

Assessment report
Limited Framework Programme Assessment

Master Mathematics

University of Groningen

Contents of the report

1. Executive summary	2
2. Assessment process	4
3. Programme administrative information.....	7
4. Findings, considerations and assessments per standard	8
4.1 Standard 1: Intended learning outcomes	8
4.2 Standard 2: Teaching-learning environment	11
4.3 Standard 3: Student assessment.....	14
4.4 Standard 4: Achieved learning outcomes	16
5. Overview of assessments.....	17
6. Recommendations	18

1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Master Mathematics 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 bring students to advanced levels of knowledge and skills in the mathematics discipline, to introduce them to research in mathematics and to educate them thoroughly in one of the fields offered. Students are trained in research skills and in academic skills. The panel supports the programme intentions to prepare students both for careers in the professional field or for careers in academia.

The panel understands and supports the considerations to offer both Mathematics and Applied Mathematics programmes. The panel, however, advises to make the distinctions between these 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 panel finds it, however, important to specify the societal specialisations more clearly in the Framework. The objectives and intended learning outcomes of this programme meet the Framework and, therefore, correspond to international standards set for the discipline.

The programme intended learning outcomes meet the programme objectives, are comprehensive and conform to the master level. They have been well elaborated, also for each of the tracks.

The panel approves of the admission requirements and procedures. The panel recommends to try and raise the influx in the programme, as the current inflow of students is rather low.

The curriculum of the programme matches the intended learning outcomes. The panel considers the curriculum to be solid. The mathematics discipline and the specific fields in the tracks are in-depth addressed. Although the course Mathematics and its Environment is welcomed, the panel advises to strengthen the subjects of history of mathematics and ethics. The panel is pleased to hear the Faculty will recruit an expert on ethics and scientific integrity to lecture in the programme. The panel supports the programme intentions for the Science, Business and Policy track to align the Internship and the Master Research project and suggests to schedule the Internship before the Master Research Project.

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 welcomes 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 panel approves of the study guidance in the programme and considers the programme to be feasible. The buildings and the material facilities are up to standard. As some Mastermath courses have become more challenging, the panel suggests to discuss this with Mastermath management. The panel advises to monitor drop-out rates and student success rates for the programme and 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 that teaching assistants are involved in peer-reviewing draft examinations. The panel approves of the quality control of the Mastermath examinations by the Board of Examiners.

The course examination methods are approved by the panel, as they match course contents. The panel appreciates the diversity in examination methods. The course examinations are assessed reliably.

The Master Research 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 Master Research Projects.

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

Although the extra-curricular events scheduled by the Faculty are appreciated, the panel proposes to promote labour market orientation activities in the programme. The involvement of the External Advisory Board in aligning the programme to professional field requirements is positive. The panel advises to strengthen the contacts with alumni of the programme.

The panel is convinced that the programme graduates have reached the intended learning outcomes. Programme graduates find appropriate positions very easily.

The panel that conducted the assessment of the Master 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 Master 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 tracks offered in the programme were covered in the selection.

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: M Mathematics
Orientation, level programme: Academic Master
Grade: MSc
Number of credits: 120 EC
Tracks: Mathematics and Complex Dynamical Systems
Statistics and Big Data
Science, Business and Policy
Location: Groningen
Mode of study: Full-time
Language of instruction: English
Registration in CROHO: 21PC-66980

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 Master Mathematics programme is one of the master programmes of the Faculty of Science and Engineering of University of Groningen. The programme is part of the Graduate School of Science and Engineering, which organises all master programmes of the Faculty. The director and the Board of the School are responsible for this and the other master programmes of the Faculty. On behalf of the School director, the deputy director of the Master 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 provide students with advanced knowledge and advanced skills in the mathematics discipline. The programme introduces students broadly to research in mathematics and provides them with thorough education in one of the fields within the mathematics discipline. Students are also trained in research skills and in general academic skills. The programme is research-based, the subjects and topics taught being based upon research done in these fields.

In the programme, three tracks are offered, being Mathematics and Complex Dynamical Systems, Statistics and Big Data, and Science, Business and Policy. The first two tracks are research tracks, students being introduced to research in the subjects mentioned. The Science, Business and Policy track educates students to apply mathematics in social, commercial or political contexts and to be employed in non-academic organisations. This track has been initiated by the Faculty of Science and Engineering to offer students this option, next to the two research-oriented tracks. Within the track Mathematics and Complex Dynamical Systems, students may take the Double Master programme in Mathematics and Physics.

The Faculty of Science and Engineering not only offers Bachelor and Master Mathematics, but also Bachelor and Master Applied Mathematics programmes. 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 and University of Padova.

Students are primarily educated to enter the labour market. Graduates are prepared to build careers as mathematicians in various industries or to pursue academic careers, proceeding to PhD trajectories. Students having taken the Science, Business and Policy track, are educated for policy or management positions in mathematics.

The objectives of the programme have been translated into the intended learning outcomes for the programme. These include, as main elements, understanding the most important concepts in the mathematics discipline; knowledge and skills to contribute to the scientific advancement of a field within the mathematics discipline; knowing how to solve problems on the basis of abstract thinking and mathematical modelling; awareness of social and ethical aspects of applying mathematics; skills to work in multidisciplinary teams; communication skills; and knowing how to keep knowledge up-to-date. For each of the three tracks, intended learning outcomes have been specified.

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

Considerations

The panel welcomes the programme objectives to bring students to advanced levels of knowledge and skills in the mathematics discipline, to introduce them to research in mathematics and to educate them thoroughly in one of the fields within the discipline. The panel appreciates students being trained in research skills and in general academic skills.

The panel understands and supports the considerations to offer both Mathematics and Applied Mathematics programmes. The panel, however, advises to make the distinctions between these 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 panel finds it, however, important to specify the societal specialisations more clearly in the 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 prepare students both for careers in the professional field or for careers in academia. The panel welcomes students being offered two research tracks to choose from and one track, meant for policy or management positions in mathematics. The programme could consider the option of shifting the emphasis from the Statistics and Big Data track to a Probability and Statistics track, bringing this track closer to the expertise of the staff in these areas.

The intended learning outcomes of the programme correspond to the programme objectives and are comprehensive. They have been well elaborated, also for each of the tracks. They conform to the master level.

Assessment of this standard

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

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 entering the programme is quite stable, being on average 15 incoming students per year. The proportion of foreign students is limited. The entry requirements for the programme are the Bachelor Mathematics degree from Dutch universities. Other applications are screened by the Admissions Board for the Master Mathematics and Applied Mathematics programmes. Students with deficiencies may be admitted after having taken the pre-master programme. In the beginning of the programme, students are contacted by the academic advisor.

The study load of the curriculum is 120 EC. The curriculum takes two years to complete. In the programme assessment plan, the matching of the curriculum to the intended learning outcomes has been demonstrated. The curriculum was renewed in the academic year 2016/2017. For the research tracks, the curriculum consists of 15 EC of compulsory courses, at least 25 EC of track-specific courses, at least 15 EC of guided-choice courses, at most 15 EC of free elective courses and 50 EC for the Master Research Project. The compulsory courses are *Complexity and Networks*, *Mathematical Modelling Colloquium*, and *Mathematics and its Environment*. The last mentioned course introduces students to societal and ethical aspects of mathematics. In the Mathematical Modelling Colloquium, students address specific mathematical topics. The course may be regarded as preparation for the Master Research Project. For track-specific courses, students may select from a range of courses going in-depth into the subjects of the tracks. The guided-choice courses allow students to either deepen their track-specific knowledge and skills or to broaden their study by taking courses from other fields within mathematics. The free electives have to meet the master level and have to be relevant for this programme. The Master Research Projects, scheduled at the end of the curriculum, are individual research projects. For the Science, Business and Policy track, the composition of the curriculum is in the first year 10 EC of compulsory courses, 20 EC of courses from either one of the research tracks, and 30 EC for the Master Research Project, and in the second year, 20 EC of business or policy courses and 40 EC for the Internship. In the Internship, mathematics research and the organisational and policy aspects of this research are combined. The Master Research Project and the Internship are aligned to assure the required level of mathematics. Students tend to take about 20 EC of Mastermath courses. The distances to the places where these courses are offered, limit the number of courses taken by students.

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 compulsory courses in the curriculum are scheduled to promote community-building among students. The students-to-staff ratio is about 39/1 for the Bachelor and Master Mathematics and the Bachelor and Master Applied Mathematics programmes together, but this programme is small-scale. Study methods adopted in the programme are lectures, tutorials, seminars, colloquia and self-study. Tutorials are less common than in the Bachelor Mathematics programme. In the lectures, staff members introduce students to the subjects addressed in the courses. For a number of courses, web lectures have been adopted. The academic advisor schedules information meetings, guides students, and assists them in drafting their study plans. Students may also turn to the academic advisor in case of questions or problems. The average student success rates are about 26 % after two years and about 50 % after three years (last five cohorts). The average drop-out rate of the programme is about 30 %, which is considerable for master programmes.

Considerations

The panel approves of the entry requirements and the admission procedures of the programme. The panel recommends to try and raise the influx in the programme, as currently the inflow of students is rather low.

The curriculum of the programme matches the intended learning outcomes. The panel considers the curriculum to be solid. The mathematics discipline and the specific fields in the tracks are in-depth addressed. In the courses, students are trained in research skills and in academic skills. Although the course Mathematics and its Environment 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 supports the programme intentions for the Science, Business and Policy track to align the Internship and the Master Research project and suggests to consider reverting the order, scheduling the Internship before the Master Research Project. This way, students may continue the research project on the same topic and with more mathematical depth.

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 welcomes 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, seminars, colloquia and tutorials allow students to obtain the knowledge and insights required and to acquire the skills needed. The panel approves of 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. Some Mastermath courses have become more challenging. The panel suggests to discuss this with Mastermath management. 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.

Findings

The examination and assessment regulations for the programme are in line with 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 examination methods are aligned with the course goals. In most courses, multiple examination methods are scheduled. The final grade of a course is the weighted outcome of the grades of these examinations. If they are part of the course examinations, homework assignments have a limited weight of maximum 30 % to 40 % of the final course grade to counter any effects of free-riding. Examinations are assessed and graded by lecturers and teaching assistants together, working on the basis of answer keys. Internships in the Science, Business and Policy track are supervised and assessed by the supervisors, being the Master Mathematics staff member, Science, Business and Policy instructor and internship organisation supervisor. Internships are preceded by the student action plan which has to be approved by the supervisors.

The final Master Research Project is conducted in one of the research groups of the Department of Mathematics of the Bernoulli Institute. Every academic year, information meetings are scheduled to inform students about the procedures and organisation of the projects. Before starting the project, students are to draft the project proposal and the project plan. They do this in cooperation with their supervisor. Master Research Projects have fixed deadlines. Not meeting the deadline will result in a fail and the need for an improvement plan. Students meet with their supervisor regularly. In an interim evaluation in the course of the process, the progress is discussed. The results of the Master Research Projects are presented by students both in writing and in oral presentations. These results are assessed by the supervisor and the second reader. The assessment criteria are scientific quality, research project management, written report and final presentation/colloquium. The examiners use standard assessment forms. Master Research Projects are checked for plagiarism, but not all of them.

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 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 Master Research Projects and Master Research Project assessment forms.

The examination board monitors the contents and quality of the Mastermath courses and of the examinations of these courses. Mastermath presents the course records, examination reports and the names of the examiners for the courses to the examination boards of the participating universities. These boards verify the quality of the courses and of the examinations. If one board, notably of the institution offering the course, approves of the quality, the other boards accept this decision as their own. The examination boards of all of the programmes, participating in Mastermath, meet yearly to discuss the Mastermath examinations' and assessments' quality assurance. The Teaching and Examination Regulations of this programme apply for the Mastermath courses.

Considerations

The panel observed that 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. The course examinations are assessed reliably, teaching assistants being guided by examiners and answer keys being used.

The Master Research 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 Master Research 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. The panel approves of the regulations regarding the Mastermath examinations and the quality control of these examinations by the Board of Examiners.

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.

Findings

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

The panel reviewed the Master Research Projects of fifteen graduates of the programme with different grades and from different tracks. In the Master Research Projects, students are to demonstrate having attained all of the intended learning outcomes of the programme. The average grade for the Master Research Projects of the last three years was 8.1. In the past three years, 29 % of the graduates was awarded *cum laude*.

Every year, two extra-curricular events are scheduled to inform students about the professional field and career opportunities. 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.

The programme graduates either find positions in the professional field or proceed to PhD trajectories, pursuing careers in academia. The vast majority of the graduates find suitable positions shortly after graduation. About 18 % of the graduates of the programme find positions as PhD students, 23 % of them are employed by data science companies, 12 % find jobs at IT companies, and 6 % become teachers.

Considerations

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

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

Although the extra-curricular events scheduled by the Faculty are appreciated, the panel proposes to promote labour market orientation activities in the programme. The involvement of the External Advisory Board in aligning the programme to professional field requirements is positive. The panel advises to strengthen the contacts with alumni of the programme.

The panel is convinced that the programme graduates have reached the intended learning outcomes. Programme graduates find appropriate positions very easily.

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	Satisfactory
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 Mathematics and Applied Mathematics programmes more clear, especially for prospective students.
- To specify the Science, Business and Policy track clearly in the Domain-Specific Framework of Reference.
- To try and raise the number of incoming students.
- To strengthen the subjects of history of mathematics and ethics in the curriculum
- In the Science, Business and Policy track, to align the Internship and the Master Research project, as the programme intends to do and to consider reverting the order, scheduling the Internship before the Master Research Project.
- 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 new staff members.
- To discuss with Mastermath management the more challenging level of Mastermath courses.
- 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 prevent teaching assistants participating in the review of draft examinations.
- To add more extensive comments and arguments to substantiate the assessments of the Master Research Projects.
- To promote career orientation in the programme.
- To strengthen the contacts with alumni of the programme.