ONDERZOEKERIJ

Bachelor's programme

Science Business & Innovation

Vrije Universiteit Amsterdam

Report of the limited programme assessment

De Onderzoekerij
Vondellaan 58
2332 AH Leiden

Email: info@onderzoekerij.nl
Internet: www.onderzoekerij.nl

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Executive summary

The outcome of the external assessment of the bachelor's programme Science Business & Innovation (SBI) of the Vrije Universiteit Amsterdam by an NVAO-approved panel is positive.

The SBI bachelor is a three-year programme with a total study load of 180 European Credits (EC). The programme focuses on innovation management in a business context in two specific fields: Energy & Sustainability (E&S) and Life & Health (L&H). The panel values the relevant interdisciplinary programme with natural science, business, innovation, and entrepreneurship as central elements.

The programme translated the goals into a convincing set of fourteen intended learning outcomes (ILOs) which clearly reflect the level that may be expected of graduates of an academic bachelor's programme in the field of innovation science.

The programme has a well-designed curriculum. During the first two years, students acquire a solid understanding of natural science and learn how to use business and innovation theories to analyse and develop strategic insight into innovation processes. In the third year, students can define their own learning path by choosing their minor and by choosing the topic and the organisation of their Bachelor's project. The four Innovation Projects and the Bachelor's project allow students to gain insight in what is needed to align innovative technologies with the demands of the market and the users.

The students are positive about the programme's content and structure. They appreciate the broad orientation of the programme and the mix between the natural-science subjects and business subjects. However, students indicated that they would like to be more challenged in business courses.

The programme is embedded in a strong interdisciplinary academic environment. The teaching staff is enthusiastic, well-qualified and knowledgeable in their respective areas. The panel noted that the programme relies on a small group of key staff members to realise the core identity of the programme.

The programme has a solid set of documents and procedures in place which secure an adequate assessment system. The panel appreciates the range of assessment modes used, including written exams, papers, essays, individual assignments and group assignments, and presentations. The panel applauds the carefully designed assessment procedure of the Bachelor's project that involves all lecturers of the SBI division and combines comprehensive assessment with personalised feedback.

The panel concludes that graduates achieve the ILOs by the end of the programme. The theses showed that graduates acquire a broad scientific basis in natural sciences, business and social sciences and can expand these skills and knowledge in the field of SBI. The subjects of the theses were very timely and relevant to the innovation field. The panel encourages the programme to further strengthen the quality of the theses by requiring a critical reflection on the research methods and the theoretical framework.

Distinctive quality feature entrepreneurship

The panel verified that the programme meets all criteria regarding the distinctive feature entrepreneurship. The programme's vision on entrepreneurship is in line with the international understanding of the concept of entrepreneurship. The science-based entrepreneurship education approach fits well with an academic programme in the Faculty of Sciences. Entrepreneurship is an integral part of the programme and is regularly evaluated, involving relevant key stakeholders.

The programme's vision on entrepreneurship and the programme's strategy and objectives are adequately reflected in the ILOs of the programme. The content and structure of the curriculum enable students to achieve the ILOs regarding entrepreneurship. Several compulsory courses explicitly emphasise, explain, and apply innovative entrepreneurship theory and application substantiated by current scientific insights. Students develop a practical, behavioural component in the four Innovation Projects and the internship in the Bachelor's project.

Lecturers in the programme are familiar with entrepreneurship, not only from a theoretical perspective but also from practical experience. Several staff members are actively involved in research on entrepreneurship. In addition, the programme benefits from its strong network by attracting guest lecturers who present valuable contextual cases emanating from the surrounding entrepreneurial ecosystem.

Since the last visitation, the programme made several improvements regarding the assessment of entrepreneurial skills. Several courses include practical assignments to develop entrepreneurial competencies. The panel welcomes the programme's plans to further develop its approach to the assessment of skills.

The chair and the secretary of the panel hereby declare that all panel members have studied this report and agree with the judgements in the report. They confirm that the assessment has been conducted in accordance with the requirements relating to independence.

Date: 25 January, 2023

Wiebe Bijker	Esther Poort
(chair)	(secretary)

1. Introduction

1.1 Administrative data

Name of institution:	Vrije Universiteit Amsterdam
Status of institution:	Publicly funded
Result institutional quality assurance assessment:	Positive, June 2020
Name of the programme:	B Science Business & Innovation
CROHO number:	50670
Level of the programme:	Bachelor
Orientation of the programme:	Academic
Study load:	180 EC
Location:	Amsterdam
Variant:	Full-time
Special feature:	Entrepreneurship
Language of instruction	Dutch
Submission deadline:	1 May 2023

1.2 Introduction

This report focuses on the assessment of the bachelor's programme Science Business & Innovation (SBI) of the Vrije Universiteit Amsterdam (VU). This assessment forms part of a cluster assessment of six programmes at three universities. Appendix A provides an overview of the six participating programmes.

The assessment is based on the standards and criteria described in the NVAO Assessment framework for the higher education accreditation system of the Netherlands 2018 (limited framework).

In addition, the VU asked the panel to review the distinctive quality feature of entrepreneurship. For the assessment of the distinctive quality feature of entrepreneurship, the panel proceeded according to the NVAO Assessment Framework further elaboration special (quality) feature entrepreneurship 2013.

1.3 Panel composition

The panel that assessed this bachelor's programme consisted of the following members:

- Prof. Wiebe Bijker (chair), emeritus professor of Technology & Society, Maastricht University;
- Prof. Magnus Klofsten, Professor in innovation and Entrepreneurship, Linköping University, Sweden;

- Dr. Lotte Krabbenborg, Associate Professor Public participation in the development of science and technology, Radboud University;
- Dr. Pieter Heringa, Strategic advisor research policy, Hogeschool Inholland;
- Iris Brugmans MSc (student member), student M Healthcare policy innovation and management, Maastricht University.

The panel was supported by Esther Poort, who acted as secretary.

All panel members and the secretary have signed a declaration of independence and confidentiality. In this declaration, they affirm not to have had any business or personal ties with the programme in question for at least five years prior to the review.

The NVAO approved the composition of the panel on 13 September 2022.

1.4 Working method

Preparation

The programme drew up a self-evaluation report describing the programme's strengths and weaknesses. This self-evaluation report included a chapter in which the students reflected on the programme. The panel members prepared the assessment by analysing the self-evaluation report and the appendices provided by the institution. An overview of these materials can be found in Appendix B.

The panel also studied a selection of fifteen bachelor theses and the accompanying assessment forms from the programme. The thesis selection was made by the panel's secretary based on a provided list of theses of the most recent years. In the selection, consideration was given to a variation in specialisations, assessments (grades) and topics.

The panel members individually formulated their preliminary findings and a number of questions they wanted to raise during the site visit. The secretary made an overview of these preliminary findings and questions and sent these to the panel members. On 2 November, the panel held a general online preliminary meeting. In this meeting, the panel discussed the programme's preliminary findings and discussed the most important topics they wanted to touch upon during the site visit.

Visit

The site visit of the bachelor's programme SBI and the master's programme SBI took place on 10 November 2022 (see Appendix C for the schedule). During the preparatory meeting, the panel discussed which questions to raise in their meetings with the programme representatives. During the visit, the panel spoke with representatives of the management, students, lecturers, alumni, and the Examination Board. Everybody involved in the programme had the opportunity to inform the panel in confidence about matters they consider important to the assessment. No one made use of this opportunity. The panel used the last part of the visit to evaluate the interviews and had a second meeting with the programme's management to receive answers to any remaining questions. At the end of the visit, the chair presented the panel's preliminary findings and impressions of the programme.

Report

The secretary drew up a draft report based on the panel's findings. This draft report was presented to the members of the panel and adjusted based on their feedback. After adoption, the draft report was sent to the institution for verification of factual inaccuracies. The secretary discussed the programme's comments with the chair, after which the secretary drew up the final report and circulated it to the panel for a final round of comments.

The report follows the four standards as specified in the NVAO's Assessment Framework 2018 (limited framework): 1) the intended learning outcomes, 2) the teaching-learning environment, 3) assessment, and 4) achieved learning outcomes. Regarding each of the standards, the assessment panel gave a substantiated judgement on a three-point scale: meets, does not meet, or partially meets the standard. The panel subsequently gave a substantiated final conclusion regarding the quality of the programme, also on a three-point scale: positive, conditionally positive, or negative.

The report on the distinctive quality feature of entrepreneurship follows the five standards as specified in the NVAO Assessment Framework 'further elaboration special (quality) feature entrepreneurship 2013: 1) vision and policy on entrepreneurship, 2) intended learning outcomes, 3) the teaching-learning environment, 3) assessment, 4) staff, and 5) achieved learning outcomes. Regarding each of the standards, the assessment panel gave a substantiated judgement on a three-point scale: meets, does not meet, or partially meets the standard. The panel subsequently gave a substantiated final conclusion regarding the quality of the programme, also on a three-point scale: positive, conditionally positive, or negative.

Development dialogue

Although separated from the process of the programme assessment, the assessment panel members and programme representatives conduct a development dialogue, to discuss future developments of the programme considering the outcomes of the assessment report.

2. Review

2.1 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, analysis, and considerations

The bachelor's programme Science Business & Innovation (SBI) is a 180 EC programme offered in the Faculty of Science (BETA) by the Department of Physics and Astronomy and the Department of Chemistry and Pharmaceutical Sciences. The bachelor's programme is a joint endeavour of these two departments, together with the Faculty of Social Sciences (FSW) and the School of Business and Economics (SBE). The programme aims at studying innovation management in a business context and is characterized by a strong focus on science-based, technological innovations stemming from knowledge and insights in physics and chemistry.

The panel noted with appreciation that the SBI bachelor's programme is an important player in the VU's priority theme 'Science for Sustainability'. The programme contributes to this theme by integrating the different aspects of the development of technological innovation for sustainability. In addition, the programme prepares students to guide the process from a scientific idea to real innovation, including knowledge of (growing) organisations, market research, competitive studies, stakeholders, and investments.

The programme focuses on university-industry technology transfer from both the natural sciences as well as the social sciences and business and economic perspectives. The basic concept of the educational programme is that students follow natural science courses, social science courses and courses with an interdisciplinary character. Students gain natural scientific knowledge in the disciplinary fields of chemistry and physics, related to topics in the energy and life sciences. In addition, students learn about the social scientific fundamentals of innovation sciences, business processes and organisational sciences. The programme focuses on natural science-driven innovation processes in two specific fields: Energy & Sustainability (E&S) and Life & Health (L&H).

In close collaboration with the programme directors of the affiliated programmes at Utrecht University and the Eindhoven University of Technology, a domain-specific reference framework (DSRF) was established in 2021, in which the respective bachelor's and master's programmes were included that educate students in the field of innovation sciences. The panel was impressed by this joint effort and considers the framework to be a coherent description of the international academic field of innovation sciences and the identity of the innovation sciences programmes in the Netherlands. As stated in the self-evaluation report, the VU bachelor's programme SBI differentiates itself in the cluster innovation sciences by means of the special feature 'entrepreneurship'. Entrepreneurship is apparent in the programme as a theoretical concept, knowledge base, and practical behaviour that supports the organisation of valorisation. The panel appreciates this explicit positioning of the programme within the framework.

The panel values the relevant and interdisciplinary programme with natural science, business, innovation, and entrepreneurship as central elements. The involvement of three different faculties allows for a synthesis of the natural sciences and the social sciences with business and economic

perspectives. The panel also values the choice of the two domains E&S and L&H. Both domains are aligned with the expertise of the teaching staff and strengthen the programme's profile.

The programme translated the goals into a convincing set of fourteen intended learning outcomes (ILOs) which are linked to the Dublin descriptors for the bachelor's level. In the eyes of the panel, the ILOs clearly reflect the level that may be expected of graduates of an academic bachelor's programme. In addition, the ILOs meet the DSRF and, therefore, are well aligned with the international standards set for the discipline. The panel applauds the explicit reference to ethical aspects in one of the ILOs ('the student is able to weigh ethical aspects in the application of science and has an understanding of the importance of his/her discipline in a broader historical, philosophical and social context'). The panel was pleased to hear that this also includes developing a critical stance in relation to innovation processes.

The programme has a Professional Advisory Board that provides a critical external perspective on the SBI programme. The Board advises the programme director on the connection with the professional field and the content of the study programme, the alignment of the ILOs to the needs of the professional field. The Professional Advisory Board comprises senior academics from the discipline and professionals who are in a position to judge what the research and the job market require from SBI graduates.

Conclusion

The panel concludes that the programme meets Standard 1.

2.2 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, analysis, and considerations

Curriculum

The bachelor's programme SBI is a three-year programme, with a total study load of 180 European Credits (EC).

In the first year, the programme builds a broad basis with courses such as 'Sustainable Energy', 'Physics', 'Biochemistry', and 'Physics lab'. In the second year, knowledge, insight, and skills are deepened with courses such as 'Research, Design and Methodology', 'Statistics', 'Clinical Diagnostics and Imaging', and 'Finance'. During the first two years, students work on four different 'Innovation Projects' (24 EC in total) in which they combine their knowledge and skills acquired in the courses. All courses in the first two years are compulsory.

The third year starts with a minor of the student's choice (30 EC). Alternatively, the student is allowed to choose five courses of 6 EC, within or outside the faculty. In the second semester, students conduct a research internship during the 'Bachelor project' (24 EC). Students are obliged to find an external position for their project, which can be at a wide variety of companies, institutions, and government services. The research question(s) and research design must include both science, business, and social-science elements so that students can demonstrate and expand their skills and knowledge in the field of SBI. In addition, the third year comprises two compulsory courses. One of these courses is

'Philosophy of Science' (3 EC) where students learn to apply philosophical insights to the field of innovation sciences and reflect on this.

The programme distinguishes five learning tracks:

- *Science basics*. The track consists of courses that teach foundational knowledge and understanding in chemistry, pharmaceutical science, physics, and mathematics.
- *Energy and sustainability*. The track includes courses that allow for the integration of energy and sustainability-related problems in society, directed at the conversion process of science to business through case- and problem-oriented research and analysis.
- *Life and health*. The track includes courses that allow for the integration of life and health-related problems in society, and that direct the conversion of science to business through case- and problem-oriented research and analysis.
- *Innovation and entrepreneurship*. This learning track is by far the largest component in the programme. The track consists of courses that teach business, social and innovation science fundamentals as well as courses that provide the integration of exact and social sciences.
- *Methodology*. This track includes two short courses ('Physics lab' and 'Thermodynamics') that combine natural sciences theory with experimental design, execution, and related communication. In addition, the course 'Research Design and Methodology' provides an introduction to qualitative research design in social sciences. The introductory classes of the Innovation Projects and the Bachelor project also offer SBI research methodology and methods.

Next to these five learning tracks, students follow the *Academic skills programme (Tutoring).* This programme starts with a personal intake conversation with the SBI study advisor at the beginning of year one. Each year, students follow modules of the programme parallel to the mandatory courses. Examples of modules are 'Learning how to study effectively' and 'Close reading of academic literature'. In addition, students can choose elective modules like 'Personal effectiveness'. The Academic Skills Programme in the third year consists of writing a reflection report on the research internship in the Bachelor project, followed by a discussion of the content with the internship coordinator. Credits can only be awarded once the report has been received and discussed.

A complete overview of the courses can be found in Appendix E. The self-evaluation report provides an elaborate explanation of how the five learning tracks, the course 'Philosophy of Science' and the 'Academic Skills Programme' contribute to the ILOs.

Based on the documents and the interviews with the staff and students, the panel concludes that the programme successfully translated the ILOs into a well-designed curriculum with a clear focus on entrepreneurship. The five learning tracks ensure the coherence of the curriculum, and the Academic skills programme ensures the academic training of the students. The panel established that the first two years lay the groundwork. During these two years, students acquire a solid understanding of natural science and learn how to use business and innovation theories to analyse and develop strategic insight into innovation processes. The panel highly appreciates the opportunities that students have, to work on projects in and for companies during the four Innovation Projects and during the Bachelor project. This allows students to gain insight in what is needed to align innovative technologies with the demands of the market and intended users. Furthermore, the panel established that students have ample opportunity in the third year to define their own learning path by choosing their minor and by choosing the topic and the organisation of their Bachelor project.

The panel appreciates the programme's broad scope and the integration of the natural sciences, the social sciences, and business and innovation sciences. However, it was not fully transparent to the panel on which subdomains of the social sciences the programme focuses. It advises the programme to make this more explicit.

As mentioned, the panel applauds the explicit reference in the ILOs to considering ethical aspects in the application of science. During the site visit, the panel heard convincing examples of how the programme addresses these ethical aspects. This particularly happens in the 3 EC course 'Philosophy of Science'. The panel encourages the programme to further strengthen this and focus more explicitly on ethical aspects, in the form of taking a critical stance towards innovation processes, throughout the entire programme.

The students are positive about the programme's content and structure. They appreciate the broad orientation of the programme and the mix between the natural-science subjects and business subjects. Students are less satisfied with the academic level of the business courses. They considered the business courses interesting and relevant, but some courses address the same theories and don't provide enough depth. The panel advises the programme to reduce the overlap between courses and challenge students by providing more academic depth within these courses.

Learning environment

The programme adheres to the core values of the VU vision of university education, as stipulated in the VU strategic plan 2020-2025. These core values are ownership, active learning and blended learning, next to open, personal and responsible. Furthermore, the VU strategic plan emphasises entrepreneurship, scientific integrity, and science for sustainability as core themes. As stated in the self-evaluation report, this vision is reflected in the programme in several ways. Important elements are the extensive focus on academic skills and the extensive focus on entrepreneurship. The panel is pleased that the programme has taken the recommendation of the previous assessment panel by heart to address academic skills more explicitly in the courses. It also appreciates the extensive focus on entrepreneurship (see chapter 4 for the assessment of the panel on this distinctive feature).

The panel established that the programme uses multiple teaching methods, such as inviting guest lecturers who share their practical experience, tutorials, computer labs, experimental labs, exploring cases provided by firms in a variety of sectors, oral presentations, poster presentations and interviews with external experts. In the conversations with students, it appeared that they were positive about the teaching methods. They highly appreciate the opportunity to interact with the 'real world' during the Innovation Projects. However, the students indicated both in the student chapter and the interviews that some lecturers could make their courses more interactive.

There is a lively student association, *Subliem*, which organises study as well as informal events, often in cooperation with the programme. *Subliem* organises, for example, symposia, study trips abroad, and a career day where companies attend and speak with students about career opportunities. *Subliem's* activities also include the first-year weekend, drinks, a magazine, and news blogs.

Student intake

The programme is open to students with a vwo-degree including mathematics B, chemistry, and physics. Students with a propaedeutic exam or bachelor's degree in applied sciences must also have a vwo- certificates in mathematics B, chemistry, and physics. The influx in the programme is about 80 to 90 students per year. This number has been quite stable over the years. However, in 2021-2022 only 51 students entered the programme. The panel thinks that the programme is highly relevant and encourages the programme to bring student numbers for prospective cohorts to the previous level.

Study load and study guidance

The Programme Coordinator has an essential role in guaranteeing the personal approach. In addition, the Programme Coordinator fulfils the role of study advisor. The internship coordinator plays an important role in guiding the student in the choice of internship and formulating the research question for the graduation project. The internship coordinator is responsible for monitoring the process across the bachelor project from start to finish and ensuring that the entire course process is organized properly.

The panel considers the offered support of good quality. This impression is also confirmed by students, who feel equipped and supported to create their own study path in the third year, including the choice of internship. According to the students, the workload is in line with what can be expected of a full-time study. They consider the programme sometimes challenging, yet feasible.

Staff

The panel noted that the programme is embedded in a strong interdisciplinary academic environment. The disciplinary courses in the area of natural sciences of the master's programme are offered by the departments Chemistry & Pharmaceutical Sciences and Physics & Astronomy. The School of Business and Economics (SBE) and the Faculty of Social Sciences (FSS) offer business and social-science disciplinary courses. The panel established that the teaching staff is didactically skilled: all lecturers are required to have the University Teaching Qualification (UTQ). In addition, several SBI lecturers also hold a senior teaching qualification (STQ), or a diploma from the educational leadership course. The academic staff for the SBI bachelor's amounts to 29 staff members (10 full professors, 9 associate professors, 7 assistant professors and 3 lecturers). Most of the assistant, associate, and full professors, as well as the lecturers and guest lecturers involved in the SBI section, also participate in other accredited fields of academic education, either at or outside the VU.

The interviews during the site visit gave the panel a positive view of the teaching staff. The teaching staff is enthusiastic, well-qualified and knowledgeable in their respective areas. The panel noted that the programme relies on a small group of key staff members to realise the core identity of the programme. These key SBI lecturers and supporting officers meet once each month to exchange information about operational affairs concerning the programme. Twice a year all lecturers are invited for a meeting about the SBI programme. During the visit, the management indicated that it is difficult to get all lecturers to participate in the meetings. Since these meetings are key to making SBI a multi-disciplinary yet coherent and integrated programme, the panel recommends encouraging all involved lecturers to attend the meetings.

Conclusion

The panel concludes that the programme meets Standard 2.

2.3 Student assessment

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

Findings, analysis, and considerations

Assessment policy and assessment system

The panel established that the programme has a solid set of documents and procedures in place which secure an adequate assessment system. Based on the VU-wide Assessment Framework, the Faculty of Science has formulated an assessment policy that describes the roles and responsibilities of all stakeholders in the assessment process following the quality assurance cycle of the faculty. The Faculty Board establishes the assessment policy, and the Examination Board (EB) assures its implementation by the Programme Director and the examiners. The Assessment Plan for SBI describes, among other things, how the programme works towards its ILOs, why certain types of assessment take place and how the programme guarantees quality assurance. The SBI Assessment Plan comprises an assessment matrix that relates the ILOs to the various courses and examinations. The panel verified that the assessments cover and thoroughly assess all ILOs.

The panel appreciates the range of assessment modes used, including written exams, papers, essays, individual assignments and group assignments, and presentations. Most courses use multiple assessment types in order to stimulate the active learning process of students. Written exams usually consist of open questions, although some exams also feature multiple-choice questions. The panel noted with appreciation that each course is designed to address the learning outcomes according to the principle of constructive alignment.

Assessment of the bachelor's thesis

The Bachelor project was revised in 2018 to include a modular setup with partial assignments that lead to the compilation of a final thesis. Assessment takes place in two stages, during the project and after completion of the project. The first stage of the assessment is divided into five modules. These five modules are subdivided into seven assignments which are linked to a lecture on the relevant topic. Each assignment is graded by a lecturer of the SBI division, who also provides the student with feedback on how this assignment could be improved. Students can attend consultancy hours to ask questions about the provided written feedback. In case the assignment has been completed successfully, the student can incorporate the feedback in the final report. In case an assignment scored lower than 5.5 the student needs to hand in a sufficiently improved version to be allowed to continue with the next project assignment. The grading of the individual assignments rotates amongst a team of assessors of the SBI section and the Department of Physics.

The second stage of the assessment takes place after the completion of the project. After completing all project assignments, the student hands in a complete thesis in which all assignments are combined and edited into a cohesive final report. This final report is independently evaluated by two members of the SBI division (the course coordinator and the division head SBI). These two assessors determine the overall grade of the Bachelor project, based on their evaluation and the grades of the individual project assignments. They also consider the scores in the company supervisor feedback form. All grades are plenarily presented to and discussed by all members of the SBI division leading to the final grade of the bachelor project. The final grade document is signed by the course coordinator and SBI

division head. When the (partial) grade of the two VU assessors on (one or multiple of the thesis modules in) the final report and overall assessment differs more than 1.5 points, the EB will appoint a third assessor who will mediate for consensus between both assessors. The panel highly values the involvement of a third assessor but would like to suggest involving the third assessor in case of a discrepancy of more than one point.

As indicated in the self-evaluation report, the organisation of the Bachelor project trajectory is seen as exemplary within the Faculty of Science. This innovative format will be implemented in more programmes, and the SBI-staff has been awarded a grant to help with this implementation.

The panel is very positive about this carefully designed assessment procedure that involves all lecturers of the SBI division. The panel applauds the combination of comprehensive assessment per assignment with personalised feedback.

Examination Committee

The SBI programme shares an Examination Board (EB) with several other bachelor's and master's programmes of the Faculty of Science. The SBI sub-committee, which consists of three members, is responsible for the quality of assessment and the end level of the bachelor's programme and master's programme SBI. Since the SBI programme doesn't only consist of courses and projects offered by the Faculty of Sciences but also comprises courses by other faculties, the SBI sub-committee contacts the EBs of the partner faculties to discuss findings and possibly implement improvements if needed. Every year the SBI sub-committee does a random check of at least three bachelor's theses and at least three courses. The SBI sub-committee writes a comprehensive report which is discussed with the programme directors.

The panel gathered from the discussion with representatives of the EB and SBI subcommittee that the quality assurance of student assessment is well organised. The panel noted with appreciation that the SBI subcommittee plays an important and active role in the quality assurance of both course assessments and the final thesis.

Conclusion

The panel concludes that the programme meets standard 3.

2.4 Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings, analysis, and considerations

To judge whether students achieve the ILOs by the end of the programme, the panel studied a sample of final reports and corresponding evaluation forms, completed in 2020, 2021 or 2022. The selection covered a balanced range of final marks.

The panel concludes that the final report of the Bachelor project demonstrates the realisation of the programme's ILOs. The theses are of the level and quality that may be expected from a bachelor's thesis in the field of innovation sciences. The theses showed that graduates acquired a broad scientific basis in natural sciences, business, and social sciences and can apply these skills and

knowledge in the field of SBI. The panel considers the theses' quality to be in line with the grades given.

The panel appreciates that all Bachelor projects were linked to real-world assignments for a firm or organisation. The subjects of the theses were very timely and relevant to the innovation field. However, the panel would have welcomed more critical reflection by the students on the research methods and the theoretical framework. The panel was pleased to hear that the lecturers discuss this with the students. It encourages the programme to further strengthen the quality of the theses by making this kind of critical reflection an explicit requirement of the final report.

The programme gives students clear options to pursue a master's programme. Graduates have direct access to the SBI master's programme at the VU. Depending on the electives they chose, graduates can also enrol in several other master's programmes at the VU or programmes at other universities in the Netherlands and abroad.

The programme stays in contact with the alumni through the LinkedIn alumni page, and the annual organisation of an alumni symposium. The programme observed, based on these contacts and events, that most students do well in follow-up master programmes.

Conclusion

The panel concludes that the programme meets standard 4.

3. Strengths and recommendations

3.1 Strengths of the programme

The panel is impressed by the following features:

- Relevant profile - The interdisciplinary programme has a relevant profile in the innovation sciences with natural science, business, innovation, and entrepreneurship as central elements;
- Empirical context - The four Innovation Projects and the Bachelor's project allow students to gain insight in what is needed to align innovative technologies with the demands of the market and the users;
- Teaching team - The teaching staff is enthusiastic, well-qualified and knowledgeable in their respective areas;
- Assessment system - The programme has a solid set of documents and procedures in place which secure an adequate assessment system;
- Design bachelor project - The Bachelor project is linked to a real-world assignment for a firm or organisation. The carefully designed assessment procedure combines a comprehensive assessment with personalised feedback.

3.2 Recommendations

For further improvement of the programme, the panel makes the following recommendations:

- Social sciences domains - Make explicit on which social science subdomains the programme focuses;
- Ethical aspects - Further strengthen the focus on ethical aspects, in the form of taking a critical stance towards innovation processes, throughout the programme;
- SBI teacher meetings - Encourage all lecturers involved in the programme to attend the SBI teacher meetings;
- Business courses - Reduce the overlap between the business courses and challenge students by providing more academic depth within these courses;
- Critical reflection – Further strengthen the quality of the thesis by requiring a critical reflection in the final report on the research methods and the theoretical framework.

4. Special feature entrepreneurship

4.1 Vision and policy on entrepreneurship

Findings, analysis, and considerations

Vision and policy

The panel highly appreciates the strong focus of the programme on entrepreneurship. The self-evaluation report states that effective entrepreneurship is about the discovery, creation, and exploitation of opportunities with the purpose to create value. This type of value creation is an important study object in the bachelor's programme SBI.

The content of the SBI programme fits well with the central themes that VU adopts in its Strategic Plan 2020-2025. This Strategic Plan puts specific emphasis on entrepreneurship and science for sustainability. Within the VU, entrepreneurship education is understood as science- and tech-based entrepreneurship education. As explained in the self-evaluation report, this means that the focal point of the SBI programme is to create value through the deployment of academic knowledge, discoveries and technologies by professionals who display entrepreneurial competence. Recently, the programme leaders published a paper in which they give a convincing description of their vision on science-based entrepreneurship education as a means for university-industry technology transfer.[1]

Furthermore, the self-evaluation report states that the programme's vision on entrepreneurship consists of three dimensions:

- Entrepreneurship as a personal competence: the entrepreneurial person has an intrinsic capacity to deploy knowledge (theoretical and practical), skills and attitudes that all are tied to entrepreneurial behaviour (for example: to discover, create, and utilize opportunities) as a function of the concrete, daily and changing professional situation and as a function of personal and societal activities. As described in the self-evaluation report, this includes general and job-specific competences as well as explicit, implicit, and unintentional competences.
- The process of entrepreneurship: entrepreneurship assumes a strong connectedness and active exchange between entrepreneurship theory, planning and practice. The entrepreneurial business model depends on means, transactions, and value fluctuations. By regarding entrepreneurial processes as transformational processes where inputs, by way of throughputs are converted into outputs, a structured view of the process of entrepreneurship can be established. In this way, responsible and reasoned initiatives can be developed and designed that contribute to the direction and future of these transformational processes.

[1] Blankesteijn, M., Bossink, B., & van der Sijde, P. (2021). Science-based entrepreneurship education as a means for university-industry technology transfer. *International Entrepreneurship and Management Journal*, *17*(2), 779-808.

- The context of entrepreneurship: enterprises operate in and are continually subject to institutional contexts. These contexts include parties who operate in the value chain, from knowledge institutes or the company's R&D labs, via product and market development parties to users and clients. An enterprise exists and develops as a function of its network. Being able to identify, understand and work in such a constellation of parties in each phase of science and technology-driven entrepreneurship is decisive for company success.

According to the panel, the programme's vision on entrepreneurship is in line with the international understanding of the concept of entrepreneurship. The policy of providing science-based entrepreneurship education as a means for university-industry technology transfer fits well with an academic programme in the Faculty of Sciences.

Evaluation of entrepreneurship

The panel established that entrepreneurship is an integral part of the programme and is regularly evaluated, involving relevant key stakeholders among which the Professional Advisory Board and the School of Business and Economics (SBE).

The programme's Professional Advisory Board advises on the connection with the professional field. This also includes a regular evaluation and advice on the ILOs aimed at the development of entrepreneurial competencies. Two of the six members of the Board have a special interest in entrepreneurship.

SBE is an important stakeholder in the organisation of the bachelor's programme SBI and has a special interest in and knowledge of the entrepreneurship component of the programme. Through regular contact with recognised experts, the didactical underpinning of the vision on entrepreneurship education is constantly kept up to date and informed by evidence from the latest educational research.

Conclusion

The panel concludes that the programme meets standard 1.

4.2 Intended learning outcomes

Findings, analysis, and considerations

Entrepreneurship is most notably featured in the following ILOs of the SBI programme:

- ILO 6: (the student) has knowledge and understanding of entrepreneurial and innovation processes and the implementation and integration of scientific innovations in business processes.
- ILO 9: (the student) has developed skills to work on projects, to think in an interdisciplinary manner, to connect scientific and business information, and to understand the different roles of actors in an innovation process.

In the vision of SBI, entrepreneurship translates to the knowledge, attitude, and behaviour of students. The self-evaluation report indicates that lecturers recognize that SBI students become highly motivated when the integration of science and business is the object of study. The necessary competences are explicit in the following ILOs:

- ILO 11: (the student is able to) critically review assembled information, research results, professional literature and scientific reports in the exact, business and social sciences that relate to life science or energy science and is able to judge their applicability.
- ILO 14: (the student is) capable of presenting, communicating, and discussing his/her knowledge and understanding in a clear and transparent way.

The panel studied the ILOs of the programme and considers the entrepreneurship vision, strategy and objectives of the programme to be well reflected in these ILOs. In the eyes of the panel, the ILOs reflect the level that may be expected of graduates of a bachelor's programme.

Conclusion

The panel concludes that the programme meets standard 2.

4.3 Teaching-learning environment

Findings, analysis, and considerations

The panel established that the content and structure of the curriculum enable students to achieve the programme's objectives regarding entrepreneurship. Several compulsory courses explicitly introduce, explain, and apply innovative entrepreneurship theory and application substantiated by current scientific insights. Important courses in this respect are: 'Essentials of SBI', 'Management and Organisation of Technological Innovation', 'Corporate Social Responsibility & Sustainability' and 'Entrepreneurship & Innovation'.

Students develop a practical, behavioural component in the four Innovation Projects and the internship in the Bachelor's project. Furthermore, the programme stimulates entrepreneurial behaviour by fostering competences such as autonomy, self-reliance, and networking. Active reflection on how these competences have been sharpened during these exercises, helps students to draw lessons from their experiential learning.

The VU strongly advocates the development of entrepreneurial competences as an attitude and a competence – so not per se with the ambition to start one's own company. The panel agrees with this view. Therefore, the panel is pleased with the strong commitment of the VU to provide practical contexts for developing these competences and attitudes. Entrepreneurship education is on the five-year strategic agenda of the VU. The staff of the SBI programme connects with university-wide initiatives to provide the students with a vibrant research context: the Amsterdam Centre for Entrepreneurship (ACE), Innovation Exchange Amsterdam (IXA), the Demostratorlab, the European university network Aurora, and other academic and professional networks of the supervisors involved. Furthermore, the self-evaluation report mentions the possibility of collaboration with the university-wide Broader Mind programme, which combines academic and societal relevance and has, via community-service learning, a close link to, especially, social entrepreneurship. The panel does encourage such a collaboration.

Conclusion

The panel concludes that the programme meets Standard 3.

4.4 Staff

Findings, analysis, and considerations

The panel noted with appreciation that lecturers in the programme are familiar with entrepreneurship, not only from a theoretical perspective but also from practical experience. Several staff members are actively involved in research on entrepreneurship. Many lecturers in the SBI section and in the collaborating faculties (BETA, SBE, FSW) who provide courses in the programme, have experience with entrepreneurship, for instance through the establishment of a spin-off company, through other ways of participation in valorisation activities, or through collaboration with the VU-IXA (Innovation Exchange Amsterdam, previously the Technology Transfer Office). These lecturers use their experience in their lectures where they speak about case studies and real-life examples based on first-hand experience. In addition, the programme benefits from its strong network by attracting guest lecturers who present the necessary anecdotal and contextual cases. As indicated in the self-evaluation report, SBI students highly appreciate this.

Overall, the panel considers the staff to be equipped to lecture on entrepreneurship in a meaningful way.

Conclusion

The panel concludes that the programme meets standard 4.

4.5 Achieved learning outcomes

Findings, analysis, and considerations

The SBI Assessment Plan comprises an assessment matrix that relates the ILOs to the various courses and examinations. The panel verified that the assessments cover and thoroughly assess all ILOs, including the ILOs regarding entrepreneurship.

The internship is a research project on science-to-business conversion, which requires entrepreneurial skills and attitudes. The panel appreciates that all projects are linked to real-world assignments for a firm or organisation. The programme has a wide network of companies in all sectors of society both in the Netherlands and abroad. The panel noted with appreciation that several firms spread over various sectors have become regular internship providers to students, whereby students exercise their entrepreneurial skills as 'intrapreneurs'.

The panel is pleased with the improvements made since the last visitation regarding the assessment of entrepreneurial skills. Several courses include practical assignments to develop entrepreneurial competencies, most notably the Innovation Projects. The assessment of entrepreneurial skills is also part of the Entrepreneurship & Innovation course. In this course, students are challenged to identify and develop an opportunity. This experience (together with an interview with an entrepreneur) is compared to entrepreneurial behaviour. Furthermore, skills development is integrated and assessed in the assignments of the bachelor's project.

Although the programme has already made several improvements in its approach to the assessment of skills, the self-evaluation indicates that this needs further attention. The panel understood that the programme also has concrete plans to further develop this approach. The panel encourages the programme to pursue these plans.

Based on anecdotal information, the self-evaluation report indicates that graduates usually settle quickly in a graduate programme or job and demonstrate a skill set that enables them to adapt quickly to a new environment. Graduates are used to working on a project basis and to familiarizing themselves quickly with new materials and data.

Overall, the panel is convinced that graduates of the SBI programme achieve the ILOs.

Conclusion

The panel concludes that the programme meets standard 5.

5. Conclusion

The panel has found that the intended learning outcomes (standard 1), the teaching-learning environment (standard 2), the assessment system (standard 3) and the achieved learning outcomes (standard 4) meet the criteria.

The intended learning outcomes reflect the programme's aims and vision and are in line with the discipline and international requirements. The curriculum, the teaching methods, the quality of the teaching staff and the assessment system enable the incoming students to achieve the intended learning outcomes.

Four standards from the NVAO Assessment framework for the higher education accreditation system of the Netherlands 2018 (limited framework)

Standard	Judgement
Standard 1	Meets the standard
Standard 2	Meets the standard
Standard 3	Meets the standard
Standard 4	Meets the standard
Final conclusion	**Positive**

With regard to the distinctive feature entrepreneurship, the panel has verified that the programme meets all five standards.

Five standards from NVAO Assessment Framework further elaboration special (quality) feature entrepreneurship 2013.

Standard	Judgement
Standard 1	Meets the standard
Standard 2	Meets the standard
Standard 3	Meets the standard
Standard 4	Meets the standard
Standard -5	Meets the standard
Final conclusion	**Positive**

Appendix A –Programmes of the cluster

The cluster Innovation Sciences consists of six programmes:

56265	B Technische Innovatiewetenschappen	Eindhoven University of Technology
66265	M Innovation Sciences	Eindhoven University of Technology
56982	B Natuurwetenschap en Innovatiemanagement	Utrecht University
60709	M Science and Innovation	Utrecht University
50670	B Science, Business & Innovation	Vrije Universiteit Amsterdam
69320	M Science, Business and Innovation	Vrije Universiteit Amsterdam

Appendix B – Documents studied

Self-evaluation report bachelor's programme Science Business & Innovation

Appendix 01 – Overview of staff
Appendix 02 – Article Science-based entrepreneurship education
Appendix 03 – Domain specific framework of reference Innovation Sciences
Appendix 04 – Year schedule bachelor SBI
Appendix 05 – Learning Lines and courses in the Bachelor's SBI
Appendix 06 – Assessment plan bachelor SBI
Appendix 07 – Alignment Dublin Descriptors, ILO's and assignments in the bachelor's project
Appendix 08 – Example Bachelor's Project Poster
Appendix 09 – Honours programme at the Faculty of Science
Appendix 10 – Teaching and Examination Regulations (TER) B SBI 2022-2023
Appendix 11 – Assessment Policy Faculty of Science
Appendix 12 – Rules and Guidelines Examination Board 2022-2023 Faculty of Science
Appendix 13

a) Bachelor's Project manual (Dutch)
b) Manual partial assignments bachelor's project (Dutch)
c) Rubrics bachelor's project (Dutch)

Appendix 14 – Study Guide 2022-2023
Appendix 15 – Management information Factsheet 2021-2022 Appendix 16 – Management information visitation report Appendix 17 – Results NSE 2021
Appendix 18 – Overview Final Projects

In addition, the panel had access to:

- Canvas provides detailed information on several courses
- The assessment dossiers of three bachelor's programme courses

Appendix C – Schedule of the visit

10 November, 2022

Time	Session
8:30 - 9:30	Welcome and preparation interviews by panel
9:30 - 10:15	Programme management
10:30 - 11:00	Bachelor students
11.00 – 11:30	Master students (including member programme committee)
11:45 12:30	Lecturers BSc, including member programme committee and thesis assessors
12:30 -13:30	Lunch and consultation hour
13:30 -14:15	Lecturers MSc, including members programme committee and thesis assessors
14:30 -15:00	Examination Board
15:15 -16:00	Alumni and professional field representatives (online)
16:15 - 16:30	Programme management
16:30 - 17:45	Deliberations panel
17:45	Presentation preliminary findings

Appendix D – Abbreviations

DSRF	domain-specific reference framework
EB	Examination Board
EC	European Credit
E&S	Energy & Sustainability
ILO	Intended Learning Outcomes
FSW	Faculty of Social Sciences
L&H	Life & Health
NVAO	*Nederlands-Vlaamse Accreditatieorganisatie*
SBE	School of Business & Economics
SBI	Science Business & Innovation
UTQ	University Teaching Qualification
STQ	Senior Teaching Qualification
VU	Vrije Universiteit Amsterdam
Vwo	*Voorbereidend wetenschappelijk onderwijs*

Appendix E: Courses and learning lines

Year 1 – course	Period	EC	Learning line
Essentials of Science, Business & Innovation	1-2	6	ELI
Calculus	1-2	6	S
Management and organization for technological innovation	1	6	I
Biochemistry	2	6	L
Innovation Project Medicine	3	6	L/M
From Molecule to Medicine	4	3	L
Sustainable Chemistry	4	3	SE
Organic Chemistry	4	3	S
Physics: mechanics	4	3	S
Entrepreneurship & Innovation	4	3	I
Physics Lab	5	3	SM
Sustainable chemistry: biomass and biofuels	5	3	E
Innovation Project Energy	6	6	EIM
Academic Skills programme 1a & 1b	1-6	0	
Year 2 – Course	**Period**	**EC**	**Learning track**
Research, design & methodology	1	3	M
Strategic management of technology and innovation	1	6	I
Statistics	1-2	6	SM
Clinical diagnostics and imaging	2	6	L
Applied computer science	2	3	S
Innovation project diagnostics and health	3	6	LIM
Linear algebra	4	3	S
Corporate social responsibility and sustainability	4	6	I
Thermodynamics	4	3	SEM
Finance 1	5	6	I
Physics: electricity and magnetism	5	3	S
Sustainable energy: sun, wind and water	5	3	E
Innovation Project Energy Transition	6	6	EIM
Academic skills programme 2	1-6	0	

Year 3 – Course	*Period*	*EC*	*Learning track*
Minor	*1-3*	*30*	
Computer modelling	*4*	*3*	*SM*
Philosophy of science	*4*	*3*	
bachelor's Project	*4-6*	*24*	*All tracks*
Academic skills programme 3	*1-6*	*0*	
Year 3 – Minor SBI	*Period*	*EC*	*Learning track*
Theories of new venture creation	*1*	*6*	*I*
Strategic management of Technology and Innovation	*2*	*6*	*I*
Technology Entrepreneurship in Practice	*1-3*	*18*	*All tracks*

Figure 1 Learning lines in the BSc SBI. Specified are courses, teaching period, study load in EC and the learning lines that a course is part of. Learning lines are: S= Science basics E=Energy and sustainability, L= life and health, I=innovation and entrepreneurship, M= research methods