

Assessment report
Limited Programme Assessment

Bachelor Medical Informatics

University of Amsterdam

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1. Executive summary

In this executive summary, the panel presents the main considerations which led to the assessment of the quality of the Bachelor's programme Medical Informatics of University of Amsterdam, which has been assessed according to the NVAO Assessment Framework.

The panel noted that programme management followed up on the recommendations, made during the previous assessment in 2010. Among others, the admission requirements have been changed, giving students with Dutch VWO-diplomas with mathematics A or B and physics direct access to the programme, the student intake in the programme has increased substantially and five professors have been newly appointed. In addition, the curriculum has been adapted to include new developments like e-health and big data.

In the panel's opinion, the programme's name matches its contents and corresponds to the names of similar programmes.

The subject-specific framework of reference, drafted by the management of this programme, defines the Medical Informatics domain adequately. In the panel's view, the programme objectives, training students to become junior specialists who are familiarized with all Medical or Biomedical subdomains and who are mainly practice-oriented, approaching topics and subjects in this domain, however, from a distinctly scientific perspective, are appropriate as well. The intended learning outcomes meet the programme objectives, are well aligned with the International Medical Informatics Association (IMIA) standard for this domain and match the Bachelor's requirements. In addition, the learning outcomes prepare graduates of the programme to continue their studies at the Master's level or to enter the labour market as junior specialists in the healthcare sector. Programme management follows quite closely international trends and developments in this domain and is, therefore, well-placed to incorporate these in the programme.

The admission requirements and procedures of the programme are very adequate, being definitely geared towards allowing only talented and motivated students to enroll.

The curriculum of the programme fully matches the intended learning outcomes and, therefore, meets the international IMIA standard. The panel considers the computer science subjects and the health care subjects to be very well balanced in the curriculum and the curriculum to be coherent. The curriculum is regularly updated in a responsible way, preventing to attach too much weight to *hypes* in this field. As a suggestion, the panel would advise to promote the international exchange of students. The academic skills training part of the curriculum and the integration of this training in the modules are welcomed by the panel. This training was introduced in 2010 and was recently updated. The panel would advise to take it one step further and to separate the academic skills training and professional skills training and to introduce portfolios to monitor students' progress.

The educational principles of the programme are well-designed and have been conscientiously implemented, with a strong emphasis on student-centered learning and, also, on students learning to cooperate on multidisciplinary subjects in group assignments and internships. The panel supports the plans of programme management to reinforce the e-learning part of the curriculum.

The workload in the curriculum is appropriate. The number of contact hours and the student-to-staff ratio are very generous. The panel suggests keeping the student-to-staff ratio at this level, when the programme grows, as is intended. Study guidance in the programme is well-organized and well-managed.

The lecturers in the programme are renowned experts in their fields, the vast majority of them having PhD's and a very substantial number of them possessing BKO-certificates. The panel found the lecturers very motivated to participate in the programme and observed a strong consensus among programme management and lecturers about the programme profile, contents and educational principles.

The panel regards the quality assurance of the programme to be effective.

The policies of the programme ensure the quality, validity and reliability of the tests and assessments. As the so-called four-eyes principle in drafting tests and the assessment reports are relatively new, the panel encourages programme management to proceed and implement these procedures. The Examination Board is set to monitor the quality and the procedures regarding tests and assessments, but the process of actual reviewing the tests and assessments is still in the early stages of implementation. Although the panel does not question this process taking shape in the coming months and years, the panel encourages the Board to implement this process. The formative and summative tests fulfil a clear function in the programme and contribute to the students' study progress and their acquisition of knowledge and skills. The test methods have been carefully selected and reflect the module learning goals. The variety of test methods allows students' knowledge and skills to be tested reliably. Students' individual performances are adequately assessed in case of group work. The supervision of the final internship and thesis projects is well-organized, being done by two supervisors. The assessment is adequate, being performed by three examiners, using relevant assessment components and criteria.

The panel studied tests of various modules and concludes these to be well organized, high-level and in part challenging. The theses were generally good quality scientific products, addressing relevant medical informatics subjects, exhibiting sound and well-elaborated scientific approaches and targeting mostly practical and relevant real-life problems. In a number of instances, methodological choices were definitely made but were not always satisfactorily accounted for. None of the theses, the panel studied, were unsatisfactory. About 70 % of the graduates proceed with their studies at the Master's level. About 50 % of the students entering the Master's programme Medical Informatics of University of Amsterdam complete their studies in three years. This may also be a result of their having a job next to their Master's studies, prolonging their studies. The students who do not proceed with their studies, about 30 %, obtain positions in industry, hospitals and consulting, testifying to their being broadly trained in the programme. The percentage of students feeling well-prepared for the labour market is 68 % to 78 %.

The panel assesses the Bachelor's programme Medical Informatics of University of Amsterdam to be good and recommends NVAO to grant re-accreditation to this programme.

Rotterdam, 14 September 2016

Prof. J. Mantas PhD
(panel chair)

W. Vercouteren MSc, RC
(panel secretary)

2. Assessment process

Certiked VBI received a request to conduct a limited programme assessment for the re-accreditation of the Bachelor's programme Medical Informatics. This request was submitted by University of Amsterdam.

Certiked requested the approval by NVAO of the proposed panel of experts to conduct this assessment. NVAO have given their approval. The panel composition was as follows (for more detailed information please refer to Annex 4: Composition of the assessment panel):

- Prof. J. Mantas PhD, professor of Health Informatics and director of Laboratory of Health Informatics, University of Athens, Greece (panel chair);
- Prof. E. Ammenwerth PhD, professor for Medical Informatics and head of Institute for Biomedical Informatics, University for Health Sciences, Medical Informatics and Technology, Hall, Austria (panel member);
- F. Koens PhD, educational policy advisor, VUmc School of Medical Sciences, VU University Medical Center, Amsterdam, the Netherlands (panel member);
- S.D. Post, general manager Salves, company specializing in EPD- and ERP-implementations' testing in healthcare, Helvoirt, the Netherlands (panel member);
- R.C.A. Wink MA, student Master programme Neerlandistiek, Leiden University, the Netherlands (student member).

On behalf of Certiked, W. Vercouteren MSc, RC was responsible for the process co-ordination and for drafting the panel's report. All panel members and the secretary signed a statement of independence and confidentiality.

The panel conducted this assessment on the basis of the standards of the NVAO Assessment Framework of 19 December 2014 (Staatscourant nr. 36791).

The following procedure was adopted. The panel members of the panel studied the documents presented beforehand by programme management, including a number of theses, taking into account the NVAO Guidelines for the assessment of final projects during external assessments of 18 February 2015 (please refer to Annex 2 and 3: Documents reviewed and Theses reviewed).

Only a few days before the site visit, panel member Mr Post informed the panel secretary he would not be able to attend the site visit nor the preliminary meeting of the panel due to personal circumstances.

Before the date of the site visit, all panel members were informed by e-mail about the accreditation procedures by the panel secretary. The panel chair and the panel secretary had a telephone conversation, preparing the site visit. All panel members sent in their preliminary findings, based on the information file submitted by programme management, a number of questions to be put to the programme representatives on the day of the site visit and their findings about the theses, they had studied.

On 8 June 2016, the panel had a meeting to discuss the preliminary findings concerning the quality of the programme. Mrs Ammenwerth had previously informed the panel secretary not to be able to attend this meeting. Mrs Ammenwerth was, however, present during the site visit.

During the preliminary meeting of the panel on 8 June 2016, the findings of the panel members, including those concerning the theses were discussed, and some questions were added to the list drafted beforehand. On the basis of this input, the secretary drew up a definitive list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

On 9 June 2016, the panel conducted a site visit on the University of Amsterdam/Academic Medical Center campus. The site visit schedule was in accordance with the schedule drafted beforehand (please refer to Annex 1: Site visit schedule). Programme management communicated the open office hours to the students and staff of the programme. No persons called on the panel.

In a closed session at the end of the site visit, the panel considered their findings and drew conclusions regarding the quality of the programme. At the end of the site visit, the panel chair presented a broad outline of the findings to programme management, lecturers and students.

Mr Post was informed by the panel secretary in writing and in a personal meeting about the findings, considerations and conclusions of the panel. Having studied the information file of the programme and a number of theses, Mr Post indicated being in agreement with the panel's findings, considerations and conclusions.

The panel chair, Mr Post and University of Amsterdam Medical Informatics programme management indicated being of the view the assessment process was conducted in a sound and valid way, even though Mr Post could not be present at the site visit on 9 June. They all confirmed this in writing.

A draft version of this report was finalised by the secretary, having taken into account the information presented as well as the findings and considerations of the panel. The draft report was sent to the panel members, who studied the draft report and made a number of changes. Mr Post participated fully in this process. Thereupon, the secretary drew up the final report. This report was presented to programme management to be corrected for errors. After having been corrected for errors, the report was sent to the institution's Board to accompany their request for re-accreditation of this programme.

3. Overview of the programme

3.1 Basic information about the programme

Administrative information about the programme:

Name programme in CROHO: B Medical Informatics
 Orientation, level programme: Academic Bachelor
 Grade: BSc
 Number of credits: 180 EC
 Specializations: n.a.
 Location: Amsterdam
 Mode of study: full time
 Registration in CROHO: 56573

Administrative information about the institution:

Name of institution: University of Amsterdam
 Status of institution: Government-funded university
 Institution's quality assurance: Approved

Quantitative data about the programme

Percentage of students who dropped out after one, two or three years (vwo matriculation)

Cohort	2007	2008	2009	2010	2011	2012
Drop-out rate after one year	18 %	17 %	28 %	42 %	39 %	28 %
Drop-out rate after two years (cumulative)	18 %	25 %	28 %	42 %	39 %	32 %
Drop-out rate after three years (cumulative)	35 %*	25 %	28 %	42 %	39 %	32 %

* estimate

Percentage of students who continued their study in the second year and who completed the programme after three, four, five and six or more years (vwo matriculation)

Cohort	2007	2008	2009
Success rate after three years	29 %	50 %	77 %
Success rate after four years	79 %	70 %	85 %
Success rate after five years	79 %	80 %	100 %
Success rate after six or more years	79 %	80 %	100 %

Percentage of students who continued their studies in the second year and who completed the programme after three, four, five and six or more years (all students)

Cohort	2007	2008	2009
Success rate after three years	28 %	50 %	77 %
Success rate after four years	67 %	64 %	85 %
Success rate after five years	72 %	71 %	100 %
Success rate after six or more years	78 %	71 %	100 %

Lecturers' qualifications

Qualification	MSc	PhD	BKO*
Percentage of lecturers	100 %	86 %	64 %

*BKO means having obtained Dutch University Teaching Qualification. Another 9 % of the lecturers is in the process of obtaining this BKO-certificate. All lecturers in the programme with teaching loads of 8 unique teaching hours or more hold BKO-qualifications.

The student-to-staff ratio is 9.6 : 1.

Number of contact hours per week for each of the years of the programme

Year of the programme	Year 1	Year 2	Year 3
Number of contact hours per week	22.3	17.1	16.0

3.2 Main facts about the institution

The Bachelor's programme Medical Informatics is a programme of the Faculty of Medicine/Academic Medical Centre of University of Amsterdam.

University of Amsterdam was founded in 1632. About 30,000 students are enrolled in the programmes of the University and about 5,000 staff are employed by the University. University of Amsterdam is one of the leading research universities in Europe with about 10,000 academic publications by University staff every year.

According to its website, University of Amsterdam aspires to be a broad, research-intensive academic institution, rooted in the history of the city of Amsterdam, an internationally oriented which can compete with leading in the Netherlands and around the world. University of Amsterdam provides academic training in all areas of science and scholarship, and welcomes students and staff, from all backgrounds, cultures and faiths, who wish to devote their talents to the development and transfer of academic knowledge as a rich cultural resource and foundation for sustainable progress.

University of Amsterdam adopted as core values innovation, determination and engagement. In its own words, the University wants to be innovative and take up a position in the vanguard of fundamental research and its applications. For determination, University students and staff are encouraged to carve out their own paths and thus to set new trends. Engagement for the University means to use acquired knowledge and insights to play an ongoing, prominent and visible role in the social debate.

The University of Amsterdam has seven Faculties, being the Faculties of Economics and Business, Humanities, Law, Medicine, Science, Social and Behavioural Sciences and Dentistry.

3.3 Intended learning outcomes

The intended learning outcomes of the programme are as follows. The graduates of the programme are expected:

- To have basic knowledge of the theories and methods of medical informatics, and to have mastered the theories and methods of computer science, mathematics, epidemiology, biostatistics and information management relevant to medical informatics.
- To have knowledge of the principles of medicine and general procedures guiding healthcare, including as regards strategic processes and policymaking.
- To have basic knowledge of theories and methods about the analysis, design, development and implementation of interactive healthcare information systems, and to be able to apply this knowledge.
- To be able to analyze simple problems that affect healthcare information systems in practice using medical informatics methods and consequently to issue recommendations for specific actions within the care organizations involved.
- To know the basic principles of scientific research and to be able to combine and apply this knowledge and understanding in a practical scientific project.
- To be able to gather and process information according to a structured and project-based method both independently and as part of a multidisciplinary team, and to be able to identify and analyse problems.
- To be able to convey well-founded information, ideas and solutions, in Dutch, to an audience consisting of medical informatics professionals, ICT professionals and healthcare professionals.
- To be able to adapt their behaviour based on feedback or self-reflection and to have the necessary learning skills to pursue an advanced programme that presupposes a high level of autonomy.

3.4 Outline of the curriculum

In the table below, the programme curriculum has been presented.

Curriculum components	Credits
Semester 1, year 1	30 EC
Introduction to Medical Informatics	8 EC
Basic Biomedical Principles	10 EC
Introduction tot Programming and Logic	12 EC
Semester 2, year 1	30 EC
The Medical Process in a Primary Care Setting	12 EC
Advanced Programming and Mathematics	12 EC
Basic Medical Principles	6 EC
Semester 1, year 2	30 EC
Databases, Computer Networks and Security	12 EC
Clinical Epidemiology and Biostatistics	12 EC
The Medical Process in a Secondary Care Setting	6 EC
Semester 2, year 2	30 EC
Registration and Classification	12 EC
Software Engineering Theory	8,5 EC
Intramural Internship	1,5 EC
Software Engineering Project	8 EC
Semester 1, year 3	24 EC
Artificial Intelligence	6 EC
Public Health and Healthcare	9 EC
Information in Medical Images	6 EC
E-Health	3 EC
Semester 2, year 3	36 EC
Strategic Information Management	6 EC
Internship Project or	30 EC
Internship Project (min. 18 EC) + discipline-related electives (max. 12 EC)	30 EC
Total credits of the programme	180 EC

4. Overview of assessments

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

5. Findings, considerations and assessments per standard

5.1 Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to contents, level and orientation; they meet international requirements.

Findings

As the Bachelor's and Master's programmes Medical Informatics of University of Amsterdam are the only programmes in this domain in the Netherlands, management of these programmes drafted its own subject-specific framework of reference. In this framework, the objectives of the programme have been listed. These objectives are to train students to become junior specialists in the medical or biomedical domain who understand the healthcare sector and who are able to work with healthcare providers in order to analyze information problems in this sector and to develop, substantiate, evaluate and implement solutions to these problems. Graduates of the programme may contribute to the development and evaluation of information-based solutions that support, among other, the treatment of diseases, improve the healthcare logistics and provide insight into the quality and efficiency of healthcare.

The Medical or Biomedical Informatics domain is an interdisciplinary field that aims to contribute to the enhancement of healthcare efficiency and quality by providing (automated) solutions for capturing, storage, processing, retrieval and dissemination of medical and healthcare data, information and knowledge and to reveal underlying general scientific principles in this respect. The domain comprises four different subdomains, which are bioinformatics (focus on molecular and cellular processes), imaging informatics (focus on tissues and organs), clinical and medical informatics (focus on individuals and patients) and public health informatics (focus on patient populations and society). In this programme, all of these subdomains are studied, being approached from a practice-oriented, yet scientific angle.

Programme management drafted a series of intended learning outcomes (please refer to the complete list in section 3.3 of this report). In these learning outcomes, domain-specific knowledge and skills, generic knowledge, understanding and skills, research skills, communication skills and learning skills have been listed.

The intended learning outcomes of the programme have been aligned with the International Medical Informatics Association (IMIA) standard and, therefore, include knowledge and skills in Biomedical and Health Informatics, Medicine, Health and Biosciences, Health System Organization, Informatics, Computer Science, Mathematics and Biometry.

In addition, the learning outcomes have been formulated in relation to the Dublin-descriptors for the Bachelor's level. Programme management drafted a table showing the relations between the intended learning outcomes and these Dublin descriptors.

Programme management keeps abreast of international developments by, among other, participating in the IMIA and other international organizations, in the IPHIE network, by participating in joint international teaching modules and by international projects and publications. Programme management assisted in the recent revision of the IMIA standard. Although this programme is the only programme in this domain in the Netherlands, there are a number of similar programmes abroad, like in Sweden, Germany, the United States and Taiwan. Programme management indicated these programmes indeed being comparable.

Although the graduates of the programme are mainly trained to continue their studies in this domain at the Master's level, they may also be employed in junior positions in healthcare organizations or in the healthcare ICT industry. Therefore, programme management intends to ensure the learning outcomes to meet the demands of relevant Master's programmes and to be in line with the requirements of the professional field.

Considerations

The panel approves of the subject-specific framework of reference programme management drafted to define the Biomedical or Medical Informatics domain. The panel is in agreement with the objectives of the programme, training students to become junior specialists in this domain.

The panel understands and agrees this programme to have a broad scope, addressing all Medical or Biomedical Informatics subdomains and to be mainly practice-oriented, approaching topics and subjects in this domain, however, from a distinctly scientific perspective.

In the panel's opinion, the intended learning outcomes meet the programme objectives and describe the domain-specific and generic knowledge and skills and research, communication and learning skills to be acquired by the students adequately and comprehensively.

The panel regards the intended learning outcomes of the programme to have been well-aligned with the International Medical Informatics Association (IMIA) standard and, therefore, to meet the international standards for the Medical Informatics domain.

As the panel has noted, the programme intended learning outcomes comply with the Dublin-descriptors for the Bachelor's level and, therefore, correspond to the Bachelor's requirements.

The panel observed programme management to follow international trends and developments in this domain quite closely and, therefore, to be well-placed to incorporate these developments in this programme.

The panel considers the intended learning outcomes of the programme to prepare graduates of the programme to continue their studies at the Master's level or to enter the labour market as junior specialists in the healthcare sector.

Assessment of this standard

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

5.2 Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Findings

The number of students enrolling in the programme has increased over the years from an average of about 20 students per year in the years from 2007 to 2011 to 45 students in 2014 and 57 students in 2015. Programme management has set a target for student intake of 50 students each year, maintaining high standards for the incoming students. The vast majority of the incoming students (about 87 %) have VWO-diplomas (VWO: Dutch secondary education). VWO-students who have taken mathematics A or B and physics in their prior education may be admitted directly. Students having HBO-diplomas in for instance Computer Science or having obtained certificates equal to VWO-diplomas may be admitted as well. Part of the intake procedure are an introductory programme, acquainting applicants with the Bachelor's programme and a so-called matching procedure, to establish if applicants would be able to complete the programme successfully. If applicants do not meet the matching requirements, they are given a negative advice on entering the programme.

Programme management drafted a table in which the relations between the intended learning outcomes and the curriculum components have been specified. For each of the modules, the learning goals, module contents, compulsory literature, teaching methods, schedule, lecturers, test methods and grading schemes have been specified.

The modules in the curriculum are compulsory. Besides the electives-option at the end of the curriculum (please refer to section 3.4), programme management indicated not having been able to find any space in this curriculum for electives. In the first year, students are familiarized with the constituent parts and disciplines of Medical Informatics, like basic informatics, mathematical knowledge, biomedical principles, clinical practice and patient care processes. In the second year, they are taught these at a higher level, are taught how to integrate them and apply them to problems in healthcare. In the third year, the integration process is taken one step further, deepening students' knowledge and skills in informatics, handling medical data and healthcare organization and healthcare information management. At the beginning of modules, case studies are offered, to be used to illustrate methods and techniques.

In the curriculum, ample attention is given to academic skills training. This academic skills training is not offered separately but has been embedded in the modules. Five academic skills tracks are offered, being research skills, academic writing, presenting, management skills and professional conduct.

In order to ensure the coherence of the curriculum, module coordinators meet four times per year to discuss the modules and to prevent overlap or gaps between the modules. In addition, module coordinators meet with the lecturers within the module to ensure the internal coherence of the modules.

The educational principles in the programme are putting the learning processes of the students first, encouraging them to work together, offering the students thorough academic and professional training and giving them continuous feedback on their learning processes and outcomes. For each of the modules, teaching methods have been specified. These are lectures, seminars, tutorials and practical training. In addition, students collaborate in assignments and take internships to link subjects taught in the curriculum with actual research projects. Programme management intends to strengthen the e-learning component in the curriculum. The lecturers will be offered workshops to train them for this type of teaching.

Students are offered 22 contact hours per week in the first year, 17 hours per week in the second year and 16 hours per week in the third year. These contact hours are scheduled across the week, to promote the study progress. The staff-to-student ratio is 9.6 : 1. At the end of the first year, students are given a notice of exclusion, if they have not gathered 42 EC. The study advisor invites students who may not meet this target and offer them remedial courses. In the beginning of the programme, every one of the students are guided by mentors, senior students, who themselves are guided by the head of the programme. In all of the years, students may turn to study advisors for guidance and assistance and to the programme secretaries who may introduce students to module coordinators, the head of the programme or the programme director. The drop-out rate in the first year is about 30 % to 40 %. After the first year, the drop-out rate is very limited. Dropping out in the first year may be partly accounted for by students who entered the programme as their second choice.

About 95 lecturers are involved in the programme, including guest lecturers. About 86 % of them, excluding guest lecturers, have obtained PhD's. With regard to the teaching capabilities of the permanent lecturers, 64 % of them now have BKO-certificates (BKO meaning Basic Teaching Qualification). This number will raise to 73 % in the foreseeable future. All lecturers with teaching loads of 8 unique teaching hours or more hold BKO-qualifications. Programme management has set a target of 80 % of the lecturers having BKO-certificates. As this figure comes within reach, programme management intends to focus on SKO-certified (SKO meaning Senior Teaching Qualification) lecturers. Dutch National Student Survey results show 70 % of the students in this programme to be (very) content with the lecturers' performances.

The core academic staff consists of 14 lecturers. These lecturers are experienced researchers in their field of expertise, together covering all of the subjects to be addressed in this interdisciplinary programme. In addition, they have ample experience in teaching abroad.

For the programme, a system for quality assurance has been put in place. This system consists, among other, of regular surveys among students and lecturers and includes participation in quality assurance processes on the part of lecturers and students, the Examination Board and the Field Advisory Council.

Considerations

The panel considers the admission requirements and the admission procedures of the programme to be very adequate, the matching process definitely geared towards allowing only talented and motivated students to enroll.

As the panel observed, the curriculum fully matches the intended learning outcomes and, therefore, meets the international IMIA standard. The panel considers the computer science subjects and the health care subjects to be very well balanced in the curriculum and the curriculum to be coherent. The curriculum is regularly updated, being done so in a responsible way and preventing to attach too much weight to *hypes* in this field. The panel suggests promoting the international exchange of students.

The panel considers the academic skills training part of the curriculum to be well-designed and welcomes the integration of this training in the modules. This training was introduced in 2010 and was recently updated. The panel would advise to take it one step further and to separate the academic skills training and professional skills training and to introduce portfolios to monitor students' progress. In addition, the panel suggests to pay attention to students' privacy in this training.

The panel considers the educational principles of the programme to be well-designed and to be strictly and conscientiously enforced, with a strong emphasis on student-centered learning. The panel is, especially, positive about students learning to work on multidisciplinary subjects in group assignments and in internships. The plans of programme management to reinforce the e-learning part of the curriculum are supported by the panel.

The workload in the curriculum is considered by the panel to be appropriate, although monitoring the workload in this rather demanding curriculum remains advisable. The number of contact hours and the student-to-staff ratio are very generous. This may be regarded to be conducive to the students' study processes but may, on the other hand, warrant to monitor the students' workload. The panel suggests keeping the student-to-staff ratio at this level, when the programme grows, as is intended. Study guidance in the programme is well-organized and well-managed.

The panel thinks highly of the lecturers in the programme. They are renowned experts in their fields, while the vast majority of them have PhD's and a very substantial number of them possess BKO-certificates. Programme management plans to have lecturers obtain SKO-certificates. The panel observed a strong consensus among programme management and lecturers about the profile, the contents and the educational principles of the programme. In addition, the panel regards the core team of lecturers and the other lecturers the panel met, to be very motivated to participate in this programme.

The panel regards the quality assurance of the programme to be effective.

Assessment of this standard

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

5.3 Standard 3: Assessment

The programme has an adequate assessment system in place.

Findings

The procedures regarding tests and assessments in the programme are governed by the assessment policy plan, which is renewed every four years. The procedures are meant to ensure the quality, validity and reliability of the tests and assessments. The main elements of the programme assessment policy are the test plan for each of the modules, drafted by the module coordinators and specifying the relations between the module learning goals and the tests. The purpose of the test plan is to make sure all learning goals are tested, to specify the test methods to be adopted and their relative weight in the overall testing of the modules. In addition, test matrices for each of the tests are drafted. Lecturers draft the tests, using the test plan and the test matrices. Each test is to be reviewed by a second lecturer, ensuring the so-called four-eyes principle. For the assessments, answer models for the written examinations and rubrics for the reports and assignments are included in the tests. Students are informed about the test methods, the weight of the test components and the criteria to be met in the tests. When modules are completed, an assessment report is drafted by the module coordinators, in which they evaluate the tests and assessment in the module.

For the programme, an Examination Board is in place. The Board convenes every two months to discuss the tasks at hand. This Board is independent of programme management, having been appointed by the Dean of the Faculty of Medicine. The Examination Board has the responsibility to monitor the quality of the tests, including the students' theses or final products, to monitor the test and assessment procedures in the programme and to address complaints and cases of fraud or plagiarism. The tests and assessments of each of the modules are to be reviewed by the Board at least every three years. The actual reviewing of the tests and assessments by this Board is still in the early stages of implementation, as no systematic reviews have been conducted thus far.

Programme management makes a clear distinction between formative tests (meant to monitor students' progress in acquiring knowledge and skills) and summative tests (meant to assess and grade formally students' knowledge and skills). Formative tests are very regularly used in the courses and are meant, among other, to foster students' active participation in class, to enhance their study pace and to promote collaboration among students. This is also meant to prepare students for their prospective careers in which they will have to cooperate in groups and in multidisciplinary settings, with experts from different backgrounds.

The summative test and assessment policies by programme management are to adopt different methods to test students' knowledge and skills at the end of the modules. Programme management feels this to be conducive to the reliability of the testing. Module coordinators propose the mix of test methods to programme management. In nearly all of the modules, summative tests include written examinations. In addition to these written examinations, students are to complete assignments, draft reports and give presentations. In the modules, each of the tests has to be completed satisfactorily. In case of group work, different marks may be given to students, depending on their individual performances.

As the academic skills training is integrated in the modules of the curriculum, academic skills are assessed in conjunction with the knowledge and skills taught in the modules. Knowledge, skills and academic skills are assessed jointly by the module lecturer and the academic skills lecturer.

For their final internship and thesis project, students may either choose the 30 EC internship project or the 18 EC internship project and 12 EC of electives. Thus far, the majority of the students selected the first option. Students are guided by their day-to-day supervisor on the internship site with whom they meet regularly. In addition, they meet four times with the departmental supervisor and the day-to-day supervisor. During the internship, a number of welcome-back days are scheduled, during which the phases in scientific research projects are addressed and discussed. At the start of the project, the two supervisors are to approve the student's work plan. During the project, they review the student's interim progress report. At the end of the project they are to assess the draft report and the final report. The grade for the internship project is made up of the grades for the research design (20 % of grade), project completion (20 %), academic report taking the form of an article (40 %) and oral presentation (20 %). For each of these components, criteria have been listed. The final report and the presentation are assessed by the academic skills coordinator as well.

Considerations

The panel welcomes the test and assessment policies of the programme, as these ensure the quality, validity and reliability of the tests and the assessments. The panel learned that test plans and test matrices are in effect drafted by module coordinators and lecturers. The so-called four-eyes principle in drafting the tests has only recently been introduced and the assessment reports are relatively new as well. The panel encourages programme management to proceed and implement these procedures.

The panel is positive about the independent position and the responsibilities of the Examination Board, monitoring the quality of the tests and assessments and the test and examination procedures. As the panel noted, however, the process of actual reviewing the tests and assessments by the Board is still in the early stages of implementation. The panel does, however, not question this process taking shape in the coming months and years and leading to a solid and reliable reviewing process on the part of this Examination Board. The panel encourages the Board to implement the actual reviewing process.

For the panel, the formative as well as the summative testing fulfil a clear function in the programme and contribute to the fostering of the students' study progress and their acquisition and testing of knowledge and skills.

The panel considers the test methods to have been carefully selected and to reflect appropriately the module contents and module learning goals. The panel welcomes the variety of test methods in the modules, allowing students' knowledge and skills to be tested reliably. Students and alumni informed the panel students' individual performances to be adequately assessed in case of group work.

In the panel's view, the supervision, scheduling and assessment of the final internship and thesis projects are appropriate. The supervision is well-organized, being done by two supervisors. The assessment is adequate, being performed by three examiners, using relevant assessment components and criteria.

Assessment of this standard

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

5.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings

In their final project, the students are expected to participate in ongoing research at Academic Medical Center or at another institute. Students are expected to demonstrate their capabilities in doing scientific research in the medical informatics domain at the required Bachelor's level. This includes formulating a clear research question, assessing and interpreting literature, gathering reliable data in sufficient numbers, processing and critically evaluating these data, drawing conclusions and critically commenting on the results. Students also have to demonstrate academic skills, like being able to cooperate with others, to keep the time schedule and to work independently.

In the annual Dutch Student Survey, 68 % to 78 % of the students regarded to have been (very) well prepared by the programme for their careers. On the day of the site visit, the panel was informed alumni and industry representatives are content about the knowledge and skills of the graduates.

About 70 % of the graduates continue their studies at the master's level, some 50 % of them in the Master's programme Medical Informatics but also in programmes of other Dutch Universities. Another 30 % of the graduates enters the labour market, obtaining work in line with their studies in, among others, the medical informatics sector or computer programming.

Considerations

The panel studied a number of tests of various modules, presented by programme management on the day of the site visit. From inspection of these tests, the panel concludes these to be well organized, high-level and in part challenging.

None of the theses, the panel studied, were unsatisfactory. The theses were generally good quality scientific products, addressing relevant medical informatics subjects, exhibiting sound and well-elaborated scientific approaches and targeting mostly practical and relevant real-life problems. In a number of instances, methodological choices were definitely made but were not always satisfactorily accounted for. The panel recommends putting more emphasis on accounting for chosen methodologies in the bachelor theses.

About 50 % of the students entering the Master's programme Medical Informatics of University of Amsterdam complete their studies in three years. This may also be a result of their having a job next to their Master's studies, prolonging their studies.

The percentage of students feeling well-prepared for the labour market is 68 % to 78 %, which indicates the programme preparing these students well for their careers. The students who do not proceed with their studies at the Master's level, obtain diverse positions in industry, hospitals and consulting, testifying to their being broadly trained in the programme.

Assessment of this standard

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

6. Recommendations

In this report, a number of recommendations have been listed. For the sake of clarity, these have been brought together below. The recommendations are the following.

- To promote the international exchange of students.
- To consider to separate the academic skills training and the professional skills training and to introduce portfolios to monitor students' progress.
- To keep the student-to-staff ratio at the current, very generous level, when the programme grows, as is intended.
- To proceed and implement the four-eyes principle in drafting the tests as well as the reports on the tests and assessments in the modules.
- To proceed and implement the actual reviewing process of tests and assessments on the part of the Examination Board.
- To put more emphasis on accounting for chosen methodologies in the bachelor theses.

Annex 1: Site visit schedule

The site visit took place in Amsterdam on 3 June 2016. The site visit schedule was as follows.

09.00 h. – 10.30 h.	Arrival and deliberations panel (closed session)
10.30 h. – 11.00 h.	Dean and programme management Prof. M.M. Levi PhD (Dean Faculty of Medicine), prof. M.W.M. Jaspers PhD (programme director)
11.00 h. – 12.00 h.	Programme management and core lecturers Prof. M.W.M. Jaspers PhD (programme director), F.J. Wiesman PhD (head Master's programme), ir. T.H.F. Broens PhD (head Bachelor's programme), L.W.P. Dusseljee-Peute PhD (Academic Skills training), prof. A. Abu Hanna PhD (coordinator Scientific Research Project), F.P.J.M. Voorbraak PhD (coordinator/core lecturer Computer Science), J.M. van Es PhD (chairperson Board of Studies)
12.15 h. – 13.00 h.	Examination Board B. Blom PhD (chairperson Examination Board), F.P.J.M. Voorbraak PhD (member Examination Board), J.M. Ruijter PhD (member Examination Board), Y.J. Heinen-van Zuthem MSc (member Examination Board). Prof. C. Lucas PhD (member Examination Board)
13.00 h. – 14.00 h.	Lunch panel (closed session), open office hours 13.00 h. – 13.30 h.
14.00 h. – 15.00 h.	Lecturers and theses' examiners Prof. K.J. Jager PhD (Bachelor's and Master's programmes), N.F. de Keizer PhD (Master's programme), D. Sent PhD (Bachelor's and Master's programmes), J. Beldman MSc (Master's programme), M.W.T. Tanck PhD (Bachelor's programme), ir. R. Cornet PhD (Bachelor's and Master's programmes), prof. J.H. Ravesloot PhD (Bachelor's programme)
15.00 h. – 15.45 h.	Students and alumni, including members of Board of Studies F. Horenberg BSc (first year, Master's programme, member Board of Studies), R. Goud PhD (alumnus), A.M.W. Koning (second year Bachelor's programme), E. Kilsdonk MSc (alumnus), S.K. Medlock DVM, PhD (alumnus) A.L. Beukenhorst MSc (alumnus), E. Tensen BSc (second year Master's programme, member Board of Studies), P. van Damme (second year Bachelor's programme, student assessor), V.A. Stangenberger BSc (first year Master's programme, student assessor)
15.45 h. – 17.30 h.	Deliberations panel (closed session)
17.30 h. – 18.00 h.	Main findings presented by panel chair to Dean, programme management and others

Annex 2: Documents reviewed

The panel studied the following documents, presented prior to the site visit:

- Self-assessment report Medical Informatics
- Subject-specific reference framework and learning outcomes of programme
- Overview of curriculum
- Course Catalogue Bachelor's and Master's programme in Medical Informatics
- Teaching and Examinations regulations
- Overview of staff
- List of graduates Bachelor's programme in Medical Informatics
- List of graduates Master's programme in Medical Informatics
- University education indicators
- Teachers' credentials
- Average amount of face-to-face instruction

On the day of the site visit, programme management presented the following documents:

- Policy plan Department Medical Informatics
- Mission, vision on educational concept
- Course material (selection)
- Pre-master's conversion programme
- Assessment policy
- Examinations, answer models (selection)
- Bachelor's thesis manual
- Master's thesis manual
- Student evaluation results
- Results alumni and employee surveys
- Programme management minutes and reports
- Board of Studies minutes and reports
- Examination Board minutes and reports
- List of publications by graduates

In addition, panel members were given access to the programme Blackboard Electronic Learning Environment

Annex 3: Theses reviewed

The theses of the following 15 students have been selected for review by the panel

- 10000274
- 10244042
- 1077774
- 10193707
- 10187596
- 6231764
- 10375880
- 10362134
- 10465863
- 6285457
- 10447202
- 6103170
- 10158049
- 10440348
- 10180494

Annex 4: Composition of the assessment panel

The assessment panel had the following composition:

- Prof. J. Mantas PhD, professor of Health Informatics and director of Laboratory of Health Informatics, University of Athens, Greece (panel chair);
- Prof. E. Ammenwerth PhD, professor for Medical Informatics and head of Institute for Biomedical Informatics, University for Health Sciences, Medical Informatics and Technology, Hall, Austria (panel member);
- F. Koens PhD, educational policy advisor, VUmc School of Medical Sciences, VU University Medical Center, Amsterdam, the Netherlands (panel member);
- S.D. Post, general manager Salves, company specializing in EPD- and ERP-implementations' testing in healthcare, Helvoirt, the Netherlands (panel member);
- R.C.A. Wink MA, student Master programme Neerlandistiek, Leiden University, the Netherlands (student member).

Prof. J. Mantas PhD, panel chair

Mr. Mantas is professor of Health Informatics at University of Athens, Greece and the director of the Laboratory of Health Informatics at this University. His current research interests are in health information systems, patient safety, biomedical informatics, and management of healthcare. He is the organizer for more than ten years of the International Conference on Informatics, Management, and Technology in Healthcare. Mr. Mantas is the author of more than 200 academic publications and, in addition has supervised numerous Master's theses and doctoral dissertations.

Prof. E. Ammenwerth PhD, panel member

Mrs. Ammenwerth is professor for Medical Informatics and the head of Institute for Biomedical Informatics at University for Health Sciences, Medical Informatics and Technology, Hall, Austria. Her main research interests are, among others, patient safety informatics, CPOE, medication safety, electronic health records, management of information systems and evaluation of health information systems. Mrs. Ammenwerth has ample experience in education and has published widely.

F. Koens PhD, panel member

Mrs. Koens is an educational policy advisor at VUmc School of Medical Sciences of VU University Medical Center, Amsterdam, the Netherlands. She took her doctorate from University Utrecht, her doctoral dissertation addressing aspects of teaching and learning processes of biomedical knowledge by students in medicine. Mrs. Koens published a number of scientific articles, focusing on concepts and processes with regard to medical education.

S.D. Post, panel member

Mr. Post is the general manager of Salves, a company employing over 100 employees and specializing in testing of EDP- and ERP-implementations in healthcare. Salves clients are, among others, Erasmus Medical Center, University Medical Center Utrecht and Radboud University Medical Center. Mr Post is chair of VMBI, the Dutch Association for Information Processing in healthcare organizations.

R.C.A. Wink MA, student member

Mr. Wink is studying in the Master programme Neerlandistiek of Leiden University. Previously, he completed the Research Master History of this University. He was a member of the Education Committee of this programme. Mr. Wink was, among other, employed as a junior marketing analyst and an account manager. He has been a student member in a number of assessment panels.