



MSc Data Science and Society
Tilburg University

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Project code P2303

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Summary

Standard 1. Intended learning outcomes

According to the panel, the MSc Data Science and Society has a clear profile. Its aim to provide data science education to students with a non-technical background, so that they can apply these skills to challenges within their domain, is relevant. The intended learning outcomes reflect the academic master's level of the programme and show a clear alignment with international requirements for academic data science programmes. The programme's aims correspond well with the need for interdisciplinary data scientists in the professional field. The panel recommends setting up a structure to uphold relation with the professional field in order to keep the programme relevant and up-to-date.

Standard 2. Teaching-learning environment

The panel concludes that the curriculum has a clear structure and strikes a good balance between technical and applied components, allowing students with a non-technical background to obtain technical data science skills, and connect these to their disciplinary knowledge. It particularly values the attention paid to societal and ethical aspects of data science. To further improve the curriculum, the programme could consider introducing learning trajectories for academic skills, as well as societal/ethical aspects of data science. These might help students to see the coherence of the curriculum. The educational methods aim to utilize diversity in the classroom so that students learn from fellow students with different backgrounds. The panel appreciates this approach but thinks it could be further developed to make more explicit use of the possibilities for learning in a diverse and multidisciplinary environment. The use of English as language of instruction is well-substantiated and well-implemented and is relevant for the expected future career of graduates.

The programme invests in substantive support and guidance to help students realize the intended learning outcomes. The admission criteria safeguard that all students are sufficiently challenged by the programme and are able to work from a multidisciplinary perspective. Student guidance is set up in such a way that students have the opportunity to practice skills in a small-scale setting. The curriculum is challenging yet feasible: the panel was impressed that students without previous education in exact sciences are able to master technical content within a year. The feasibility of the curriculum could be further improved by revising the thesis trajectory so that students have sufficient time and guidance to find a suitable dataset for their thesis. The growth in student numbers has been followed by a growth in staff numbers, realizing an appropriately sized teaching staff for the programme, although students would definitely benefit from additional investments in staff to increase opportunities for working in a smaller-scale teaching-learning environment. The teaching staff is well-qualified and enthusiastic and is able to connect research and education. The panel appreciates the attention paid to teacher professionalization and encourages the programme to keep working towards a teaching qualification for all staff members. The programme-specific facilities in the form of computer rooms and a high-performance computing cluster are appropriate, although opportunities for additional investments in computing facilities would be welcome.

Standard 3. Student assessment

The panel considers assessment policies and their implementation in the programme to be solid. Assessment methods are varied and appropriate quality assurance procedures safeguard the quality of assessment. The Board of Examiners fulfils its legal duties and checks assessment quality through course checks as well as thesis calibration sessions. The panel welcomes the restructuring of the Board in programme-specific chambers and recommends monitoring whether this has the desired effect of bringing the Board closer to the programmes. The theses are assessed in a valid and insightful way, with appropriate

grading, and using two independent examiners, although in some cases substantiation of grades on the assessment form could be more elaborate. The panel advises to include process evaluation in thesis assessment, and to assess relevant skills and attitudes demonstrated by students throughout the thesis project through a separate grading criterion. Finally, the panel recommends reflecting on the current extensive use of resits in the thesis process because of too tight time schedules, and looking for alternative options to provide more flexibility and less workload for examiners.

Standard 4. Achieved learning outcomes

The good quality of the theses, as well as the careers of alumni, convinced the panel that students of the MSc Data Science and Society achieve the intended learning outcomes. Graduates are in high demand, and quickly find a position in a variety of positions relevant to the programme.

Score table

The panel assesses the programme as follows:

M Data Science and Society

Standard 1: Intended learning outcomes	meets the standard
Standard 2: Teaching-learning environment	meets the standard
Standard 3: Student assessment	meets the standard
Standard 4: Achieved learning outcomes	meets the standard

General conclusion positive

Prof. Aske Plaat
Chair

Peter Hildering MSc
Secretary

Date: 8 February 2024

Introduction

Procedure

Assessment

On 1 December 2023, the master's programme Data Science in Society of Tilburg University was assessed by an independent peer review panel. The assessment followed the procedure and standards of the NVAO Assessment Framework for the Higher Education Accreditation System of the Netherlands (September 2018). Quality assurance agency Academion coordinated the assessment upon request of the programme. Peter Hilderling acted as both coordinator and secretary. He has been certified and registered by the NVAO. The assessment was combined with a panel advice on the funding level of the programme. This advice was provided to Tilburg University in a panel letter separate from this report.

Preparation

Academion composed the peer review panel in cooperation with the programme and taking into account the expertise and independence of the members. On 14 September 2023, the NVAO approved the composition of the panel. The coordinator instructed the panel chair on his role in the site visit according to the Panel chair profile (NVAO 2016).

The programme composed a site visit schedule in consultation with the coordinator (see appendix 3). The programme selected representative partners for the various interviews. It also determined that the development dialogue would be made part of the site visit. A separate development report was made based on this dialogue.

The programme provided the coordinator with a list of graduates over the period 2020-2022. In consultation with the coordinator, the panel chair selected 15 theses, taking the diversity of final grades and examiners into account. Prior to the site visit, the programme provided the panel with the theses and the accompanying assessment forms. It also provided the panel with the self evaluation report and additional materials (see appendix 4).

The panel members studied the information and sent their findings to the secretary. The secretary collected the panel's questions and remarks in a document and shared this with the panel members. In a preliminary meeting, the panel discussed the initial findings on the self-evaluation report and the theses, as well as the division of tasks during the site visit. The panel was also informed on the assessment framework, the working method and the planning of the site visit and report.

Site visit

During the site visit, the panel interviewed various programme representatives (see appendix 3). The panel also offered students and staff members an opportunity for confidential discussion during a consultation hour. No consultation was requested. The panel used the final part of the site visit to discuss its findings in an internal meeting. Afterwards, the panel chair publicly presented the preliminary findings.

Report

The secretary wrote a draft report based on the panel's findings and submitted it to a colleague at Academion for peer assessment. Subsequently, the secretary sent the report to the panel for feedback. After processing this feedback, the secretary sent the draft report to the programme in order to have it checked for factual irregularities. The secretary discussed the ensuing comments with the panel chair and changes were

implemented accordingly. The panel then finalised the report, and the secretary sent it to the School of Humanities and Data Science of Tilburg University.

Panel

The panel assessing the master's programme Data Science and Society at Tilburg University consisted of the following members:

- Prof. dr. Aske Plaat, Scientific Director of the Leiden Institute of Advanced Computer Science, Leiden University – chair;
- Mag. dr. LL. M. Oskar Gstrein, Programme Director BSc Data Science and Society, Deputy Department Head Governance and Innovation, University of Groningen, Campus Fryslân;
- Dr. Katrin Schulz, Associate Professor at the Institute of Logic, Language and Computation (ILLC), University of Amsterdam;
- Prof. dr. Wim Van Petegem, Professor Learning Technologies at KU Leuven, Faculty of Engineering Technology;
- Martine Landman, master's student Data Science for Food and Health, Wageningen University & Research - student-member.

Information on the programme

Name of the institution:	Tilburg University
Status of the institution:	Publicly funded institution
Result institutional quality assurance assessment:	Positive
Programme name:	Data Science and Society
CROHO number:	60964
Level:	Master
Orientation:	Academic
Number of credits:	60 EC
Location:	Tilburg
Mode(s) of study:	Fulltime
Language of instruction:	English
Submission date NVAO:	1 May 2024

Description of the assessment

Reflection on the recommendations of the previous panel

During the initial accreditation in 2018, the MSc Data Science and Society received conditions to be met regarding the admission criteria, the constructive alignment of the curriculum and the development of a system of suggested individual study paths. In an assessment of these conditions in 2020, the panel concluded that these conditions had been met. Furthermore, the panel provided the programme with a recommendation regarding the intended learning outcomes, which is discussed further in standard 1. Overall, the panel concludes that the programme has taken the conditions and recommendations of the initial accreditation to heart, and that this has led to further improvements of the MSc.

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

Profile and aims

The MSc Data Science and Society (DSS) is a multidisciplinary programme designed for students with previous expertise in a specific societal domain. It is organized by the department of Cognitive Science and Artificial Intelligence (DCA) in the Tilburg School of Humanities and Digital Sciences (TSHD) of Tilburg University. The programme is provided in collaboration with different schools of Tilburg University: Tilburg School of Social and Behavioral Sciences, Tilburg School of Economics and Management, and Tilburg Law School participate by providing teaching staff members and organizing specialization courses.

The programme's aim is for graduates to combine their domain-specific expertise with the data science knowledge and skills they obtain in the programme and apply this knowledge and these skills to societal challenges in their domain. The MSc DSS trains professionals who can dissect complex data and transform them into understandable information for colleagues and decision-makers. Graduates are a linking pin between data science and their domain, and combine technical skills, knowledge about legal and ethical issues, and interdisciplinary communication skills. Furthermore, the programme provides students with academic training and a theoretical background in data science. Due to the domain knowledge students need in the programme, admission takes place on the level of the MSc's four specializations: Business, Governance, Media, and Health.

The panel studied the profile and aims of the programme and discussed them with various programme representatives during the site visit. It concludes that the MSc Data Science and Society has a clear and ambitious profile, aiming to educate students with no previous education in data science, so that they can apply these skills to challenges within their domain. This is a very relevant aim, as it contributes to the education of interdisciplinary data scientists, who are in demand in the industry and society. The aim is consistently visible throughout the design of the programme, with the admission criteria, curriculum and teaching-learning environment all adding to realizing this goal. According to the panel, the four specializations are relevant domains in which data science can be applied, and they align well with the research specialisms at Tilburg University.

Intended learning outcomes

The profile and aims of the programme have been translated into 11 intended learning outcomes (ILOs). These have been substantially refined since the recommendations of the initial accreditation. The 2018 panel recommended to benchmark with international frameworks in the data science field, include the multidisciplinary perspective more clearly and articulate a vision focused on the enrichment of other disciplines with data science. In reaction to this, the programme reflected with stakeholders including staff, alumni and programme committee on the overall vision of the programme and conducted a benchmark with other data science programmes. This input was used to update the ILOs, including the addition of specific multidisciplinary learning outcomes for each specialization next to the general learning outcomes. The programme also used the EDISON Data Science Competence Framework to reformulate the data science components in the ILOs. The learning outcomes are formulated using terminology from the Dublin descriptors, reflecting the master's level and academic orientation of the programme.

The panel concludes that the intended learning outcomes are appropriate and reflect the academic master's level as demonstrated in their alignment with the Dublin descriptors. It pays its compliments to the programme with its thorough work on meeting the recommendations of the previous panel. The update of the ILOs results in a better alignment with international requirements for data science programmes. It also reflects the multi-disciplinarity of the programme through specific learning outcomes for all four specializations.

Next to alignment with international frameworks for data science education, the programme is currently working on expanding its external network in order to tailor its aims to the expectations of the professional field. The department is developing a structure to achieve long-term relationships with its alumni and is planning to use this to discuss the programme in the light of developments in the field. It also will build up more systemic partnerships with companies and NGOs within the region. The panel fully supports this and encourages the programme to bring these plans to fruition. Structural relations with the professional field, for instance in the form of a professional field committee consisting of alumni and representatives of companies and NGOs, could help in keeping the programme relevant and up-to-date in a dynamic professional environment.

Considerations

According to the panel, the MSc Data Science and Society has a clear profile. Its aim to provide data science education to students with a non-technical background, so that they can apply these skills to challenges within their domain, is relevant. The intended learning outcomes reflect the academic master's level of the programme and show a clear alignment with international requirements for academic data science programmes. The programme's aims correspond well with the need for interdisciplinary data scientists in the professional field. The panel recommends setting up a structure to uphold relation with the professional field in order to keep the programme relevant and up-to-date.

Conclusion

The panel concludes that the programme meets standard 1.

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

Curriculum

The MSc Data Science and Society's curriculum balances theory and practice. Students are taught knowledge and skills in data science, learn how to utilize these in the context of societal challenges in their domain and are provided with academic training regarding research skills and attitudes. An important part of this academic training is addressing the ethical and legal aspects of data science and reflecting on the impact of data science on society. The full-time, one year curriculum encompasses 60 EC. This includes four mandatory courses (24 EC) on data science and research methodology, two restricted-choice research skills courses (6 EC), two specialization-specific electives (12 EC) and a master's thesis (18 EC). See appendix 2 for an overview.

In the *mandatory courses*, students learn data science methodology as well as academic skills. Students in all specializations follow the same course, but are stimulated to apply this in the context of their specific specialization in cases and assignments. *Research skills courses* can be chosen based on their personal ambitions, such as the skills relevant to their thesis project. For the *electives*, students choose from a list of courses for their specialization. The list is composed carefully to ensure that all specialization-specific ILOs can be covered in each course, regardless of students' choices. These electives are designed specifically for the programme and are offered by the four Schools associated with the programme. In the *master's thesis*, which is labelled 'Data Science in Action', students conduct an individual research project: the application of a machine learning approach to a data science topic in their field of specialization. Students are encouraged to use different algorithms in combination with multiple feature sets to derive the best predictive model for their problem. They also explore model errors and explainable AI techniques to discuss and reflect on the scientific value as well as the societal and ethical impact of their work.

The panel studied the MSc's curriculum as well as the content of a selection of courses and discussed them with teaching staff and students. It concludes that the curriculum is well-aligned with the intended learning outcomes. It has a clear structure and offers a good balance between technical and applied components, with relevant and up-to-date course content. The panel noted differences between the four specializations regarding the electives. It understood from the discussions during the site visit that depending on the student numbers in the specializations, more or fewer specialization-specific electives are offered. The panel understands this but points out that fewer options could also contribute to a lower popularity of specializations. It thinks that a specializations with lower enrolment such as Media could be made more attractive to students by offering more tailored specialization courses. The panel suggests reflecting on this.

The panel was pleased to note that there is substantial attention for data science from a societal and ethical perspective, which it considers essential for data scientists working on societal challenges. The panel suggests developing the societal and ethical aspects within the courses into a learning trajectory, clearly highlighting the various course components in which these aspects are covered, culminating in the thesis as capstone (see also standard 4). This could help students to see the coherence of the curriculum regarding this aspect.

The panel also concludes that sufficient attention is paid to academic skills within the curriculum. Students have the opportunity to obtain specific research skills in the restricted-choice courses, and practice transferable skills such as presenting, writing and teamwork throughout the courses. At the same time, the panel thinks that the programme would benefit from a more systematic structure for skills education. The skills components are currently embedded in the courses in such a way that they are hard to identify on a curriculum level. The panel recommends bringing skills education to the surface and systematically describing in an overview how this is covered throughout the curriculum. Such a learning trajectory also makes it easier to keep track of academic skills education in the event of future curriculum changes, as well as allowing for the systematic assessment of skills. In this learning trajectory, the thesis could serve as the capstone for the assessment of academic skills (see standard 3).

Teaching methods and language of instruction

The educational vision of the programme is focused on learning by doing, and on teaching in a diverse and inclusive learning environment. Students often work in multidisciplinary teams on realistic societal assignments, often with links to societal partners. In these projects, they apply the techniques they learnt in the courses, and discuss and reflect on the results. By teaching in such a learning environment, the programme aims to exploit the diversity of the student population in terms of nationality, work experience, specialization domain, age, and gender by having students learn from each other.

The panel appreciates the educational vision and thinks that the diversity in background of students provides a fruitful environment for students to learn from each other. It learnt from discussions during the site visit that this often works well in practice. At the same time, the panel noted that there is still unused potential in the implementation of this educational vision, and that the programme could make more conscious use of the diversity within the student population. The programme could for instance develop a general policy for composing diverse project groups and help students to reflect on the group process and the way they made use of the diversity on various levels to add to the final result. The panel recommends further developing the educational methods in this aspect, in order to fully make use of the opportunities for learning in a diverse and multidisciplinary environment.

English is used as the language of instruction, as the programme considers both the academic and professional field of data science to be strongly internationally oriented. A substantial number of graduates can be expected to work for larger organizations where English is the working language. Furthermore, as mentioned above, diversity is part of the programme's educational vision, where intercultural diversity is part of this approach. To promote the quality of English language education, all lecturers are required to be proficient in English on C1 level minimum. In addition, international students need to demonstrate sufficient command of English as an admission requirement. The panel discussed the choice for English with the programme management. It considers this choice well-motivated and well-implemented and agrees that sufficient command of English will likely be important in graduates' future careers. Considering the programme's aim to connect to companies and NGOs in the region (see standard 1), the panel thinks that it will be helpful to also keep paying attention to the acquiring of the Dutch language by international staff members. This might make it easier to connect to local organizations and companies.

Admission

As the focus of the programme is to educate non-technical students in data science, the programme takes much care to guide students in the process of acquiring technical skills in a relatively short time. Students entering the programme typically do not have much prior knowledge in data science and machine learning. The programme's admission requirements focus on disciplinary knowledge in one of the four specialization domains, as students are expected to connect this knowledge to their data science skills in the curriculum.

That means that students with academic experience with data science and/or machine learning are normally not admissible to the programme. Students who lack some of the necessary academic skills to be admitted to the programme must take part in the pre-master programme. This includes students from higher vocational education (hbo), who currently comprise about 40% of the intake.

As was also concluded by the 2020 panel that assessed the conditions posed during the initial accreditation, the admission criteria match the curriculum content well and safeguard sufficient challenge and multidisciplinary focus for all students. From students that took the pre-master, the panel got very favourable feedback, as students felt that it prepared them really well for the programme. As it already contained programming education, some students even felt that this gave them a head start compared to other students.

Guidance and support

The programme experienced rapid growth in the first few years, peaking at an enrolment of 329 students in 2019-2020. Student numbers have now stabilized around 250 students per year. To accommodate these student numbers, the students are often divided into smaller classes for practical sessions, particularly those related to the acquiring of technical skills, for which students need frequent feedback and guidance. Thesis supervision is set up in a similar way. Students can submit their preference for a topic and supervisor and are assigned to a study group of five to eight students working under the guidance of the same supervisor. Students present in-progress analyses and results in thesis supervision meetings, and they give and receive feedback to and from their peers and supervisor.

The panel is positive about student guidance in the MSc Data Science and Society. It considers the small-scale set-up of the practical sessions with immediate feedback to be very valuable in helping students acquire technical skills. In the thesis supervision groups, students can learn from each other as well as from their supervisor. The panel understood from both students and the programme management that a further implementation of small-scale education would be beneficial to the programme, particularly in the form of extra tutors in the practical sessions and smaller thesis supervision groups. Through its request for a higher funding level, for which the panel expressed its support in a separate letter, the programme aims to acquire the necessary funding to realize this.

Additional support is provided by the study advisor, who helps students navigate the curriculum and discusses study progress in individual meetings. The programme organizes extra-curricular support components, such as information sessions, labour market orientation and student panel sessions. These student panels are informal bodies of students that discuss the ongoing education half-way the semester, so that their input can be used to improve courses while they are still running. The panel approves of student support in the programme. It learnt from students that feedback provided through student panels, as well as other channels, is usually taken to heart by the programme and used to improve education and guidance.

Feasibility

On average, approximately 45% of students graduate within one year, and 82% within two years. During the site visit, the panel learnt that a considerable part of study delay is due to students pursuing other goals, such as extra courses, a double master's degree, part-time jobs or extracurricular internships. Students mentioned that the curriculum schedule is tight yet feasible. The student chapter of the self-evaluation report mentioned the set-up of the thesis trajectory as a potential source of delay. The thesis trajectory is currently devised as a course with deadlines split into devising a research plan and proposal (3 EC) in the third block, and the actual research project (15 EC) in the fourth block. Students noted that finding a suitable dataset for their thesis project often took longer than expected. As a result, some students miss the deadline

for an approved research plan and proposal and have to delay their thesis. The programme is currently experimenting with a set-up where students can voluntarily choose an earlier deadline for their proposal, so that they have sufficient time to address any unforeseen circumstances. The panel thinks that this is a good idea to tackle the potential delay in the thesis trajectory and recommends adopting this as the standard procedure for all students. According to the panel, this earlier starting moment should be accompanied with increased communication and guidance with respect to the search for a data set that is suitable for a thesis project.

Teaching staff

All lecturers in the programme are employed at Tilburg University. Most staff is from the TSHD, with staff from the other three associated Schools participating in specialization-specific electives and thesis supervision. All lecturers have obtained a PhD and the large majority are active researchers that are able to connect research and education. Tutors assisting the lecturers in the practical sessions are either PhD students or student assistants. The growth in student numbers was followed by a growth in teaching staff: the programme was able to increase the teaching staff in the DCA department from twenty in 2020 to fifty in 2023. The staff is relatively young, diverse, and international: 70% has an international background. Teaching staff members revise the course content annually to reflect the latest insights from the field. Since 2010, all lecturers have been required to obtain a University Teaching Qualification (UTQ); 78% of the staff members have currently obtained the UTQ or are in the process of doing so. The UTQ track includes training on student supervision and providing feedback to students.

Based on an overview of the teaching staff as well as discussions during the site visit, the panel concludes that the teaching staff is well-qualified and enthusiastic to teach in the programme. The panel appreciates the attention paid to teacher professionalization, particularly thesis supervision, giving feedback and the continuous improvement of courses in the UTQ. It encourages the programme to keep working on having all teaching staff obtain a UTQ. Even though the panel considers the teaching staff numbers sufficient for current student numbers, it thinks that students would definitely benefit from additional investments in staff to increase opportunities for working in a smaller-scale teaching-learning environment. This was discussed in the aforementioned letter supporting the request for higher funding from the programme.

The panel praises the DCA department for their success in attracting new highly qualified staff members to the department. The panel learnt that there is sufficient support available to help new staff members find their way in the programme. It suggests that this support could be further structured, as it understood that most of the support is currently offered upon request. A set onboarding trajectory for all new staff members in the programme, for instance through a mentoring programme, would provide all staff members with a comparable support structure.

Programme-specific facilities

For the practical programming seminars, exams and tutorials, the programme uses computer rooms on campus with a variety of software, including VS Code, Jupyter Lab, RStudio, SQL Server Management Studio and Spark. Furthermore, the programme participates in a high-performance GPU computing cluster at Tilburg University for educational purposes, which it shares with the Cognitive Science and AI programmes. Access to this cluster is currently reserved for thesis projects, with a maximum of 36 hours of computing time per student. If a higher funding level can be successfully secured, the programme aims to invest in expansion of this cluster with more personalized support, additional computing time per student and the opportunity to also use high-performance computing facilities in courses.

The panel concludes that the programme-specific facilities are appropriate but agrees with the programme that they are currently limited and that additional investments in the form of machines, licences, cloud services and computing capacity would be welcome. The use of high-performance computing in courses in addition to thesis projects would add to the quality and content of the courses. Furthermore, the panel learnt that students sometimes use their own resources to arrange additional computing power and services. Improved facilities for all students would increase equal opportunities for all students, also for those with limited own resources. The panel recommends, provided that the abovementioned request for higher funding is granted, investing in additional computing facilities.

Considerations

The panel concludes that the curriculum has a clear structure and strikes a good balance between technical and applied components, allowing students with a non-technical background to obtain technical data science skills, and connect these to their disciplinary knowledge. It particularly values the attention paid to societal and ethical aspects of data science. To further improve the curriculum, the programme could consider introducing learning trajectories for academic skills, as well as societal/ethical aspects of data science. These might help students to see the coherence of the curriculum. The educational methods aim to utilize diversity in the classroom so that students learn from fellow students with different backgrounds. The panel appreciates this approach but thinks it could be further developed to make more explicit use of the possibilities for learning in a diverse and multidisciplinary environment. The use of English as language of instruction is well-substantiated and well-implemented and is relevant for the expected future career of graduates.

The programme invests in substantive support and guidance to help students realize the intended learning outcomes. The admission criteria safeguard that all students are sufficiently challenged by the programme and are able to work from a multidisciplinary perspective. Student guidance is set up in such a way that students have the opportunity to practice skills in a small-scale setting. The curriculum is challenging yet feasible: the panel was impressed that students without previous education in exact sciences are able to master technical content within a year. The feasibility of the curriculum could be further improved by revising the thesis trajectory so that students have sufficient time and guidance to find a suitable dataset for their thesis. The growth in student numbers has been followed by a growth in staff numbers, realizing an appropriately sized teaching staff for the programme, although students would definitely benefit from additional investments in staff to increase opportunities for working in a smaller-scale teaching-learning environment. The teaching staff is well-qualified and enthusiastic and is able to connect research and education. The panel appreciates the attention paid to teacher professionalization and encourages the programme to keep working towards a teaching qualification for all staff members. The programme-specific facilities in the form of computer rooms and a high-performance computing cluster are appropriate, although opportunities for additional investments in computing facilities would be welcome.

Conclusion

The panel concludes that the programme meets standard 2.

Standard 3. Student assessment

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

Findings

System of assessment

The MSc Data Science and Society's system of assessment is based on the TSHD Assessment Policy 2022, which describes the vision on assessment as well as general guidelines and rules to ensure the quality of assessment. This policy is operationalized in an assessment handbook for teaching staff members that describes the concrete guidelines as well as do's and don'ts regarding assessment. This includes course assessment overviews (connecting assessment to the course learning goals and programme ILOs), validating exams according to the four-eye principle, and transparent communication of assessment procedures and rubrics prior to exams and assignments. Assessment methods within the programme include written exams, presentations, essays, programming assignments and lab assignments. In the case of group assignments, the grade for group work can never account for more than 40% of the final grade to ensure that students also individually master the course learning goals.

The panel studied the system of assessment, including the assessment plan, policy and handbook, as well as some examples of assessment in courses. It concludes that the assessment policies and their implementation in the programme are solid. The assessment methods are varied and tie in with the learning goals of the courses. Assessment and the associated quality assurance are organized in such a way that they safeguard reliable, valid and transparent assessment.

Thesis assessment

The master's thesis is assessed by two assessors: the first examiner, who is usually the student's thesis supervisor, and an independent second reader. Students are always assessed individually: the thesis study groups are for supervision and support only. The thesis coordinator is responsible for assigning examiners to specific theses. Students can only execute their thesis if their proposal is approved by the supervisor. There is a strict deadline for submission of the proposal in the third block of the curriculum, so students can spend the full fourth block on the actual execution of the project. After completion, both examiners individually conduct a full evaluation of the thesis report and evaluate students on six main criteria: Problem Statement & Research Goal, Literature Review, Methodology & Experimental Setup, Results, Discussion & Conclusion, Form & Presentation (of the report). To help examiners evaluate these criteria, examiners are provided with a grading rubric for the criteria and the associated sub-criteria. In a meeting, both examiners discuss and agree upon a joint evaluation and final grade, which is then substantiated on an assessment form provided to students. The overall grade is the average of the six grades on the criteria, with the requirement that each grade is at least a passing grade.

The panel studied the thesis assessment procedures and criteria, as well the assessment of a selection of 15 theses. It concludes that the theses are assessed in an insightful way, and that appropriate grades are given. The assessment form and the associated rubric are helpful, and the two independent examiners add to the validity of the assessment. In some cases, the panel would have welcomed more substantiation of the grades on the assessment form; it recommends paying extra attention to this in the instruction to examiners.

Regarding the evaluation criteria, the panel noted that they are all associated with the final product, and that there are no separate criteria concerning the process, including the skills and attitudes demonstrated by the student. Even though these skills are assessed in course components as well, the panel thinks that it is a

missed opportunity to not use the final project as a capstone for the skills learning trajectory, especially considering the focus on character development in the educational vision. In discussing this, the programme explained that they refrained from introducing process assessment to ensure that all evaluation criteria can be independently checked by both examiners. The panel understands this reasoning but thinks that this can be assessed in a sufficient reliable way using insights collected throughout the thesis supervision process, possibly complemented by a presentation and/or defence to the thesis process. The panel recommends adding (sub-)criteria related to process and performance to the thesis evaluation, such as (but not limited to) work ethics, communication, openness to feedback and planning skills.

The panel found that a substantial part of the theses it studied consisted of resits. It understood that due to the strict deadlines for the thesis, up to 40% of students hand in an incomplete thesis and use the opportunity for a resit to get feedback and complete their thesis at the next opportunity in the following semester. The panel thinks that, although this workaround to circumvent the strict deadlines might work well for students, it also adds to the workload of examiners, who now often have to evaluate theses twice. It advises the programme to look for alternative options to either help students meet the deadlines or introduce more flexibility in the process (see also standard 2 – Feasibility).

Examination Board

The Examination Board oversees the quality of assessment within the programme. It advises the programme management and teaching staff members on assessment, including annual advice on the programme assessment plan, enforces fraud and plagiarism regulations and evaluates the quality of courses and master's theses. To evaluate the quality of courses, the Board has appointed an Assessment Committee, that selects at least one course per semester to check the validity, reliability and transparency of assessment. To evaluate the quality of master's theses, the Board issues an thesis calibration session per semester. This session is organized by the thesis coordinator and consists of the re-evaluation of a number of theses by examiners to see whether they have been completed in a transparent, reliable and objective way. The resulting report is discussed by the Examination Board and if necessary, leads to recommendations by the Board to the programme director.

The Examination Board is shared between all TSHD bachelor's and master's programmes and consists of ten members for all of the associated programmes, as well as an external member. Due to the growth of the school, the Board has adopted a new structure per 2023-2024 with separate chambers per cluster of programmes that are mandated to make decisions at the operational level. The chairs of all chambers jointly form the central Examination Board. The aim of this new structure is to increase the capacity of the Board without increasing the workload of the current members.

Based on the documentation and the discussions with the Board during the site visit, the panel concludes that the Examination Board of the programme fulfils its legal duties in the quality assurance of assessment. The quality assurance mechanisms to monitor assessment quality in the programme are appropriate. The calibration sessions are a valuable tool to combine quality assurance with teacher professionalization and alignment between assessors. The new structure with chambers within the Board is welcomed by the panel and fits the increased size of the department. The panel thinks that the chambers can lead to a closer connection between the Board and the individual programmes; it recommends an evaluation after the first year to determine whether it has indeed this desired effect.

Considerations

The panel considers assessment policies and their implementation in the programme to be solid. Assessment methods are varied, and appropriate quality assurance procedures safeguard the quality of

assessment. The Board of Examiners fulfils its legal duties and checks assessment quality through course checks as well as thesis calibration sessions. The panel welcomes the restructuring of the Board in programme-specific chambers and recommends monitoring whether this has the desired effect of bringing the Board closer to the programmes. The theses are assessed in a valid and insightful way, with appropriate grading, and using two independent examiners, although in some cases substantiation of grades on the assessment form could be more elaborate. The panel advises to include process evaluation in thesis assessment, and to assess relevant skills and attitudes demonstrated by students throughout the thesis project through a separate grading criterion. Finally, the panel recommends reflecting on the current extensive use of resits in the thesis process because of too tight time schedules, and looking for alternative options to provide more flexibility and less workload for examiners.

Conclusion

The panel concludes that the programme meets standard 3.

Standard 4. Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

To determine the exit level of students, the panel studied 15 recent master's theses of the programme, taking care that all specializations were sufficiently covered. It concludes that the theses are of good quality, and clearly show that students have achieved the MSc level required by the programme. The theses showed that students are able to apply data science methodologies to a data set from a societal context, and discuss the performance of their models, as well as the scientific and societal impact of their work. The societal-ethical reflection and embedding in the domain that the student specializes in was generally visible in the work but could be more emphasized in some cases. The panel recommends embedding this more structurally in the thesis and connecting this to a learning-trajectory on the societal-ethical aspects of data science, of which the thesis can be a capstone (see standard 2).

A recent alumni survey shows that most graduates of the programme find a relevant job within four months after graduation. The top three positions for graduates are analyst, data scientist and consultant. They are employed at a variety of organizations, including banks, IT companies, government organizations or universities as a PhD candidate. The panel concludes that the programme's alumni are in high demand and learnt that several students already receive job offers before graduation, demonstrating this demand.

Considerations

The good quality of the theses, as well as the careers of alumni, convinced the panel that students of the MSc Data Science and Society achieve the intended learning outcomes. Graduates are in high demand, and quickly find a position in a variety of positions relevant to the programme.

Conclusion

The panel concludes that the programme meets standard 4.

General conclusion

The panel's assessment of the MSc Data Science and Society is positive.

Development points

1. Realize the plans to strengthen relations with alumni and the professional field, aimed at keeping the programme relevant and up-to-date in a dynamic professional environment.
2. Define learning trajectories on a curriculum level for academic skills, as well as societal/ethical aspects of data science. These might help students to better see the coherence of the curriculum, and allows for a more systematic assessment of in particular academic skills.
3. Further develop the educational methods to make more explicit use of the possibilities for learning in a diverse and multidisciplinary environment.
4. Investigate whether the thesis trajectory can be made more flexible and ensure that students have sufficient time and guidance to meet their deadlines, particularly related to finding a suitable dataset for their master's project.
5. Include evaluation of the process to the thesis assessment, and assess relevant skills and attitudes demonstrated by students throughout the thesis project as a separate grading criterion.

In case higher funding for the programme is granted:

6. Invest in additional teaching staff to increase opportunities for working in a smaller-scale teaching-learning environment
7. Invest in additional computing facilities

Appendix 1. Intended learning outcomes

Graduates of the Master's program DSS:

Knowledge and Understanding (KU)

- KU1.** Have broad knowledge and understanding of data science theories, methods, and techniques concerning data from socially relevant domains.
- KU2.** Are able to formulate novel ways of producing and processing information with the help of data analytics using existing knowledge in socially relevant domains.
- KU3.** Have knowledge and understanding of specific legal issues relevant for data driven businesses, principles of responsible innovation, and the relation between law and ethics.

Applying knowledge and understanding (AK)

- AK1.** Apply data science methods and techniques to identify and analyze original phenomena in socially relevant domains and transform them into interesting research topics.
- AK2.** Carry out application-oriented data science experiments to support decision making and create value for the society.
- AK3.** Apply the above-mentioned qualities in particular in the following domains:
 - Business*
 - AK3B1.** Management and logistics of organizations, decision making for economic and business purposes.
 - AK3B2.** Marketing and communication of organizations with customers and stakeholders.
 - Governance*
 - AK3G1.** Public administration and technology-driven public policy.
 - AK3G2.** Public security and law enforcement.
 - Media*
 - AK3M1.** Human-computer interaction, natural language processing and language generation.
 - AK3M2.** Human communication, the use of language, and other modes of communication.
 - Health*
 - AK3H1.** Health analytics and epidemiology.
 - AK3H2.** Health-related behavior and the use of technology to influence behavior.

Making judgments (MJ)

- MJ1.** Make decisions in both theoretical and applied settings, also in case of complex, incomplete, limited and/or biased information, taking into account ethical values and societal norms and consequences.
- MJ2.** Judge the appropriateness of use for statistical and coding techniques employed in data analysis for a specific domain.

Communication skills (CS)

- CS1.** Communicate their data analytic findings and conclusions in academic English clearly and unambiguously to an audience of data science specialists and non-specialists, orally or in writing, and by using appropriate communication tools and technologies, including digital techniques and visualizations.
- CS2.** Formulate and express sound judgments and argue positions and opinions in relation to a specific domain.

Learning skills (LS)

- LS1.** Take initiative and responsibility for their own education and to steer their own learning process in order to continue to learn independently and to develop professionally.
- LS2.** Attend to new ideas in the field of data science relevant to society and revise judgments in light of new evidence.

Appendix 2. Programme curriculum

Curriculum overview M Data Science and Society (2022-2023)					
Year 1	EC	Business	Governance	Media	Health
Core Courses	24				
Data Mining for Business and Governance (6 EC)		x	x	x	x
Data Science Regulation and Law (6 EC)		x	x	x	x
Machine Learning (6 EC)		x	x	x	x
Statistics and Methodology (6 EC)		x	x	x	x
PASS (participation, 0 EC)		x	x	x	x
Research skills modules	6	x	x	x	x
Choose two of the following modules:					
Data Processing (3 EC)					
Big Data (3 EC)					
Data Processing Advanced (3 EC)					
Programming with R (3 EC)					
Image Analysis (3 EC)					
Spatiotemporal Data Analysis (3 EC)					
Elective courses					
Choose two specialization-specific modules:					
Business	12	x			
Analytics for Business and Governance (6 EC)					
Business Analytics and Emerging Trends* (6 EC)					
Business Intelligence and Business Analytics* (6 EC)					
Complex Systems (6 EC)					
Analysis of Customer Data (6 EC)					
Deep Learning (6 EC)					
Interactive Data Transformation (6 EC)					
Project Management: People and Technology* (6 EC)					
Natural Language Processing (6 EC)					
Data Science: Sustainability, Privacy and Security (6 EC)					
Computational Statistics (6 EC)					
Health Analytics (6 EC)					
Bayesian Multilevel Models (6 EC)					
Governance	12		x		
Analytics for Business and Governance (6 EC)					
Data Science: Sustainability, Privacy and Security (6 EC)					
Governance and Policy Making (6 EC)					
Natural Language Processing (6 EC)					
Deep Learning (6 EC)					
Bayesian Multilevel Models (6 EC)					
Media	12			x	
Complex Systems (6 EC)					
Computational Statistics (6 EC)					
Deep Learning (6 EC)					
Natural Language Processing (6 EC)					
Analysis of Customer Data (6 EC)					
Health	12				x
Complex Systems (6 EC)					
Data Science: Sustainability, Privacy and Security (6 EC)					
Deep Learning (6 EC)					
Health Analytics (6 EC)					
Analysis of Customer Data (6 EC)					
Computational Statistics (6 EC)					
Bayesian Multilevel Models (6 EC)					
Master's Thesis Data Science in Action	18	x	x	x	x
Total one year program	60				

* There may be a maximum number of students for these three electives.
As a result, it cannot be guaranteed that a student will be able to take these courses.

Appendix 3. Programme of the site visit

Thursday 30 November 2023

17.00 - 18.30 Preliminary panel meeting

Friday 1 December 2023

08:45 - 09.00 Arrival and welcome

09.00 - 09.45 **Interview programme management**

10.00 - 10.45 **Interview students and recent alumni**

10.45 - 11.15 Break

11.15 - 12.00 **Interview teaching staff**

12.00 - 13.00 Lunch and panel deliberation

13.00 - 13.30 **Interview Examination Board and assessment specialist**

13.30 - 14.15 Internal panel deliberation

14.15 - 14.45 **Concluding session programme management**

14.45 - 15.30 **Development dialogue**

15.30 - 16.30 Internal panel deliberation

16.30 - 17.00 Oral feedback and conclusion

Appendix 4. Materials

Prior to the site visit, the panel studied 15 theses. Information on the theses is available from Academion upon request. The panel also studied other materials, which included:

- Intended Learning Outcomes
- Curriculum overview
- Study guide
- Quantitative data on the programme
- Reflection on previous panel
- SWOT analysis
- Benchmark with similar programmes
- Assessment policy
- Assessment handbook
- Programme assessment plan
- Reports by the programme committee and Examination Board
- Course content from a select number of courses
- Alumni statistics report