

Assessment report
Limited Framework Programme Assessment

Master Mathematics

Radboud University

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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 Master Mathematics programme of Radboud University. 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 appreciates the programme objectives to educate students in the knowledge and skills to address advanced mathematical problems and to train them in analytical thinking skills and research skills to solve these problems. The panel is positive about the research specialisations and the societal specialisations the programme offers to students. These allow students to be educated in-depth in one of the fields within mathematics or to be trained for societally relevant positions. Students are rightly educated to enter the labour market.

The panel supports the plans to renew the programme, in order to clarify the programme profile and to strengthen the community feeling among students. The offering of more courses in the programme itself and the strengthening of applied mathematics in the programme are also supported by the panel. Faculty-wide measures not always fit the specific nature of mathematics education. Therefore, the panel proposes to consider more elaborately the position of the programme when implementing these.

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 programme 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 intended learning outcomes of the programme meet the programme objectives, are comprehensive and conform to the master level. The panel observes that the intended learning outcomes of the research specialisations and the societal specialisations appropriately reflect the level of mathematics knowledge and skills to be expected in these specialisations.

The panel approves of the entry requirements and the admission procedures of the programme. The panel supports the programme's intentions to improve the screening of applications, by verifying the capabilities of applicants more strictly.

The curriculum of the programme matches the intended learning outcomes, as is adequately explained by the programme. The panel considers the curriculum to be solid and the courses to be good. The panel recommends to reinforce applied mathematics courses on stochastics, numerical analysis and computer programming. In the curriculum, academic skills and research skills are addressed appropriately. The Mastermath courses are positive, as they offer a wide range of courses in various fields to students. The panel, however, supports the programme intentions to make the programme less dependent upon the Mastermath courses.

The permanent staff in the programme are all PhDs and have solid research backgrounds. Their educational capabilities are up to standard, as the substantial proportion of lecturers being BKO-certified shows. The staff is perceived by the panel to be very committed to the programme. Students are very positive about the educational capabilities and the accessibility of the lecturers. The regular staff meetings on education are positive. The panel welcomes that extra staff are recruited to alleviate the work load of the lecturers. The panel is positive that the educational capabilities are taken into account, when recruiting staff members.

The educational concept and study methods of the programme meet the programme's characteristics. The students-to-staff ratio allows for small-scale teaching. Feedback on assignments is organised appropriately. The panel is positive about the study guidance in the programme. The panel considers the programme to be feasible. As the Mastermath courses become, however, more challenging, the panel suggests to discuss this with Mastermath management. It is suggested by the panel to take the growth and development of the programme into account, when considering organisational measures. The panel advises to monitor the student success rates of the programme.

The panel observed the programme examination and assessment regulations to be in line with Faculty of Science examination policies. The panel is positive about the responsibilities and activities of the examination board. The panel considers the examination board to work very solidly. The board could be more pro-active, though. The panel appreciates the measures taken by the programme to ensure the quality of examinations and assessments. The panel approves of the regulations regarding the Mastermath examinations and the quality control of these examinations by the examination board.

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 Master thesis project supervision and assessment processes are organised effectively and reliably. The panel notes that different assessment forms are being used, the latest form not being very informative. This especially applies to the societal specialisations' forms. The panel finds the written comments on the assessment forms by the examiners comprehensive and valuable. The panel, however, advises to add more extensive arguments to substantiate the assessments of the Master theses.

The examinations of the courses are of adequate level. The panel supports the grades awarded to the Master thesis projects. No projects were found to be unsatisfactory. The panel regards the mathematics contents of the projects of the research specialisations to be up to standard. The Master thesis projects of the societal specialisations are less advanced in terms of mathematical knowledge and skills, but this is conform to the different set of intended learning outcomes being applicable for these specialisations. The language and style in the theses could be improved.

The panel appreciates the labour market orientation activities on the part of the programme and the study association. The panel suggests to strengthen the relations with the programme alumni.

The panel is convinced that the programme graduates have reached the intended learning outcomes of the programme. Programme graduates find suitable positions very easily. The level of the achieved learning outcomes is confirmed by the substantial proportion of graduates managing to secure positions as PhD students.

The panel that conducted the assessment of the Master Mathematics programme of Radboud University 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 Radboud University 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 Radboud University 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.C. Jongerius BSc, student Master Industrial and Applied Mathematics, Eindhoven University of Technology (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 specialisations of 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 6 May 2019, the panel conducted the site visit on the Radboud University campus. The site visit schedule was as planned. In a number of separate sessions, the panel was given the opportunity to meet with Faculty Board representatives, programme management, Examination Board 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
Specialisations: Algebra and Topology
Applied Stochastics
Mathematical Physics
Mathematical Foundations of Computer Science
Science, Management and Innovation
Science in Society
Science and Education
Location: Nijmegen
Mode of study: Full-time
Language of instruction: English
Registration in CROHO: 21PM-66980
Name of institution: Radboud University
Status of institution: Government-funded
Institution's quality assurance: Approved

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 of Radboud University. Within the Faculty, the programme is organised by the Educational Institute for Mathematics, Physics and Astronomy WiNSt. The director of education of the Educational Institute is responsible for this and the other programmes of the Institute, being accountable to the dean and the vice dean of education of the Faculty. The programme coordinator for the Master Mathematics programme takes care of the organisation of the programme. The lecturers involved in the programme, are employed by the Institute for Mathematics, Astrophysics and Particle Physics, IMAPP. This Institute is primarily concerned with research in, among others, the mathematics discipline. Lecturers are recruited by the WiNSt Educational Institute to lecture in this programme as well as in the Bachelor Wiskunde programme. The programme committee for the programme, consisting of both lecturers and students, advises the programme coordinator for this programme as well as the programme coordinator for the Bachelor Wiskunde programme on the quality of these programmes. The examination board is responsible for monitoring the examinations and assessments of all programmes of the Educational Institute.

The objectives of the programme are to provide students with the knowledge and skills to address advanced mathematical problems. These objectives imply strong analytical thinking skills as well as research skills on the part of the students. The programme is very strongly research-based, focussing on the research interests of the mathematics researchers/lecturers of IMAPP. Following these research interests, four distinct research specialisations are offered. These are *Algebra and Topology*, introducing students in broad terms to these fields; *Applied Stochastics*, studying statistics and probability theory and applying these to applications of the concept of randomness; *Mathematical Physics*, covering various fields of pure mathematics and applying these to physics problems; and *Mathematical Foundations of Computer Science*, combining relevant mathematical theory and theoretical computer science. From the academic year 2019/2020 onwards, the first three research specialisations have been superseded by the single specialisation *Interactive Mathematics* with the two tracks *Foundations* and *Applications* and a special option *Mathematics and Computation*. The fourth specialisation will be transferred to the Computer Science programme. In addition to the research specialisations, three societal specialisations may be taken by students. These are *Science, Management and Innovation*, educating students for policy-related and management positions and teaching them to apply their knowledge and skills in organisations, *Science in Society*, training students to bring in scientific knowledge in the societal debate and to take divergent interests and perspectives into account in this debate and *Science and Education*, educating students for positions as first-degree teachers in Mathematics in secondary education.

The programme is rather dependent upon the offering of national Mastermath courses, scheduled in Utrecht and Amsterdam. This has some downsides, such as a less clear profile of the programme itself

and less community building among students. Therefore, the programme drafted a new set-up, which will be implemented as of the academic year 2019/2020. As part of this renewal, the number of local courses offered in Nijmegen will be expanded and more applied mathematics courses will be offered.

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 employed in many sectors of society as mathematicians, applying their knowledge and skills to the subjects and problems in these sectors. Students having taken one of the societal specialisations, are educated for, among others, management positions, science policy positions or positions as teachers.

The objectives of the research specialisations of the programme have been translated into the intended learning outcomes for the programme. These include, as main elements, knowledge, insights and skills in mathematics at an advanced level, specialist knowledge in one of the sub-fields of mathematics, knowledge and skills to solve complicated, mathematical problems, programming skills, mathematical research knowledge and skills, and communication skills. The intended learning outcomes of the societal specialisations have been listed separately, indicating competencies of students to work in policy-making and management or in societal contexts or in education, depending on the specialisation chosen. The intended learning outcomes of the societal specialisations include mathematical knowledge, insights and skills, but at less advanced level than the research specialisations.

Programme management compared the intended learning outcomes of the programme to the Dublin descriptors for master programmes, from which the correspondence of the intended learning outcomes to these Dublin descriptors may be inferred.

Considerations

The panel appreciates the programme objectives to educate students in the knowledge and skills to address advanced mathematical problems and to train them in analytical thinking skills as well as research skills to solve these problems. The panel is positive about the research specialisations and the societal specialisations the programme offers to students. These allow students to be educated in-depth in one of the fields within mathematics or to be trained for societally relevant positions. The panel supports the programme intentions to educate students to enter the labour market.

The panel supports the programme plans to renew the programme, in order to clarify the programme profile and to strengthen the community feeling among students. The offering of more courses in the programme itself and the strengthening of applied mathematics in the programme are also supported by the panel. Faculty-wide measures not always fit the specific nature of mathematics education, as pursued by the programme and may even be counterproductive to the development of the programme. Therefore, the panel proposes to consider more elaborately the position of the programme when implementing these measures.

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 Netherland 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 intended learning outcomes of the programme correspond to the programme objectives. The panel concludes that the intended learning outcomes of the research specialisations and of the societal specialisations appropriately reflect the level of mathematics knowledge and skills to be expected in these specialisations. The intended learning outcomes are comprehensive and are 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 25 incoming students per year. For the year 2018/2019, the number rose to 37 students, being the consequence of the growing number of students in the Bachelor programme of Radboud University. Only few students come from other universities. About 30 % of the incoming students are female. About 25 % of the students take one of the societal specialisations, the Science and Education specialisation attracting only few students. The entry requirements for the programme are the Bachelor Mathematics degree from Dutch universities. Other applications are screened by the Faculty International and Admissions Office.

The study load of the curriculum is 120 EC. The curriculum takes two years to complete. Programme management explained comprehensively the curriculum matching the intended learning outcomes. The curriculum structure is the same for all four research specialisations. This structure is made up of the major (30 EC), the minor (24 EC), mathematical electives (16 EC), free electives (6 EC), the courses Professional Preparation (1 EC) and Philosophy (3 EC), and the Master thesis project (40 EC). The major consists of compulsory courses, teaching students the core of the research specialisation selected. In addition, electives are offered as well as the compulsory Master Seminar (6 EC), allowing students to address specific topics, study literature, do presentations and give written accounts of their findings. The electives within the major have to be approved by the examination board. The minor is composed of courses in mathematics outside of the specialisation or of courses in another discipline. These courses have to be approved by the examination board as well. The Professional Preparation course offers practical labour market preparation, such as drafting their resumé. The Master thesis project is an individual mathematics research project. The curriculum of the societal specialisations differs from that of the research specialisations. The first year is largely identical to the first year of the research specialisations. Students may, under some conditions, switch between societal and research specialisations until the end of the first year. The second years of the societal specialisations are, however, quite different. Depending on the societal specialisation chosen, in the second year courses on management and innovation, courses on science and media, societal interaction and public policy or courses on education and didactics are offered. The Master graduation projects differ as well and are 30 EC. As stated before, quite a number of mathematics courses are offered by Mastermath. The programme intends to raise the number of local courses. In the curriculum, academic skills, such as problem solving, collaboration, writing and presentation skills are addressed. Students are taught research skills, especially in the Master thesis project. The programme works on the introduction of new subjects in the curriculum, such as data science and population dynamics.

The permanent staff lecturing in this programme and the Bachelor Wiskunde programme constitute 20.5 full-time equivalents in terms of teaching capacity. Nearly all staff members are active researchers in IMAPP, all of them having PhD degrees. Practically all staff members are BKO-certified, the BKO-certification being a prerequisite for permanent positions. Staff members offer the lectures, whereas teaching assistants guide students in exercise classes. Lecturers meet to discuss the

programme and to adjust courses. Regular formal meetings of lecturers are scheduled. Informal lunch meetings take place as well. The lecturers with whom the panel met, expressed experiencing the work load to be high but manageable. The sector plan Mathematics will allow the programme to recruit extra staff. Educational capabilities are among the main criteria in staff recruitment procedures.

The educational concept of the programme is directed towards intensive, small-scale and student self-directed education. The students-to-staff ratio is about 16/1 for the Bachelor Wiskunde and the Master Mathematics programmes together. Study methods adopted are lectures, exercise classes, practical classes, group work and self-study. For Mastermath courses, mentor groups are scheduled to allow students to work together on exercises under lecturers' guidance. The main study methods are lectures and exercise classes. Lecturers teach in both. PhD students may as teaching assistants be involved in the courses. Lecturers and teaching assistants give feedback on the homework assignments. Most local lectures are recorded and are made available to students. Students may also access the learning system Brightspace for additional information. Video recordings for Mastermath classes are less frequent, which may present problems for students. Students are guided by both study advisors and lecturers. At the beginning of the curriculum, study advisors are available to advise on the specialisation to select. Later in the programme, study advisors may be consulted on the specific field and the supervisor for their Master thesis project. Students may also ask for names of organisations available for external thesis projects. At the end of the first semester, students have the chance to discuss their study plans with one of the staff members, preparing for the Master thesis project. Mastermath courses tend to become more demanding. The average student success rates are 31 % after two years and 60 % after three years (figures for last three to five cohorts).

Considerations

The panel approves of the entry requirements and the admission procedures of the programme. The panel supports the programme's intentions to improve the screening of applications, by verifying the capabilities of applicants more strictly.

The curriculum of the programme matches the intended learning outcomes, as is adequately explained by the programme. The panel considers the curriculum to be solid and the courses to be good. The panel recommends to reinforce applied mathematics courses on stochastics, numerical analysis and computer programming. In the curriculum, academic skills and research skills are addressed appropriately. The Mastermath courses are positive, as they offer a wide range of courses in various fields to students. The panel, however, supports the programme intentions to make the programme less dependent upon the Mastermath courses.

The permanent staff in the programme are all PhDs and have solid research backgrounds. Their educational capabilities are up to standard, as the substantial proportion of lecturers being BKO-certified shows. The staff is perceived by the panel to be very committed to the programme. Students are very positive about the educational capabilities and the accessibility of the lecturers. The regular staff meetings on education are positive. The panel welcomes that extra staff is recruited to alleviate the work load of the lecturers. The panel is positive that the educational capabilities are taken into account, when recruiting staff members.

The educational concept and study methods of the programme meet the programme's characteristics. The students-to-staff ratio allows for small-scale teaching. Feedback on assignments is organised appropriately. The panel is positive about the study guidance in the programme. The panel considers the programme to be feasible. Some Mastermath courses have become more challenging. The panel suggests to discuss this with Mastermath management. It is suggested by the panel to take the growth and development of the programme into account, when considering organisational measures. The panel advises to monitor the student success rates of 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 examination and assessment regulations for the programme are laid down in the programme assessment plan. These regulations are in line with the Faculty of Science examination policies. The examination board of the Educational Institute for Mathematics, Physics and Astronomy WiNSt has the authority to monitor examinations and assessments in this programme.

The examination methods in the programme include written examinations, homework assignments, reports and presentations, and oral examinations. The examination methods are aligned with the course goals. In nearly all courses, multiple examination methods are scheduled. The final grade of the courses is the weighted outcome of the grades of these examinations. Written examinations are scheduled in all courses, but may be combined with homework assignments and oral examinations.

In the first semester of the programme, students make a plan with courses they intend to take in the rest of their programme. The choices are discussed with a staff member, taking into account possible topics for the Master thesis project. Master thesis projects are done within the Educational Institute WiNSt, but may also be done in companies or organisations. The number of external projects is increasing. The project outline has to be approved by the supervisor. In the projects, students have to demonstrate that they know how to do independent mathematical research. Students are entitled to individual supervision. The main assessment criteria to assess the projects are depth and originality of the subject researched, the scientific soundness of the project done, and the reporting skills and oral presentation skills of the student. The projects are assessed by the supervisor and the second reader. The supervisor informs the second reader about the process. Every one of them completes the assessment form. If their assessments differ more than 0.5 points, they have to discuss their differences in judgements.

In the programme, measures have been taken to ensure the quality of examinations and assessments. The assessment plan for the programme has been drafted, aligning the intended learning outcomes of the programme, course objectives and course examinations. Course dossiers for all courses document, among others, the course goals, examinations and answer models, test matrices, and outcomes of surveys among students and lecturers. The examinations of the courses are peer-reviewed, before being presented to the students. Test matrices for examinations have been adopted. Every year, the examination board reviews samples of course dossiers and samples of Master thesis projects and their assessments. Master theses are checked for plagiarism.

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 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 the programme examination and assessment regulations to be in line with Faculty of Science examination policies. The panel is positive about the responsibilities and activities of the examination board. The panel considers the examination board to work very solidly. The board could be more pro-active, though.

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 Master thesis project supervision is organised effectively. The assessment of the projects is conducted reliably. The panel notes that different assessment forms are being used, the latest form not being very informative. This especially applies to the societal specialisations' forms. The panel finds the written comments on the assessment forms by the examiners comprehensive and valuable. The panel, however, advises to add more extensive arguments to substantiate the assessments of the Master theses. 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 the oral presentation by the student.

The panel appreciates the measures taken by the programme to ensure the quality of examinations and assessments. These measures enhance the validity of examinations and the reliability of assessments. The panel is positive about the regular reviews of examinations and Master thesis projects by the examination board. The panel approves of the regulations regarding the Mastermath examinations and the quality control of these examinations by the examination board.

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 Master thesis projects of fifteen graduates of the programme with different grades. In the Master thesis projects, students have to demonstrate that they are able to formulate mathematical research questions and hypotheses and have acquired the knowledge and skills to address these research questions. Students also have to show having the skills to report on this research both orally and in writing. Students have to demonstrate having reached the level of professional mathematician.

The average grade for the Master thesis projects of the last two years is about 8.0. The proportion of students graduating cum laude, amounts to about 39 % of the total number of graduates, for the last three years.

The programme meets regularly with the Commissie afnemend veld, consisting of professional field representatives, to align the programme to professional practice requirements. The programme in collaboration with the study association DESDA organises labour market orientation meetings with alumni of the programme. In addition, the study association schedules regular site visits to companies.

Programme graduates find suitable positions very easily. Mathematicians are very much in demand in a wide range of industries. On average, graduates take about three months to find fitting jobs. About 15 % to 20 % of the graduates are employed in the financial sector, also about 15 % to 20 % find positions in the computer industry, and about 15 % of them go on to work in public sector organisations. About 25 % to 30 % of the graduates proceed to PhD trajectories. Representatives of the professional field are very content about the programme graduates.

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 thesis projects. No projects were found to be unsatisfactory. The panel regards the mathematics contents of the projects of the research specialisations to be up to standard. The Master thesis projects of the societal specialisations are less advanced in terms of mathematical knowledge and skills, but this is conform to the different set of intended learning outcomes being applicable for these specialisations. The language and style in the theses could be improved.

The panel appreciates the labour market orientation activities on the part of the programme and the study association. The panel suggests to strengthen the relations with the programme alumni.

The panel is convinced that the programme graduates have reached the intended learning outcomes of the programme. The level of the achieved learning outcomes is confirmed by the substantial proportion of graduates managing to secure positions as PhD students.

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 consider more elaborately the specific position of the programme when implementing Faculty measures, as these may not always fit the specific nature of mathematics education.
- To reinforce applied mathematics courses on stochastics, numerical analysis and computer programming.
- To discuss with Mastermath management the more challenging level of Mastermath courses.
- To take the growth and development of the programme into account, when considering organisational measures.
- To monitor the student success rates of the programme.
- To add more extensive comments and arguments to substantiate the assessments of the Master project theses.
- To strengthen the relations with the programme alumni.