits: 180 EC  
Specialisations: None  
Location: Groningen  
Mode of study: Full-time  
Language of instruction: English  
Registration in CROHO: 21PC-56965

Name of institution: University of Groningen  
Status of institution: Legal body providing education  
Institution's quality assurance: Approved (up to 6 August 2025)

## 4. Findings, considerations and assessments per standard

### 4.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

#### *Findings*

The Bachelor Applied Mathematics programme is one of the bachelor programmes of the Faculty of Science and Engineering of University of Groningen. The programme is part of the Undergraduate School of Science and Engineering, which organises all bachelor programmes of the Faculty. The director and the Board of the School are responsible for this and the other bachelor programmes of the Faculty. On behalf of the School director, the deputy director of the Bachelor Applied Mathematics programme takes care of the contents of the programme and, assisted by the programme coordinator and the academic advisor, organises the programme on a day-to-day basis. The programme committee for this programme is a joint committee for all four Bachelor and Master Mathematics and Applied Mathematics programmes. The programme committee consists of four lecturers and four students and advises programme management for this and the other three programmes on quality aspects. The Board of Examiners is responsible for monitoring the examinations and assessments of all four Bachelor and Master Mathematics and Applied Mathematics programmes.

The programme objectives are to educate students broadly in the foundations of the mathematics discipline, and to equip them with knowledge, skills and attitude to apply mathematical concepts and methods to problems in engineering, science or other fields. Students are educated on the one hand in basic knowledge of the fields within the mathematics discipline and are trained on the other hand in applying their knowledge and skills in various fields. Students also acquire research skills and general academic skills. Academic skills are, among others, mathematical modelling of problems, gathering information, communicating, and collaborating. The programme is research-based, the subjects and topics taught being based upon research done in these fields.

Both Bachelor and Master Mathematics programmes and Bachelor and Master Applied Mathematics programmes are offered by University of Groningen. The latter programmes are offered by the Faculty to emphasise the engineering profile of the Faculty, to promote engineering knowledge and skills in the northern part of the Netherlands and to attract students, who are specifically interested in applied aspects of mathematics.

The joint Mathematics programmes in the Netherlands drafted the Domain-Specific Framework of Reference for both Bachelor and Master Mathematics programmes. In this Domain-Specific Framework of Reference, the generic objectives and the generic intended learning outcomes for these programmes have been listed. These objectives and intended learning outcomes meet the international standard for mathematics of ASIIN in Germany. They also correspond to the Dublin descriptors and the Meijers' criteria. In addition, they are largely comparable to those of the Mathematics programmes of renowned universities abroad, such as ETH Zürich, KU Leuven, Cambridge University and University of Padova.

Students are being prepared to enrol in master programmes in applied mathematics or in disciplines as applied physics, econometrics or operations research. Programme graduates may also enter the Master Education and Communication programme to become fully-qualified teachers in Mathematics in Dutch secondary education. Students are not primarily educated to enter the labour market, although some students may do so. As an extra option, students may take the 45 EC Honours College courses.

The objectives of the programme have been translated into the intended learning outcomes for the programme. These include, as main elements, general knowledge of the foundations and history of mathematics; knowledge of basic concepts and techniques of mathematics; knowledge of subjects of applied mathematics; awareness of societal and ethical aspects of mathematics; research skills; general academic skills; and knowledge and skills to continue studies in applied mathematics at master level.

The intended learning outcomes of the programme have been compared to the Dublin descriptors for bachelor programmes, to establish their bachelor level.

#### *Considerations*

The panel welcomes the programme objectives to educate students in all required fields within the mathematics discipline and in knowing how to apply mathematics knowledge and skills in various areas. The objectives also appropriately cover the research skills and academic skills, required for the discipline.

The panel understands and supports the considerations to offer programmes both in mathematics and applied mathematics. The panel, however, advises to make the distinctions between the programmes more clear, especially to inform prospective students.

The panel considers the Domain-Specific Framework of Reference to be an appropriate description of the mathematics discipline and of the standards and requirements graduates of both bachelor and master programmes have to meet. The panel welcomes the efforts of the joint Mathematics programmes in the Netherlands to have drafted this Framework. The objectives and intended learning outcomes of this programme meet the Framework and, therefore, correspond to international standards set for the discipline.

The panel supports the programme intentions to educate students for master programmes. The panel welcomes that students are offered a wide range of programmes they may be admitted to.

The intended learning outcomes of the programme correspond to the programme objectives. They are very comprehensive and have been very well elaborated. They conform to the bachelor level.

#### *Assessment of this standard*

These considerations have led the assessment panel to assess standard 1, Intended learning outcomes, to be good.

## 4.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

### *Findings*

The number of students enrolling in the programme increased gradually from about 7 incoming students in 2012 to 12 students in 2015 and 28 students in 2018. In 2019, more than 30 students are expected to enrol. The intake numbers meet programme targets. The proportion of international students is currently about 45 % of the total influx. The entry requirements for the programme are the Dutch secondary school diploma, including the Mathematics B certificate. Students coming from abroad have to report equivalent prior education. Non-straightforward applications are screened by the Faculty Admission Board for Bachelor programmes. To be informed about the programme, prospective students may take lectures and tutorials on information days, and may take an on-line course. They are required to complete the online matching form. Upon receipt of this form, the programme issues non-binding advice on students' plans to enrol. Having enrolled, students are invited to a number of introductory events. From 2019 onwards, these events will be bundled into a comprehensive kick-off week. In the first year of the curriculum, students are guided by student mentors and tutors to learn to study mathematics at university-level. In the first-year course *Kaleidoscope Mathematics*, students are given an overview over a number of fields within mathematics and are introduced to mathematical reasoning.

The study load of the curriculum is 180 EC. The curriculum takes three years to complete. In the programme assessment plan, the matching of the curriculum to the intended learning outcomes has been demonstrated. The curriculum has been renewed in 2018/2019, the changes primarily regarding the structure of the curriculum and the choices students can make. The Bachelor Mathematics and the Bachelor Applied Mathematics programmes share 90 EC of courses. The first year of the curriculum is the same for the two programmes, allowing students to go over from one programme to the other. Some students do so. The courses in the curriculum are arranged in learning paths, being substantive mathematics learning paths (analysis, algebra, probability, statistics and numerical mathematics), applications learning paths (mathematical modelling, systems and control, computational mathematics) and the academic skills learning path. In the first two years, courses on substantive mathematics are offered. Some courses are taken together with Bachelor Physics students. The applications of mathematical methods, concepts or models are presented in courses in the first two years (50 EC in total). In the second-year course *Mathematics: History, Ethics and Professional Issues*, students are introduced to the basics of ethics, philosophy of science and history of mathematics. In the courses in the third year, students are introduced to the computational mathematics and systems and control application fields. The number of elective courses in the curriculum is limited to three (15 EC), one in the first year and two in the third year. At the end of the third year, students complete the *Bachelor Project* (15 EC). In the *Bachelor Workgroup* preceding the Bachelor Project, students draft the project proposal and are given information on the organisation of the project. Throughout the curriculum and specially in the projects, students are trained in research skills and academic skills. Spread over the entire curriculum, students are to complete a portfolio on their career orientation, reporting on colloquia, guest lectures, symposia and site visits. The portfolio is

assessed as part of the Bachelor Workgroup. New subjects and trends, such as the subject of big data are introduced in the curriculum.

The permanent staff lecturing in the Bachelor and Master Mathematics and Applied Mathematics programmes are 24 lecturers in total. Together with PhD students employed, the teaching staff constitutes 9.7 full-time equivalents in terms of teaching capacity. All lecturers are researchers in the Department of Mathematics of the Bernoulli Institute. About 75 % of the staff members are BKO-certified. Staff without BKO-certification are in the process of obtaining the certificate. Permanent staff members offer the lectures, whereas teaching assistants, including PhD students, guide students in the tutorials. Guest lecturers speak in a number of courses. Lecturers meet regularly to discuss the programme and to adjust courses. Students appreciate lecturers' performances and approachability. The performances of teaching assistants vary, however. Teaching assistants may be trained, but this is not required. For the regular surveys of students' views on lecturers' performances, internet surveys have been adopted. The lecturers with whom the panel met, expressed experiencing the work load to be high but manageable. Faculty plans and the sector plan Mathematics will allow the programme to recruit eight extra staff members. In the recruitment processes, the educational capabilities are taken into account. Candidates do not have to give test lectures in front of students, however.

The programme educational concept is meant to introduce students to research-based mathematics, to engage actively in the learning processes, and to learn in close interaction with lecturers. The students-to-staff ratio is about 39/1 for the Bachelor and Master Mathematics and the Bachelor and Master Applied Mathematics programmes together. Study methods adopted in the programme are lectures, tutorials, projects and self-study. In the lectures, staff members introduce students to the subjects addressed in the courses. In the tutorials, teaching assistants, including PhD students, guide students in doing exercises and completing assignments. In the projects, students work individually or in small groups on more complex problems in mathematics or applications of mathematics and are trained in research skills. For a number of courses, web lectures have been adopted. As has been said, students are guided in the first year by student mentors and tutors. The mentor/tutor system is being adapted to learning communities, fostering interaction among students and teamwork and involvement by students. The academic advisor schedules information meetings, guides students, especially in the first year and assists them in drafting their study plans. Students may also turn to the academic advisor in case of questions or problems. The programme information system signals less well-performing students. These students are invited to meet with the academic advisor to discuss remedies to limit study delay. The average drop-out rate of the programme is about 62 %, calculated for the last seven years. This figure is overestimated by about 1/4 on account of physics students taking the mathematics programme for various reasons. The average student success rates are about 38 % after three years and about 67 % after four years (last four cohorts; proportions of students re-entering the programme in the second year).

### *Considerations*

The panel regards the intake numbers of the programme to be satisfactory. The panel approves of the entry requirements and the admission procedures of the programme. Prospective students are adequately informed about the programme and beginning students are accommodated well in making the transfer from secondary school to university education.

The curriculum of the programme matches the intended learning outcomes. The panel considers the curriculum to be very solid, covering both the foundations of the mathematics discipline and the applications of mathematics. The panel is pleased that, among others, complex analysis is addressed in the curriculum. The way students are trained in research skills, academic skills and modelling in the projects is appreciated. The panel suggests to reinforce the training in programming skills in the curriculum. Although the course Mathematics: History, Ethics and Professional Issues is welcomed, the panel advises to strengthen the subjects of history of mathematics and ethics in the curriculum. The panel is pleased to hear the Faculty will recruit an expert on ethics and scientific integrity to lecture in the programme.

The panel regards the lecturers in the programme to be good researchers and committed and skilled teachers. The latter is, among others, demonstrated by the proportion of BKO-certified lecturers. The panel notes the lecturers to be very approachable and to be prepared to assist students actively. As the performances of the teaching assistants vary to some extent, the panel proposes to intensify the training of teaching assistants. The internet surveys of students' views on lecturers' performances may result in non-representative results. The panel, therefore, suggests to rethink these surveys. As the work load of lecturers is rather high, the panel appreciates the plans to recruit extra staff in the near future. The panel suggests to emphasise the educational capabilities of candidates in the recruitment processes for staff members.

The educational concept and study methods are in line with the programme's characteristics. The lectures, tutorials and projects allow students to obtain the knowledge and insights required and to acquire the skills needed. The students-to-staff ratio is relatively high but will decrease with the recruitment of extra staff members. The panel is positive about the study guidance in the programme. The panel considers the programme to be feasible. The buildings and the material facilities of the programme are up to standard. The panel advises to monitor drop-out rates and student success rates for the programme. In addition, the panel proposes to hold exit interviews with students on their reasons to leave the programme.

#### *Assessment of this standard*

These considerations have led the assessment panel to assess standard 2, Teaching-learning environment, to be satisfactory.

### 4.3 Standard 3: Student assessment

The programme has an adequate system of student assessment in place.
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#### *Findings*

The programme examination and assessment regulations meet the Faculty of Science and Engineering assessment policies. The Board of Examiners of the Mathematics and Applied Mathematics programmes is responsible for monitoring the examinations and assessments of this programme.

The examination methods in the programme include written examinations, interim tests, homework assignments, practical work, written reports, and oral presentations. The projects in the curriculum are assessed on the basis of written reports and oral presentations. The examination methods are aligned with the course goals. In most courses, multiple examination methods are scheduled. In the beginning of the programme, examinations are more frequently scheduled to promote students' study progress. The final grade of a course is the weighted outcome of the grades of these examinations. Homework assignments have a limited weight of maximum 30 % to 40 % of the final course grade. Instructed by lecturers, teaching assistants give feedback on homework assignments. Examinations are assessed and graded by lecturers and teaching assistants together, working on the basis of answer keys.

In the Bachelor Workgroup course preceding the final Bachelor Project, students have to submit a review article based upon research papers about specific applied mathematics topics. Topics are presented by research groups participating in the programme. Students are also expected to comment on fellow students' papers. All papers are presented orally and discussed. In the Bachelor Workgroup, students are also to draft the proposal for the Bachelor Project. Bachelor Projects have fixed deadlines. Not meeting the deadline will result in a fail and the need for an improvement plan. Normally, students meet with their supervisor weekly. The results of the Bachelor Projects are presented by students both in writing and in oral presentations during a two-day symposium. These results are assessed by the supervisor and the second reader. The assessment criteria are scientific quality, research project management, written report and colloquium. The examiners use standard assessment forms. Bachelor Projects are checked for plagiarism.

In the programme, measures have been taken to ensure the quality of examinations and assessments. The assessment plan for the programme outlines the relations between the intended learning outcomes and the courses, the examination forms adopted for the courses and the course examiners for the courses. Per course, at least two examiners have been appointed. For each of the courses, the relations between the course goals, the study methods and the examination methods, including the grading scheme have been drafted. The draft examinations of the courses are peer-reviewed. Students are given the opportunity to inspect their marked work. The Board of Examiners on a regular basis reviews the examinations of a number of courses and samples of Bachelor projects and Bachelor Project assessment forms.

#### *Considerations*

The programme examination and assessment regulations are appropriate. The panel is positive about the responsibilities and activities of the Board of Examiners.

The examination methods selected in the courses are approved by the panel, as they meet the course contents. The panel appreciates the diversity in examination methods adopted in the courses. The panel is positive about the homework assignments being limited to 30 % or 40 % of the final course grade to counter any effects of free-riding. The course examinations are assessed reliably, teaching assistants being guided by examiners and answer keys being used.

The Bachelor Project supervision is organised effectively. The assessment of the projects is conducted reliably. The panel, however, advises to add more extensive arguments to substantiate the assessments of the Bachelor Projects. These may take the form of concise comments on the selection of the topic of the thesis, the preparation of the student on the subject concerned, the summary of the contents of the thesis, the specification of the own contributions by the student, the creativity and mathematical depth of the student contributions, and the quality of writing and oral presentation by the student.

The panel appreciates the measures taken by the programme to ensure the quality of examinations and assessments. These measures promote the validity, reliability and transparency of examinations and assessments. Teaching assistants are, however, sometimes involved in peer-reviewing draft examinations. The panel advises to avoid this.

*Assessment of this standard*

The considerations have led the assessment panel to assess standard 3, Student assessment, to be satisfactory.

#### 4.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.
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##### *Findings*

The panel studied the examinations of a number of courses of the programme.

The panel reviewed the Bachelor Projects of fifteen graduates of the programme with different grades and from different specialisations. In the Bachelor Projects, students are to demonstrate having attained most of the intended learning outcomes of the programme. The average grade for the Bachelor Projects of the last three years was 8.0.

Through the portfolio in the curriculum, students give evidence of their labour market orientation. The portfolio requires them to attend and report on guest lectures, colloquia, symposia and site visits. The External Advisory Board, consisting of professional field representatives from for the programme relevant industries, advises programme management regularly on the alignment of the programme to professional practice requirements.

About 57 % of the programme graduates proceed to the Master Applied Mathematics programme of University of Groningen. About 29 % of the graduates select applied mathematics programmes at master level of other Dutch or foreign universities. About 14 % of the graduates go to master programmes of University of Groningen in other disciplines, such as applied physics, econometrics, operations research or actuarial sciences. The number of students entering the labour market is quite limited.

##### *Considerations*

The examinations of the courses which were reviewed by panel members are of adequate level.

The panel supports the grades awarded to the Bachelor Projects. The panel considers the assessments and the grading for these projects to be very strict and definitely not too lenient. No Bachelor Projects were found to be unsatisfactory.

The panel appreciates the labour market orientation activities in the programme. The panel is positive about the involvement of the External Advisory Board in aligning the programme to professional field requirements.

The panel is convinced that the programme graduates have reached the intended learning outcomes. Programme graduates are admitted to a wide range of master programmes, which gives evidence of the learning outcomes achieved.

##### *Assessment of this standard*

The considerations have led the assessment panel to assess standard 4, Achieved learning outcomes, to be satisfactory.

## 5. Overview of assessments

Standard	Assessment
Standard 1. Intended learning outcomes	Good
Standard 2: Teaching-learning environment	Satisfactory
Standard 3: Student assessment	Satisfactory
Standard 4: Achieved learning outcomes	Satisfactory
Programme	Satisfactory

## 6. Recommendations

In this report, a number of recommendations by the panel has been listed. For the sake of clarity, these have been brought together below.

- To make the distinctions between the programmes in mathematics and in applied mathematics more clear, especially for prospective students.
- To reinforce the training in programming skills in the curriculum.
- To strengthen the subjects of history of mathematics and ethics in the curriculum.
- To intensify the training of teaching assistants.
- To rethink internet surveys of students' views on lecturers' performances, as these surveys may not give representative results.
- To emphasise the educational capabilities of candidates in the recruitment processes for staff members.
- To monitor the drop-out rates and the student success rates of the programme.
- To hold exit interviews on the reasons for students to leave.
- To avoid the participation of teaching assistants in the review of draft examinations.
- To add more extensive comments and arguments to substantiate the assessments of the Bachelor Projects.