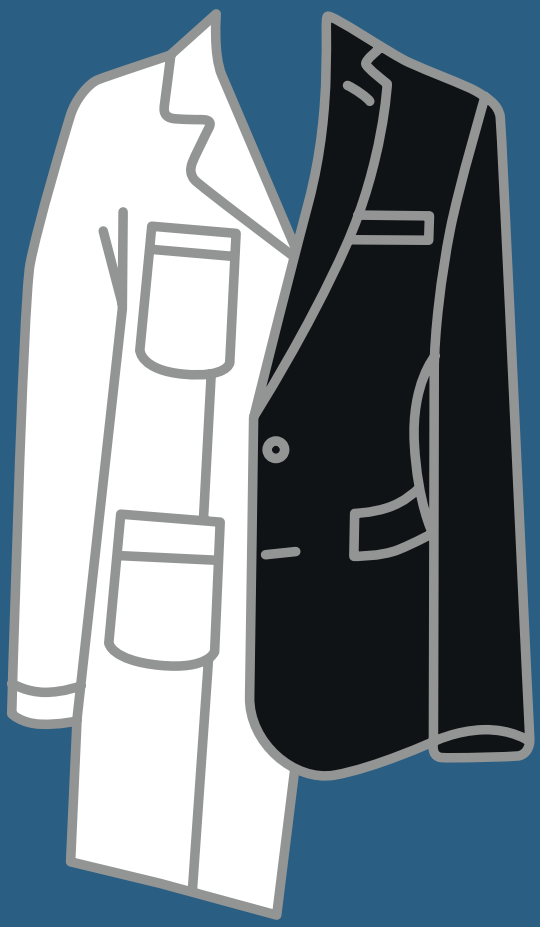
Preparing science students for society

Impact of the Science, Business and Policy program



Saskia Grooters

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Preparing science students for society, Impact of the Science, Business and Policy program

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Preparing science students for society

Impact of the Science, Business and Policy program

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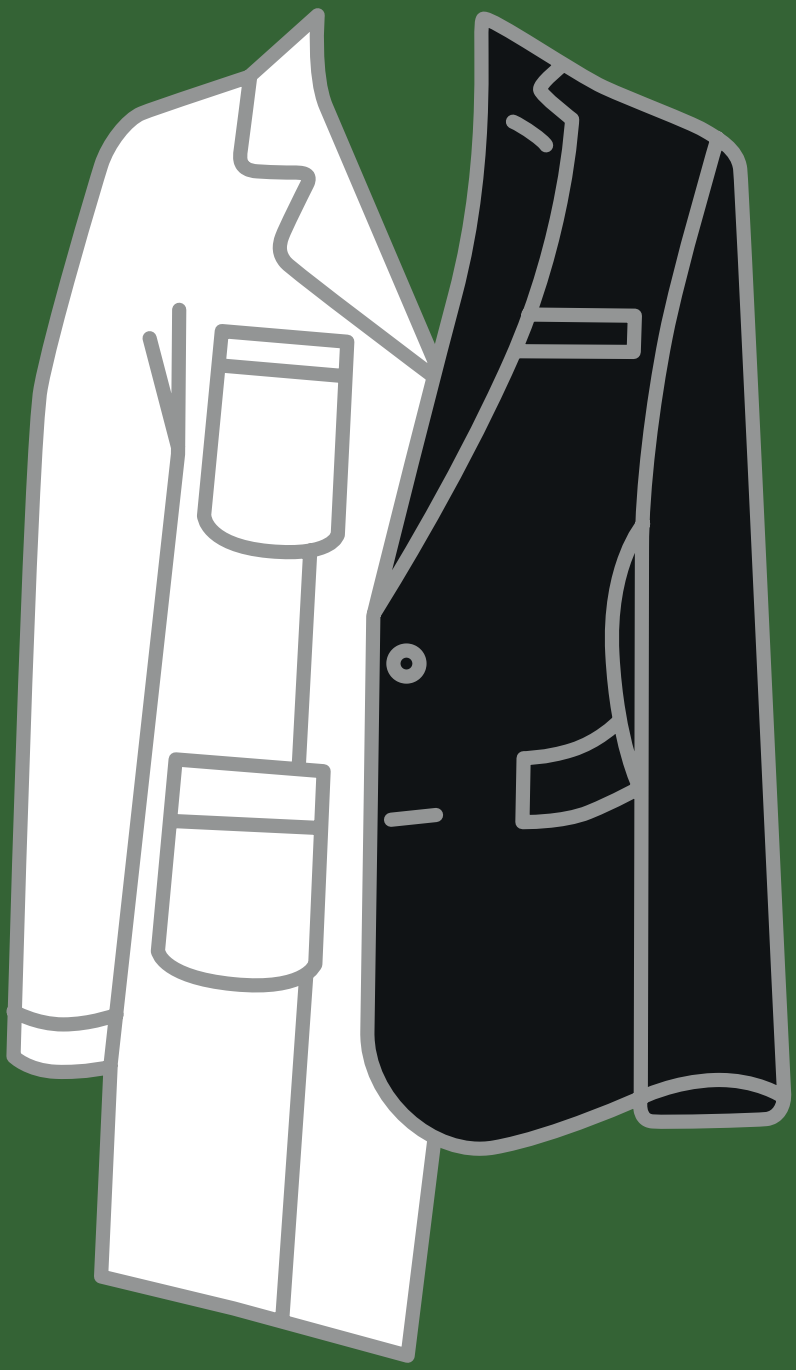
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Samenvatting
Summary

Samenvatting

In dit proefschrift is gekeken naar de impact van een alternatief master-programma voor natuurwetenschappen dat studenten voorbereidt op een carrière buiten de academische wereld. Dit programma heet Science, Business and Policy (SBP) en wordt al meer dan twee decennia aangeboden aan de Faculty of Science and Engineering van de Rijksuniversiteit Groningen. In dit proefschrift wordt verslag gedaan van een langjarig empirisch praktijkgericht onderzoek naar de ontwikkeling van SBP.

Aan de Rijksuniversiteit Groningen kunnen studenten aan een masteropleiding beginnen als ze een universitair bachelorsdiploma in de bètawetenschappen hebben behaald. Ze kiezen dan een wetenschappelijke discipline voor hun tweejarige masteropleiding (bijvoorbeeld biomedische wetenschappen). In het eerste masterjaar verwerven alle studenten disciplinaire competenties en kennis door cursussen op masterniveau te volgen. Daarnaast voeren studenten in het eerste masterjaar een onderzoeksproject uit dat resulteert in een masterthese (minimaal 30 ECTS). In het tweede masterjaar kiezen studenten voor een voortzetting van de klassieke researchgeoriënteerde mastervariant (ROM), een educatieve master of als alternatief het SBP-traject. Wanneer ze voor SBP kiezen, doen studenten (in een multidisciplinair cohort) in hun tweede jaar twee basiscursussen, namelijk een cursus met als kernvak bedrijfskunde en een cursus met als kernvak bestuurskunde. Deze cursussen hebben beide een omvang van 10 ECTS en bestaan uit een theorie deel en een daaraan gekoppeld groepsproject voor een maatschappelijke partner (respectievelijk een bedrijf en een overheidsinstantie of ngo). NA deze cursussen volgt een individuele, fulltime stage van 40 ECTS, die ook bij een bedrijf, overheidsinstantie of ngo plaatsvindt.

SBP komt voort uit het Bologna convenant over masteronderwijs in Europa en heeft een onderscheidende positie in de Europese natuurwetenschappelijke curricula. Wat SBP onderscheidend maakt in Nederland is dat het zich richt op het gehele spectrum van de natuurwetenschappen. Internationaal is ons geen vergelijkbaar programma bekend. Typerend voor SBP is verder dat het programma de student voorbereidt op een carrière buiten de universiteit. Dit onderwijs is relevant omdat een groot deel van de masterstudenten na het afstuderen niet doorgaat met research. Het lijkt dan ook een logische stap voor een opleiding om studenten ook de mogelijkheid te geven zich voor te bereiden om natuurwetenschap voor maatschappelijke vraagstukken in te zetten. SBP is daarmee bijzonder omdat het, in tegenstelling tot de ROM, specifiek opleidt tot in een carrière in het bedrijfsleven, bij overheidsinstanties of ngo's, en zo een voorbereiding vormt op een maatschappelijke carrière.

Het onderwijskundige ontwerp van SBP is gebaseerd op Work based Learning (WBL), een onderwijsvorm die uitgaat van de daadwerkelijke toepassing van kennis in de praktijk, op de werkvloer. Dit is een veel toegepast concept op MBO en HBO, maar zeldzaam in academisch onderwijs. SBP werd inmiddels in 2018 geselecteerd als best practice van een WBL op academisch niveau in Europa. Andere belangrijke kenmerken zijn dat SBP multidisciplinair is, waarbij studenten uit verschillende natuurwetenschappelijke disciplines samenwerken en hun kennis integreren met kennis uit voor hen nieuwe disciplines zoals bedrijfskunde en bestuurskunde en dat SBP zich richt op het aanleren van een entrepreneurial (strategische en ondernemings- georiënteerde) vaardigheden. De leeruitkomsten zijn dus gericht op integratie van wetenschap en samenleving om met natuurwetenschappelijke kennis oplossingen te genereren voor een maatschappelijke opdrachtgever.

Om de impact (waarmee hier het effect op de verschillende actoren wordt bedoeld) van SBP te analyseren is specifiek onderzoek verricht naar de ervaringen en waardering van de drie belangrijkste betrokken actoren: de studenten en alumni, de werkgevers waar de studenten stages hebben gelopen en de academische staf.

Om voor de eerste groep, de studenten de impact die SBP heeft te bepalen, is er een inhoudsanalyse gedaan van de rapporten van de gevolgde externe stages (het centrale WBL-component van SBP). Daaruit bleek dat SBP-studenten in staat waren voor een grote verscheidenheid aan praktijkproblemen oplossingen te genereren. Deze verscheidenheid trad op binnen zowel het bedrijfsleven als bij beleidsorganisaties van verschillend omvang, en in uiteenlopende sectoren, natuurwetenschappelijke disciplines en regio's. De behaalde cijfers van de studenten voor het adviesrapport ter afsluiting van de externe stage lieten een positieve correlatie zien met de beoordeling van de initiële theoretische voorbereiding (getoetst met klassieke tentamens).

In enquêtes (n=242) werden bevindingen van zowel SBP-alumni als ROM-alumni onderzocht. De alumni beoordeelden daarbij zelf hun eigen leerresultaten, waarbij het eigen academische niveau in beide groepen als positief werd ervaren. Op het gebied van vaardigheden werden onderzoek-gerelateerde vaardigheden door beide groepen als voldoende gezien, hoewel dit significant hoger was in de ROM-groep. Bij de zogenaamde soft skills was dit andersom: de SBP-groep ervoer de mate waarin ze deze vaardigheden beheerste aanzienlijk hoger. Beide groepen hadden een duidelijke inhoudelijke motivatie om voor hun programma te kiezen, SBP-alumni prefereerden de maatschappelijke focus van SBP en een carrière buiten de academische wereld, waar ze zich ook significant beter op voorbereid voelden. De enquêteresultaten gaven aan dat de loopbanen van beide groepen alumni ook daadwerkelijk verschilden. De twee profielen resulteerden in verschillende carrièremogelijkheden. Hoewel ROM-alumni zich voornamelijk voorbereid

voelden op een wetenschappelijke carrière, ging slechts een kwart daadwerkelijk door in de wetenschap en werkten velen van hen in het onderwijs. De meeste SBP-alumni waren daarentegen werkzaam in het bedrijfsleven of in een beleidsfunctie. Wanneer de alumni hun verloop in vaardigheden beoordeelden dan namen in beide groepen de onderzoek-gerelateerde vaardigheden af tijdens de loopbaan, terwijl de soft skills toenamen. Alumni waren over het algemeen tevreden met zowel hun eerste baan als hun huidige baan, waarbij SBP-alumni significant hoger scoorden op tevredenheid over inkomen, status, waardering en baanperspectief.

Om de impact op de werkvloer te onderzoeken zijn twintig semigestructureerde interviews met stageaanbieders gehouden. Dit waren bedrijven, overheidsorganisaties en ngo's. Werkgevers zien studenten die een stage hebben gelopen als aantrekkelijke toekomstige werknemers. De kwaliteit van het, tijdens de stages gegeven, wetenschappelijk adviesrapport (het eindrapport van de studenten) wordt gemiddeld als hoog beoordeeld. Vanuit het perspectief van de werkvloer zijn stages een sterk onderdeel in een optimale opleiding van toekomstige werknemers met een natuurwetenschappelijke achtergrond. Het integreren van academische theorie en ervaring in de praktijk draagt bij aan de inzetbaarheid na afstuderen van bètastudenten. De impact van stages gaat verder dan inzetbaarheid van studenten als personeel, omdat werkgevers ook aangeven een positief effect te zien op de dynamiek op de werkvloer en ze zien directe effecten van adviesrapporten in hun organisatie.

Ook met hoogleraren binnen de universiteit zijn twintig semigestructureerde interviews gedaan. Om WBL mogelijk te maken lijkt een culturele verandering in het academische landschap nodig, die afhankelijk is van de inzichten en steun van het wetenschappelijk personeel. Hoogleraren zijn over het algemeen positief over de toegevoegde waarde van SBP en bevelen het traject aan, vooral voor studenten met carrièreambities buiten de academische wereld. De algemene visie is dat WBL een positieve bijdrage levert aan het academisch niveau. Al met al lijkt het huidige klimaat aan de Rijksuniversiteit Groningen ten aanzien van WBL overwegend positief.

Samenvattend zijn een aantal belangrijke conclusies te trekken: Er is duidelijke behoefte aan diversificatie in onderwijsprofielen, in dit geval een maatschappelijk georiënteerd masterprogramma. SBP wordt beschouwd als een nuttige aanvulling op het curriculum. Verder wordt SBP als een programma gezien waar zowel het academisch niveau als de vaardigheden die nodig zijn op de buitenuniversitaire werkvloer, aangeleerd worden. WBL wordt ervaren als een als valide manier om een kwalitatief hoogstaand, wetenschappelijk masterniveau te verkrijgen en sluit aan bij de behoeften van de industrie en beleidswereld, bij werkgevers met en zonder academische achtergrond. De onderwijsverandering nodig voor een goed verankerde integratie van WBL in het

reguliere curriculum lijkt ondersteund te worden door alle belangrijke bevraagde actoren. Daarmee kan de SBP-track een voorbeeld zijn voor andere WBL-programma's wereldwijd. Om beter zicht te krijgen op welke elementen uit het SBP programma's vooral belangrijk zijn en op de vertaalbaarheid naar en toepasbaarheid in andere, ook research gerichte universitaire curricula wordt aanbevolen vergelijkend onderzoek te doen. Het belang van condities binnen en de buiten de academische wereld dient daarvan onderdeel uit te maken.

Summary

This dissertation examines the impact of an alternative science master's program that prepares students for a career outside academia. This program is called Science, Business and Policy (SBP) and has been offered at the Faculty of Science & Engineering of the University of Groningen for more than two decades.

SBP is a direct result of the Bologna Covenant on education in Europe and has a distinctive position in the European science curricula. This is relevant because a large number of master's students do not continue in research after graduation. Training to use science to generate answers for societal issues therefore seems a logical step. SBP can serve as an example for education developers and as a case study for various elements that characterize SBP education. SBP is so special because, unlike the classic research-oriented master variant (ROM), it specifically trains students to become science advisors, which translates into a career in business or (non)government agencies; a preparation for a societal career.

The educational design is based on work-based learning (WBL), a form of education that is based on actual application in practice, on the work floor. This is a concept often applied in secondary vocational education and bachelors, but rare on master's level. As a WBL case, SBP was selected as best practice in Europe. Other important features are that SBP is multidisciplinary, with students from various science disciplines working together on new disciplines such as business or public administration and that SBP focuses on learning an entrepreneurial mindset. The learning outcomes are aimed at integrating science and society to generate solutions for a societal client using scientific knowledge. SBP is therefore a societal science profile. There is a lot of attention for entrepreneurial and soft skills.

To properly examine the impact of SBP, we conducted specific research in the three main actor groups involved; students and alumni, the workplace and academic staff.

For the impact on students, a content analysis of the internship reports was done, which showed a wide variety of practical problems for which SBP students generate solutions. This diversity existed in both business and policy organizations, and was diverse in sector, discipline, size and region. The students' grades showed a positive correlation between the initial theoretical preparation (tested with a traditional exam) and the report made during the internship (WBL-based education).

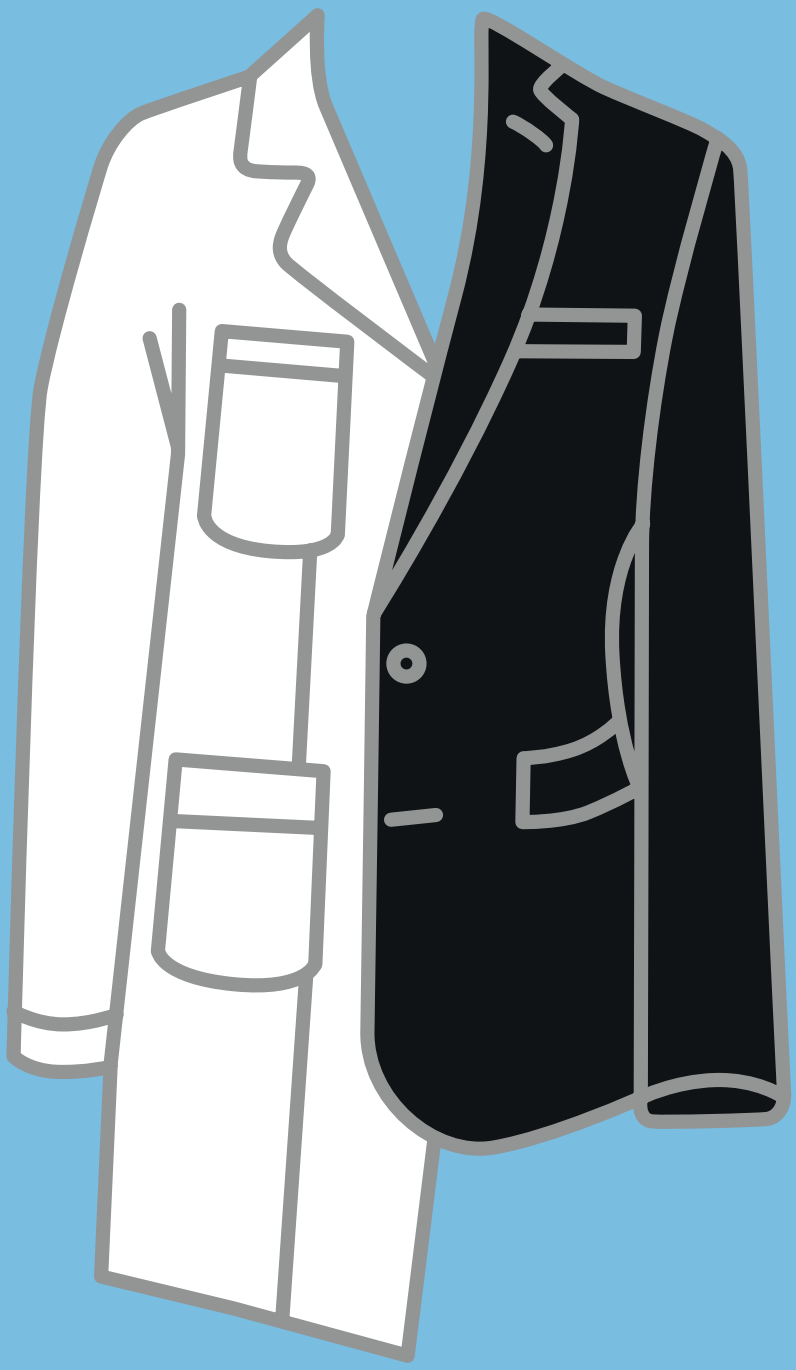
In addition, a large-scale survey was conducted among both SBP alumni and ROM alumni. They self-assessed their learning results, with their own academic level being experienced as positive in both groups. In terms of skills, research-related skills were

seen as sufficient by both groups, although significantly higher in the ROM group. The SBP group perceived their soft skills to be significantly higher. Both groups had a clear content motivation for choosing their program, SBP alumni preferred the social focus of SBP and a career outside academia, for which they also felt significantly better prepared. The alumni indicated in the survey that their careers actually differed. Both profiles resulted in good but different career opportunities, suitable for the discipline and sector of the alumni. Although ROM alumni mainly felt prepared for a scientific career, only a quarter actually continued in science career and many worked in education. In contrast, most SBP alumni pursued a career in business or policy. When the alumni assessed their progression in skills, research-related skills decreased during their careers in both groups, while soft skills increased. Alumni were generally satisfied with both their first job and their current job, with SBP alumni scoring significantly higher on satisfaction with income, status, appreciation and job prospects.

To investigate the impact on the work floor, twenty semi-structured interviews were conducted with internship providers. These were companies, policy organizations and NGOs. Employers see students who have completed an internship as attractive future employees. The quality of the science advice given by students during the internship is considered high. From the perspective of the employers, work placements are a strong part of the optimal training of future employees. Integrating academic theory and experience into practice contributes to the employability of science students after graduation. The impact of work placements goes beyond employability, because employers also indicate a direct effect on work dynamics and see the direct impact of advisory reports in their organization.

Twenty semi-structured interviews were also conducted with professors within the academy. Making WBL possible seems to require a cultural change in the academic landscape, which depends on the insights and support of academic staff. Professors are generally positive about the added value of SBP and recommend the program, especially for students with career ambitions outside academia. The general vision is that WBL makes a positive contribution to the academic level. All in all, the current climate at the University of Groningen regarding WBL seems largely positive.

Summarized, there is a clear need for diversification in educational profiles, in this case a societal oriented master's program and SBP is seen as a program where the academic level and skills needed in the workplace are learned. WBL is seen as a valid way to obtain a high-quality, scientific master's degree and meets the needs of industry and other non-academic employers. The educational change towards a solid inclusion of WBL in the regular science curriculum seems to be supported by all major actors. SBP could therefore be an example for (the development of) other WBL programs worldwide.



1 Introduction and reading guide

In 2018 , the Science Business and Policy (SBP) master education program in the Faculty of Science and Engineering of the University of Groningen was identified by European peer consultation as a best practice for work-based learning in a European Union project (WEXHE 2017-2019). Indeed, work-based learning played a major role in the SBP curriculum, during both the SBP courses for the students and their half-year work placement outside the university in an external organisation or enterprise. Working at that time as a teacher in SBP (and still doing so), I was pleased by the recognition of the program; it also strengthened a wish to share SBP with the academic community outside my own university. In order to do this, research was needed to objectively test the quality of SBP among all stakeholders of the program. This question then became the basis for this thesis.

The role of universities is in transition. Although research forms, in combination with education, the backbone of academia, nowadays most modern universities have incorporated ambitions to contribute to society, which is also fostered in education policy (European Commission, 2022). Still classically science education focuses mainly on learning how to become a good researcher. Even though most science students will end up in careers outside academia, the connection between employers and university is not common practise in science curricula. One of the consequences is growth in education that is company-offered, filling the gap that the work floor experiences. One could ask whether the universities really want to leave the role of educating to societal partners.

In this thesis I will zoom into a specific form of academic education, that aims at an optimal preparation for societal employment, generating solutions in society based on solid academic knowledge.

The SBP program for master students, offered at the Faculty of Science and Engineering (FSE) was instituted in 2002 based on the European policy for harmonizing and transforming academic education. The Bologna covenant (2005) stated a two cycle system (bachelor/master), with a guideline of 180-240 ECTS for the bachelor and 90-120 ECTS for the Master, 60 of which at the level of a second cycle degree. In reaction to this, the Dutch Ministry of Education that decided on a two year master for the natural sciences and turned this in legislation (WHW) approved by the Dutch Parliament. This is equivalent to the program length of Master programmes in natural sciences in the vast majority of other European countries. The societal profile became part of the master-transition to two years. This had severe consequences for the Science education curricula. The Groningen translation of a societal profile includes the start of SBP.

In science education intentionally the SBP program seems to be a rather special approach (explained in detail in chapter 2 of this dissertation), also in view that little is published

on results of this type of academic education. This current thesis on SBP investigates the interaction of this type of science education with society. The practical relevance of this study may be high, including for other academic institutions.

The main theme of this thesis is: what is the impact of SBP, seen by its major stakeholders from their perspectives as students, academic teachers or societal partners? In this study SBP is thus seen as a triangular relationship of involved actors in the daily ins and outs of education. Three pillars are distinguished, the university or academia, the work floor which is also highly involved in this type of education and last, and maybe most important, the students. The emerging triangle that forms the framework of this thesis is shown in figure 1.

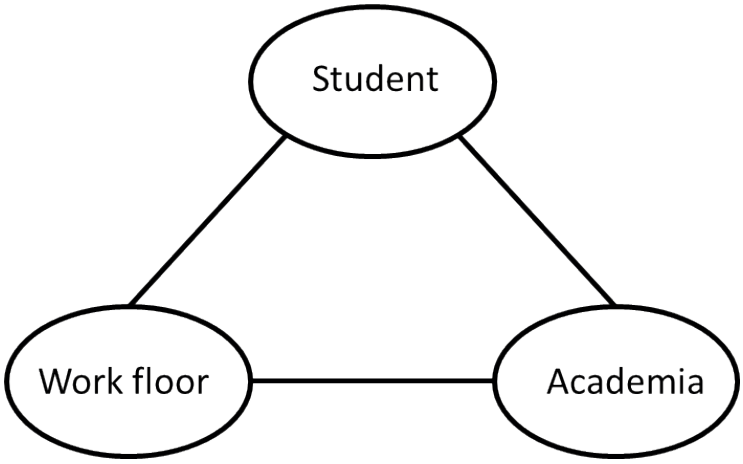


Figure 1 SBP's main actors, after Cardoso et al. (2014)

For all these actors I investigated the impact of SBP. It is important to start with what I mean by the term impact because the nature of the social impact can be defined in different ways depending on the actor and situation. Here, for the work floor finding suitable employees will be seen as impact. In addition, more indirect, in case of a company, impact may be influence on business operations, market opportunities, social acceptance or financial perspectives. In case of a policy related work floor, this indirect impact entails decision-making, policy development, agenda setting and political implications. For a student, impact will be seen as satisfaction and appreciation of the study program, the skills and attitudes they learn, but also as job opportunities and development prospects. For universities impact means the effectiveness of a study

program and added value according to the staff, as well as the implementation of the program. Altogether impact is a broad term describing the effects of the SBP program. We measured impact separately for the different actors. This results in the following research questions: what is the perceived impact of SBP on students, during and after their study, what is the perceived impact of the SBP programme on the work floor of the companies, NGOs or governmental institutions, and what is the perceived impact of SBP within the University of Groningen?

To find the impacts on these three actors, in this study we therefore compare the career achievements, satisfaction and perspectives of two cohorts of science master students from the FSE in Groningen: those that followed a research-oriented master (ROM) and those that followed the SBP curriculum. Also views of academic staff and of societal partners on the SBP program were analysed. All of these actors have a different vision on what good education is, they might also have different wishes, values and perceptions.

In the following chapters of this thesis, not only impact on different actors will be examined, but also specific key elements of SBP. This education encompasses a social profile linked to scientific knowledge, but it is also based on actual application and gaining experience in practice. This makes it an example of work-based learning (WBL). Compared to other educational methods, the emphasis in WBL is not on theoretical academic perspectives but on bridging academic knowledge with societal demands by taking the real life (work floor) situation as a basis for learning and growth. WBL is slowly gaining ground in higher education. Recently it was shown that the Netherlands is leading in the upcoming field of WBL (Perusso & Wagenaar 2021. In the following chapters the long work placement will be addressed that is offered within the curriculum. Furthermore, SBP can be seen as an example of entrepreneurial education, since it includes a wide set of learning goals that match entrepreneurial skills (like for example business management, strategic thinking, developing critical attitude, communication and networking skills).

Work-based learning as an academic educational form

WBL is a term that occurs often in this thesis. For that reason, I want to make a distinction between different types of WBL. For instance WBL is often used, especially in England, to indicate people returning to study who have been active in their working life for a long period of time (Lester & Costley, 2010). In the form of lifelong learning, employees follow courses at the university, often one day a week, and integrate this experience directly into their jobs. This practice described by Lester & Costley is different from ours, because

we focus on the regular curricular student and education within a regularly offered curriculum. However, WBL is also used in a more general way to indicate education that is entirely based on work experience (Lester & Costley, 2010), and this approach fits much better with the program we discuss here. In chapter 2 our exact definition of WBL is further described.

WBL is a higher form of learning (Lester & Costley, 2010), or deep learning. Within this category I would like to describe some common alternative forms and their differences with WBL. The first one is problem-based learning (PBL). PBL forms an enrichment of classical classroom learning because it uses a predefined problem (often by staff) that students work on (Barrows, 1996). Students receive a problem, investigate it and search for a solution. Problem solving skill development is crucial. WBL is essentially different because it is not only about understanding a predefined problem; it is also about functioning on site in a complex environment. SBP is explicitly not a case study, role play or simulation.

One could say that challenged-based learning (CBL) is a step more intense compared to problem-based learning. It is seen as an, often multidisciplinary, learning method in which students apply their knowledge to scenarios from the real world, which promotes higher levels of cognition (Gallagher & Savage, 2020). Often projects from the workplace are also present, but students usually do not join the company as a member of the team for a longer period. The core is going through the steps Engage, Investigate and Act. Students do work with problems from the real world, but not always in the actual world. I see WBL in turn as the more intense variant of challenged-based learning.

Another related term is workplace learning, which is different from WBL because the offering party in workplace learning is usually a company (Atkinson, 2016) whereas in WBL it is an educational institution. Furthermore, the term Work Integrated Learning (WIL) is often used especially in Canada, New Zealand and Australia (Atkinson, 2016). This is an approach that aims to relate student work experience with classroom learning (Jackson 2016). In some European countries this has the connotation of a walk along internship, and is used more for practical education, as often given at vocational education institutions and universities of applied sciences as well as apprenticeships in Germany.

There is a lot of literature about WBL. This is not so strange since WBL is a widely used form in secondary vocational education and higher professional or applied education. Research universities have classically a more theoretical approach with focus on knowledge and it's development. Little is published on application of WBL within classical universities. For those studies that are present, the focus is mostly on applied sciences, undergraduate or Bachelor level (for example Jackson, 2016).

The WBL articles that do discuss WBL at the academic level often describe theoretical concepts, not so much testing their effectiveness in practice. Most of these key concepts are linked to describing a key factor of alignment between industry and university (Jackson, 2016).

The description of the implications and implementation of theoretical concepts seems rare or even non-existent in literature. The field thereby is deficient on research with practical cases based on evaluation. Kay, et al.(2019) for example, describe in detail a WIL program in which potential program development is discussed, without an evaluation of an actual program. Palmer, et al (2018) do make suggestions for who and what might be important in such an evaluation.

Ferrández-Berrueco, et al. (2016) do discuss different practical cases (again mainly on bachelor level, but also some on master level); however, the basis of this is on interviews with a single person, and not on a cohort base. This is also seen in the scarce review studies that are there; Murtazin et al. (2020) do an extensive review of WBL, including the organisation and implementation, however, they do not include an analysis of data, let alone a quantitative one used in reviewed studies to come to their conclusions.

This thesis is explicitly not about concept development nor theoretical substantiation within WBL. It is about our science and society education: SBP. It has a different scientific relevance; the practical application of WBL on an academic level and its perception and reception by the various actors. More specifically a case of WBL: within the natural sciences, in the Netherlands, and investigated with different methods on a cohort base. Thereby this thesis aims to contribute to closing the existing literature gap.

Reading Guide

Education in science and society presumes to deliver a contribution to society. We restrict the use of the word society in the framework of SBP to societal institutions. We use it in the context of added value for the community in industry, policy organisation or NGO's, in places where the community benefits directly from knowledge. This knowledge can be translated to, for example, advice on solutions for actual problems on the work floor. This dissertation investigates whether that has been the case and its actual impact. As a reading guide, the content of the different chapters is summarized here:

The second chapter describes the general set up of SBP and the differences between the ROM and SBP programs. It shows the characteristics of both and how they are distinctive in terms of curriculum, approach and educational set up. It also describes the

emergence and development of SBP, like the number and disciplines of students and the multidisciplinary nature of their projects. The educational design and curriculum of the track will be discussed, including its underlying theoretical framework. The courses, multidisciplinary projects and work placements that have been developed are discussed, analysed in the framework of WBL. For this a content analysis was executed of the final products students produced at SBP, the work placement reports, over 15 years. The indicators that increase the match between WBL and academic science curriculum are also investigated. Specifically the element of integration of science and society was highlighted, and the tools developed to achieve this are explained.

In the third chapter the perception of the students, on work-based education will be discussed. A web-based survey is used to compare the experience of SBP alumni with that of ROM alumni. It focusses on the reason to choose SBP and the motivation and beliefs of students, but also how important they think it is that this education is given. Alumni rated the academic level, learning outcomes, learned skills and job preparation of their program. The satisfaction and appreciation of the study program is discussed.

The same web-based survey is used in the fourth chapter, that is again about student perception. In this chapter the career development of SBP alumni and ROM alumni is compared. The impact on students after graduation is thereby monitored by focusing on job opportunities and development prospects. Special attention is on nature and focus of career preparation, societal oriented vs academic career. The differences of the programs are reflected by the start and development of the career. Elements investigated are for example career opportunities, speed of getting a job and discipline of job. Job satisfaction was also explored in terms of income, status, appreciation and perspective. Again there was a reflection on skills and the development of those at the start and during alumni's career.

The impact of SBP on the work floor is the topic of chapter five. Here specific emphasis is on the entrepreneurial character and the work placement element of the SBP program. Twenty semi-structured interviews with providers or work placements were done to examine the perspective of the employer. Investigated is the current need for employees and more specifically what kind of employees in terms of academic level, amount of practical experience and skills. Besides attractiveness the direct societal impact of work placements was examined, in particular the effect on business operations, market opportunities, social acceptance or financial perspectives in companies and on aspects like decision-making, policy development, agenda setting and political implications in (non-)governmental organisations. Furthermore the work dynamics and impact of advice reports in the employers' organisation were examined.

Chapter six discusses the impact on the remaining actor, on university staff. Here the focus is on the implementation of WBL, and the requirements needed for this regarding academic staff. Twenty interviews with Dutch science professors connected to the FSE, were done to examine their vision on SBP. They were asked about the effectiveness of a study program and added value for the curriculum. Their perception on WBL in general, academic level, learning goals, skill development but also on the role of universities in professional development was investigated to examine the current attitude towards WBL at the University of Groningen.

The seventh chapter is written to specifically connect with a broader scientific audience and summarizes findings, with a main focus on science curricula. It is about the experiences of two decades of SBP and its impact seen from the perspectives of these different actors. In this chapter also the lessons learned are described and some implications on educational design, also aimed at the international scientific community.

The final chapter is a critical synthesis. Main conclusions will be drawn here. Comparing again the ROM and SBP programs, SBP can be seen as a case study which in itself can be translated to other universities, but also as a program containing elements that can be integrated in ROM curricula to improve the career perspectives of all science master students. This chapter also discusses the limitations of the research described in the preceding chapters, followed by conditions needed for implementation of SBP outside FSE. This last chapter concludes with suggestions for further research.

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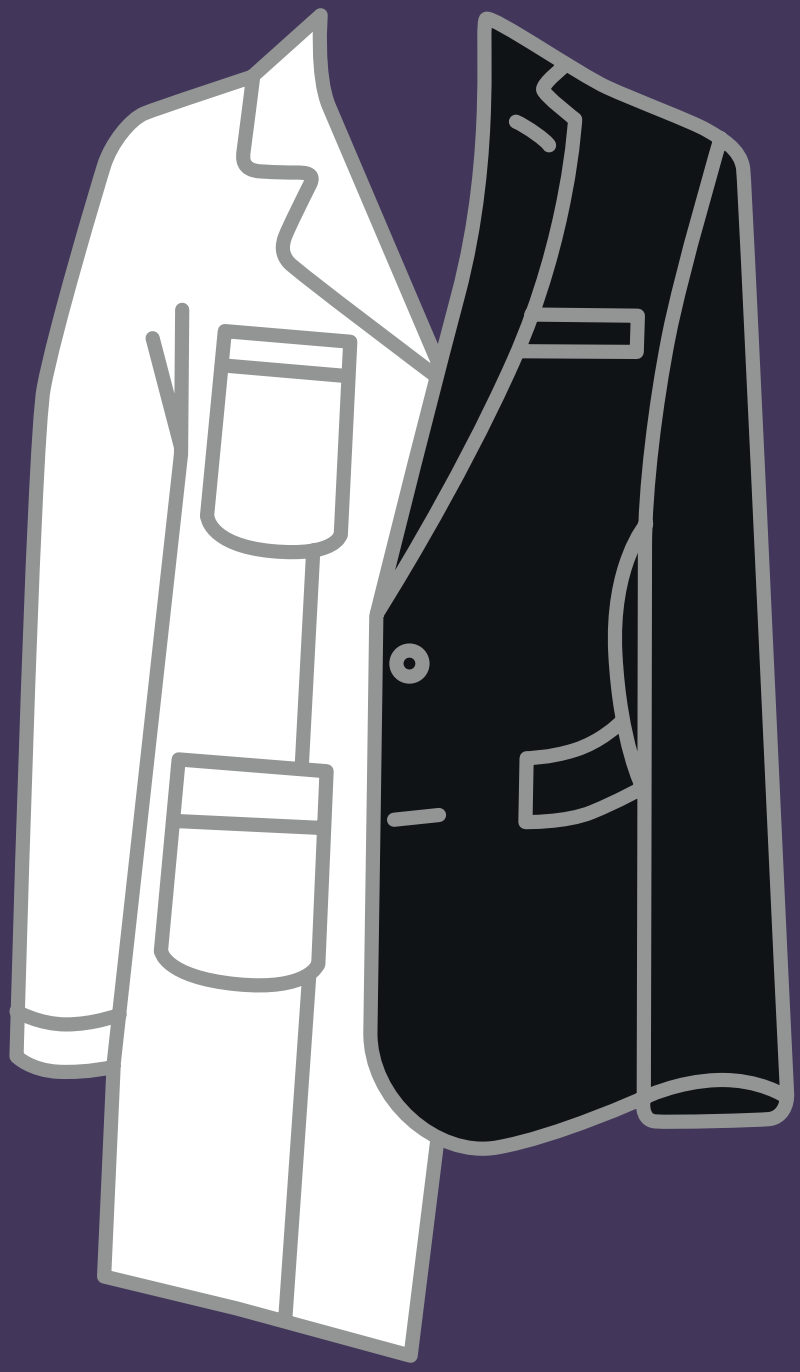
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Science, Business and Policy: A long-term reflection on multidisciplinary work-based learning in a master's track for societal integration of Science

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Abstract

A strong theoretical approach with a specific focus on disciplinary research characterizes the common science master's education in the Netherlands. However, a work-based learning (WBL) approach may as well be expedient and suitable for science education at master's level. In this paper, a case study is presented of a WBL-program designed for an academic setting: the one year Science, Business and Policy (SBP) master's track, offered at the Faculty of Science and Engineering of the University of Groningen. The paper describes the design and curriculum of the track, including its underlying theoretical framework, courses, multidisciplinary projects and work placements. Based on the SBP-track's design we identified six possible indicators of a successful elaboration of an academic WBL-program: the SBP-track 1) is designed in response to the Bologna process; 2) is offered fully within the curriculum of a master's program of a research university; 3) requires a sufficient academic level and disciplinary knowledge at entrée; 4) follows an educational project approach; 5) focuses on the integration and implementation of knowledge, and; 6) applies learning objectives that are specifically formulated to match the WBL educational method.

A directed content analysis of SBP work placements revealed an increase in the number of SBP-students between 2003 and 2019, with an overrepresentation of life science students, as well as a large variety of real-case problems addressed for both business and policy organisations diverse in sector, size and region. Students' grades showed a positive correlation between the initial theoretical preparation and the report made during the work placement. In conclusion, the societal interpretation of the Bologna process has been implemented successfully with SBP, by combining academic learning with gaining professional experience using a WBL-approach.

Keywords: Work-based learning; science, business and policy; curriculum design; science education; interdisciplinary integration; didactic model; work placement.

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Introduction

The necessity to bridge the gap between science and society has become a growing insight of our time. (Agre and Lester, 2010, Wagenaar 2019) In this perspective we have seen increasing efforts to integrate academic learning and practice-based learning in the past decades. (Lester and Costely 2010, Donà dale Rose and Serbati. For many universities science-based learning placements at an academic level in business and policy institutions are still a relatively new development. There is yet much to be learned about the determinants of quality and success for academic programs that offer and integrate such placements in their curriculum. In their literature review, Lester, Bravenboer and Webb (2016)conclude: "There are, however, few practically oriented accounts of how 'basic science' or discipline-based knowledge can be integrated with transdisciplinary workplace learning, particularly at the level of initial development."

In addition, the authors stress the need to evaluate work-integrated programs and its curricular models. Here, we present a case study of the development of an academic work-based learning master's track that is developed for science students at the University of Groningen, the Netherlands. This work-based learning program (from now on WBL), the Science, Business and Policy (from now on SBP) track, is developed to prepare science students for a science career in business and/or policy.

First, as there is a need to acquire more knowledge about how successful scientific WBL-programs are developed (Lester et al., 2016), the theoretical framework that was used to design the SBP-track, including its curriculum, is deliberated on. Second, there is a need for more comparable qualitative information on WBL-programs to collect more information on the determinants of quality and success for academic WBL-programs (Lester et al., 2016). Therefore, using a directed content analysis, SBP alumni study records between the academic years 2003/2004-2019/2020 are investigated on several variables.

We begin the paper with defining the concept of WBL and placing it in the Dutch university context. After a detailed exposé of the build-up of the WBL master's track SBP we discuss the theoretical considerations and framework of the program, as well as the derived learning goals. The methodology section comprises of a description of the units of analysis and explains why we chose to carry out a directive content analysis in the context of this case study. The results section includes information on several components of alumni study records, like student background and grades. Finally, we discuss six important success factors of the SBP-track based on its design and curriculum, summarize and give (potential) explanations regarding the results of the study record analysis, and discuss future questions on research into academic WBL-programs.

This paper will lay the foundations for a future, more extended evaluation of the societal effectiveness of WBL-approaches that are applied at an academic level. This case study is part of a so-called design-based research program (Anderson and Shattuck, 2012), that also includes studies on academic professors' perceptions of the degree to which WBL-programs as SBP are perceived as academic; the implications of the SBP-track on alumni's quality perception and career development, and a study on the perceived usefulness of the SBP-track for its societal partners (i.e., work placement organisations).

The concept of work-based learning in the Dutch university context

WBL is a term used for multiple types of education in different settings with different goals. Originally, the development of WBL was seen as a concept to lower costs of higher education. In its further development, mainly in the UK and Australia, WBL was also seen in the broader educational perspective of connecting science and society (Boud and Solomon, 2001). This interpretation comprised a twofold strategy: for students to obtain a better preparation for a science-based career outside academia and for societal institutions to obtain access to actual developments in science (Boud et al. 2001). In this article we focus on education within a curriculum of a fulltime master's program on level 7 in the context of the European Qualification Framework. Post-graduate and adult education are excluded. To define WBL we adopt a definition that is commonly used in current projects of the European Union (WEXHE 2017):
"WBL is an educational strategy or approach that provides students with real-life work experiences to apply academic knowledge and understanding as well as subject related and generic skills and competences to develop employability skills and competences."

Internationally, there is a division within higher education on WBL described by Lester et al. (2016):
"The academic literature indicates continuing debate between 'intellectualist' and 'pragmatist' positions, and discipline-based and transdisciplinary orientations."

This division can also be recognized in the organisation of the Dutch educational system. In the Netherlands, traditionally there is a strong division between research universities, providing education on level 7 (master's) and universities of applied sciences, called institutes for higher education, providing education on level 5 (bachelor's). This division originated due to their own unique histories and development (De Weert, 2006).

Research universities are commonly seen as knowledge institutes where students are prepared for a career in science. Universities of applied sciences are institutes providing vocational higher education, aimed at a professional career outside academia (Griffioen and De Jong, 2010). This division in focus between Dutch universities led to research

universities delivering graduates who are specialized in theoretical and research skills (intellectualist), whereas universities of applied sciences deliver graduates who are specialized in practical skills (pragmatist). In this way, the Dutch educational system's practices lead to the so-called 'theory and practice gap' (Schön, 1983 and 1987): graduated students from research universities cannot properly link the disciplinary knowledge gained by following theoretical courses with experiences they gain by actual practice in the professional work field, while graduates of vocational education often lack disciplinary knowledge compared to their practical skills.

Over the past decades, the need in Dutch society for professionals who are specialized in theory and practice, for instance combining reflection on their own actions with applicable knowledge of the professional field, has grown considerably (Hulst and Leijnse, 2007, Geerdink et al., 2008) Brew (2010) stresses that – internationally – institutes offering higher education should prepare students to deal with a fast-changing professional environment. As Barnett already stated in 1998, professionals should be able to deal with super-complex knowledge (Barnett, 1998).

Additionally, the Bologna Process, a large reform of the European educational system explicitly aimed at unifying European on policy and quality assurance in higher education, states that higher education in Europe should be based on research at all levels, and comparable criteria and methodologies should be established (e.g., facilitating the international exchange of students) (Juszczyk, 2013, Keeling, 2006, Quality assurance EHEA, 2020, Bologna Process, 2020). In response to this, the universities of applied sciences in the Netherlands started to offer more discipline-based and theory-forming (i.e., research-based) programs. Dutch research universities started to narrow the theory and practice gap from the other end, by creating more professional preparation.

The development of the Science, Business and Policy track as a work-based learning program

The Bologna process has shaped and structured master's programs of Dutch research universities in several ways. For instance, the policy's aim of synchronizing curricula led Dutch research universities to decide that for Mathematics and Natural Sciences, instead of one-year master's programs, two-year master's programs should be designed, divided into three different orientations: a (traditional) research-, an educational-, and a societal-oriented master's track. The addition of a second master's year allowed for the development of new master's programs, without explicit competition with existing programs. The SBP-track is developed at the University of Groningen, the Netherlands, as a societal-oriented master's track with a WBL-approach. Hence, the Bologna process facilitated the option of offering WBL-oriented programs like the SBP-track fully within the curriculum of research universities.

At the University of Groningen, students can start a master's program when they have obtained a bachelor's degree in science at a research university. After the bachelor, students choose an academic discipline for their two-year master's program (e.g., biomedical sciences). In the first master's year, all students gain disciplinary competences and knowledge by following courses at master's level. In addition, in the first master's year students carry out a research project resulting in a master's thesis (minimum of 30 ECTS). In the second master's year, students either choose a continuation of a traditional (research) track, the educational master's or alternatively the SBP-track. In this paper, we will not further elaborate on the educational track and compare the SBP-track exclusively with the research-track.

When students select the research-track, they take disciplinary courses together with other students from a similar disciplinary background. They continue to work on a research project and write a second year master's thesis. In addition, they write a short thesis, prepare and present a colloquium and follow disciplinary master's courses. Students following the research-track are specifically prepared for an academic research career (i.e., PhD-trajectory).

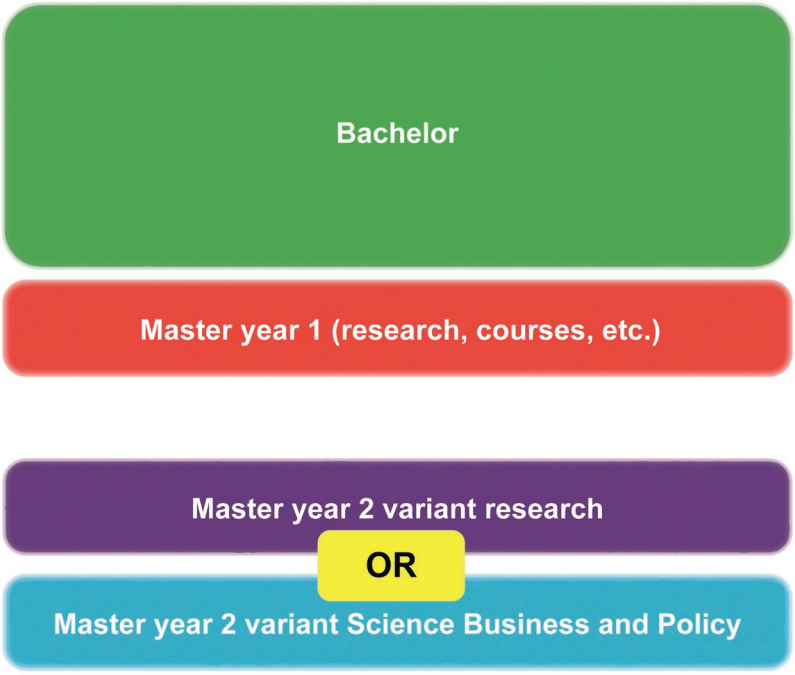


Figure 1) Curriculum design of science study programs of the Faculty of Science and Engineering at the University of Groningen.

When students choose the SBP-track, they are grouped together with students from different disciplinary backgrounds within science. Students take master's courses on business and policy and gain professional experience during a work placement at a business, policy, or non-governmental organisation. Students learn to integrate their science background with some other new disciplines: business and public administration. The SBP-staff consists of a team of coordinating SBP-lecturers, supplemented with tutors, guest lecturers, senior academic science specialists and experts from business and policy institutions. This variety of stakeholders were involved from the initial development to the continuing improvement of the SBP-track. Hence, an interdisciplinary team in the SBP-track prepares students for a career at an academic level in a business, policy or non-governmental organisation. Despite its societal focus, after the SBP-track it is also possible to pursue an academic research career (i.e., this is the case for all level 7 academic tracks).

The SBP-track consists of two courses of both 10 ECTS and a work-placement trajectory of 40 ECTS. The first 10 ECTS course is 'Introduction to Science and Business', where students receive a theoretical crash course on business administration and innovation, including a theoretical exam. This is followed by a four-week real case group project – for a company - in which students integrate and apply their knowledge of corporate management with their scientific discipline. Here, students learn integrative competences and combine knowledge from their bachelor's and first master's year with general competences like personal development, project management, communication and soft skills (i.e., a combination of interpersonal and social skills) (Dixon et al., 2010). The second course, 'Introduction to Science and Policy', has a similar set-up, focusing on policy skills. Students get a theoretical examination on public administration and finish a real case group project of four weeks for a governmental or non-governmental organisation.

The final and largest part of the SBP-track is an individual work placement of 40 ECTS (approximately six months), in which the work-based learning component is put into practice. The actual connection between science and business or policy is made during this fulltime business or policy work placement at an external organisation.

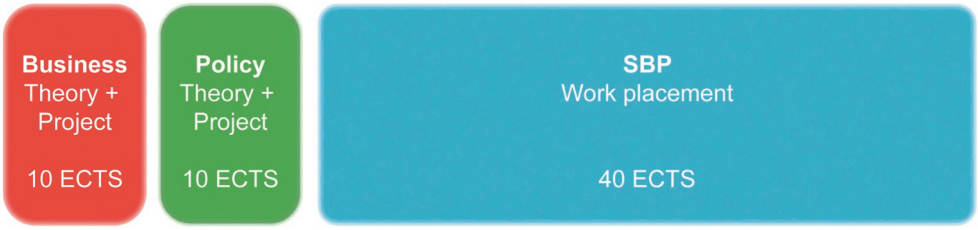


Figure 2) Program design of the Science, Business and Policy track.

The Science, Business and Policy track's work placement.

Before students start their six-month work placement, they follow a series of preparatory workshops on acquisition tools and career management (i.e., learning to construct proper resumes and application letters, practicing networking and applying for work placements). After successfully completing these workshops, it is the student's responsibility to find and apply for a work placement that fits their academic profile and personal preferences. In accordance with the work placement organisation, students formulate a work placement assignment. This assignment has to contain defined science aspects as well as business or policy aspects and has to result in a science advice report for the client that integrates and bridges theoretical (scientific) and practical (societal) aspects. These final reports have a similar status as a master's thesis - the final (research) report for students who follow a research-track. An advice report is considered to be academically sufficient when it: is based on an integration of scientific knowledge and business or public administration competences; contributes to solving real problems; creates real solutions in society, and; gives practical and implementable advice. During this advising process, the ideal attitude of the SBP-student towards the work placement organisation is to be connected but to stay independent and keep a critical attitude.

During the work placement, the students are supervised by three instructors. First, a daily supervisor at the work placement's organisation is responsible for general supervision. Second, there is a science supervisor from the university who is a specialist on the scientific aspect(s) of the assignment. Third, an SBP-supervisor who is a staff member of the SBP-track, guards the integration of the different disciplines. During the work placement, all instructors regularly contact the student and each other (i.e., at least once every 2 months).

In addition, there is one week prior to, one week during, and one week after the work placement when students have plenary education at the university:

1. Preparation week: before the work placement, students make an action plan and schedule for their work placement. In addition, students follow lectures on personal development, networking and organisational culture.
2. Midterm week: about 3 months into the work placement, all students - including students with a work placement abroad - return to the university to share experiences, reflect and if necessary, adjust their action plan.
3: Closing week: after the work placement, all completed work placement advice reports are presented and shared during a three-day symposium visited by all supervisors and other interested parties (e.g., future SBP-students). This week usually couples to a career market where interested parties can meet.

Theoretical framework of the SBP-track

This section will outline the theories and models that were used to create the SBP-track and its curriculum. The Bologna Declaration and Social Constructivism as the basis of the overall design of the program are explained. In addition, choices with regard to curricular implementation are described, including the project approach, the loop model, and the business and policy cycle. Furthermore, the learning goals and competences of the SBP-track, based on Bloom's Taxonomy and the Dublin Descriptors, are presented.

From a theoretical perspective, the nature of the SBP-track of positioning science in a societal context, can be considered a contextual approach of learning. The track introduces business and policy concepts to science students, and provides specific tools for application in a work-based situation. This all fits in a model of competence-based learning of contextualized knowledge, inspired by the Bologna Declaration (Wagenaar, 2019, Bezanilla et al, 2019). Individual development in learning is based on additional elements of the SBP-track such as differentiation in disciplinary background and personal preferences to operate in a specific societal context (commercial, governmental or other defined societal interests). Also, personal motivations and qualities may define roles in project management. Together, this asks for a corresponding educational psychology, combined with principles of social constructivism, from which the most important principle is that development takes place by social interaction (Marin et al., 2010).

In the SBP-track, a central element aimed at facilitating successfully completing the real-case group projects, and work placement success, is integrating the educational project approach as described by Bos and Harting (1998), and Bos, Harting and Hesselink (2104). The project approach focuses on working with project tools, working in project teams, managing the project environment, and personal leadership. This approach is chosen for several reasons. First, the approach provides tools to develop clear time paths and structural elements (e.g., project definition, plan of action and backward planning), as developed by Turner (1999). Second, running a complete project reflects the expected career path more realistically compared with walking along in existing work (Quality in Work-based Learning, also Eurashe report). Third, managing a project creates student involvement, clear attributed achievements, and an active and responsible attitude.

The loop model

During the work placement, students use different tools (depending on the type and topic of their work placement) and combine these with their disciplinary knowledge and skills, in order to write a sufficiently grounded science advice report. The SBP-track is quite unique and specific, and as such, no science, business and policy knowledge integration tools were available at the time SBP started as a master's track. The SBP-track's staff created its own tool-integration model: the loop model (Figure 3), evolved from a first

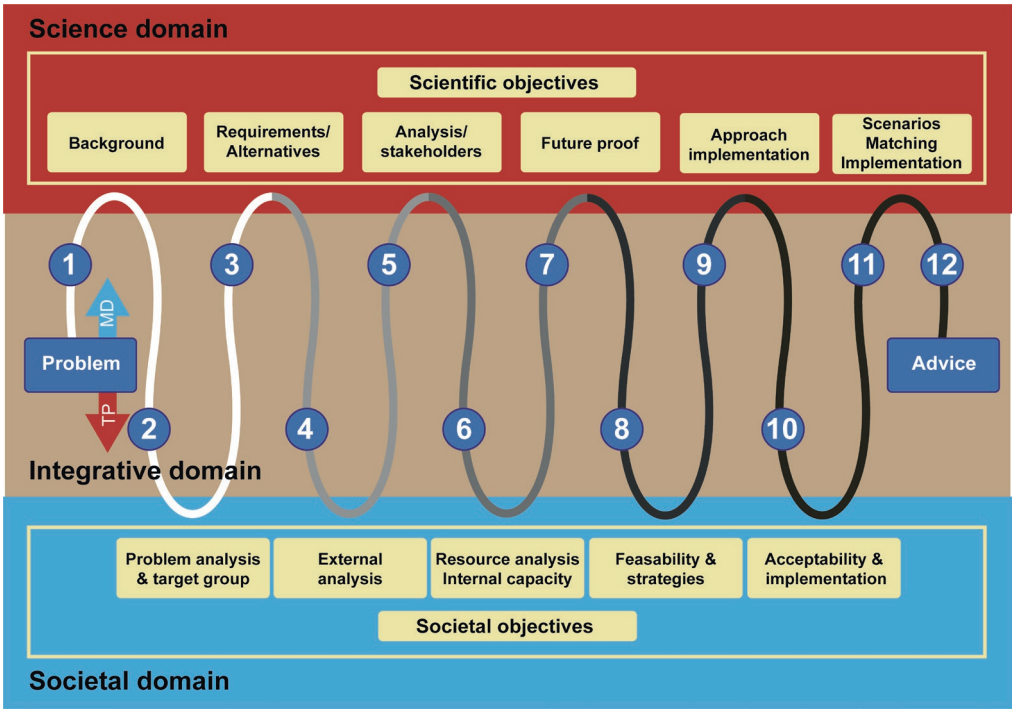


Figure 3) The loop model for integration of the science and technology domain with the societal domain

version developed in 2006 by Gerkema, Van der Windt and Karasek (Gerkema inaugural lecture, 2008 and published in education reader Gerkema et al, 2016) . The loop model is based on initial experiences as well as theoretical approaches from the field of science and business and policy integration (e.g., the Triple helix model) (Loet et al., 1996 and 1998) The loop model describes a time path from the development of an innovation, starting at an initial idea and resulting in a plan to implement this idea. Often work placement tasks take place within this time path (Figure 3). Sometimes, work placements assignments fit better in loops after the implementation of an idea, for example an evaluation study of a product. In practice, the loop model is adjusted easily to the needs of differently phased projects.

We explain the loop model from a business work placement perspective here. When a student uses the model for a business work placement, the student starts with a Problem, and determines whether there is a Market Demand problem or a Technology Push. The nature of the problem decides whether the first loop will go up to the science domain, or down to the societal domain. For instance, in case of a market demand problem, the first matter that needs attention is what the current scientific possibilities are. In case of a technology push, the first step is determining whether (individuals in) society could be

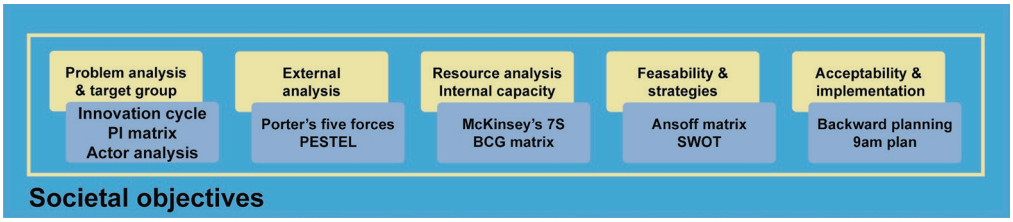


Figure 4) The societal domain of a business loop model, complemented with business tools

helped by, or are interested in this technology. The student then follows the loops and connects the science domain and the societal domain within every step. In the loops, several project phases are met. These phases are visible in the picture as numbers. The project phases they can encounter are thus: 1) Initial brainstorm; 2) Question Specification; 3) Problem Definition (concept); 4) Context & Solution; 5) Threats & Opportunities; 6) Resource Analysis; 7) Preliminary Conclusion; 8) Embedding; 9) Integration; 10) Action Plan, and; 11) Creating Commitment. During the courses' real case projects, student practice with all these phases by using them in lecture assignments.

The loop model can be adapted for business or policy projects by integrating different tools that are offered and explained to students in corresponding course lectures. In Figure 4, the societal domain of a business loop model, complemented with business tools in the societal domain as compiled from Johnson & Scholes (2002) is shown.

The business cycle and policy cycle

Supplementary to placing work placement assignments in the loop model, students have to position their work placement assignment in the business innovation cycle (Figure 5) or policy cycle (Figure 6). In their advice reports, they reflect on the impact of the position their assignment has in the cycle. The science advice can be given at all different stages in a business innovation or policy cycle. Some work placement assignments require advice on multiple stages of the cycle. The cycles have been explained to students during the business and policy courses and they practiced with those cycles during the real case projects. The business innovation cycle is based on the business innovation chain adapted after von Stamm (2008) and Conway & Steward (2009). The cyclical approach is familiar to students as they have worked with the empirical cycle (De Groot, 1969) in research courses and projects during their first master's year. Some of the essential underlying models for the policy cycle are the causal field model, the field process model and the policy tree model (Coolsma and Van Montfort, 2014). In Figure 6 the cyclic process shown is based on Howard (2005), Hoogerwerf and Herweijer (2014) and Dunn (2018).

Business innovation cycle

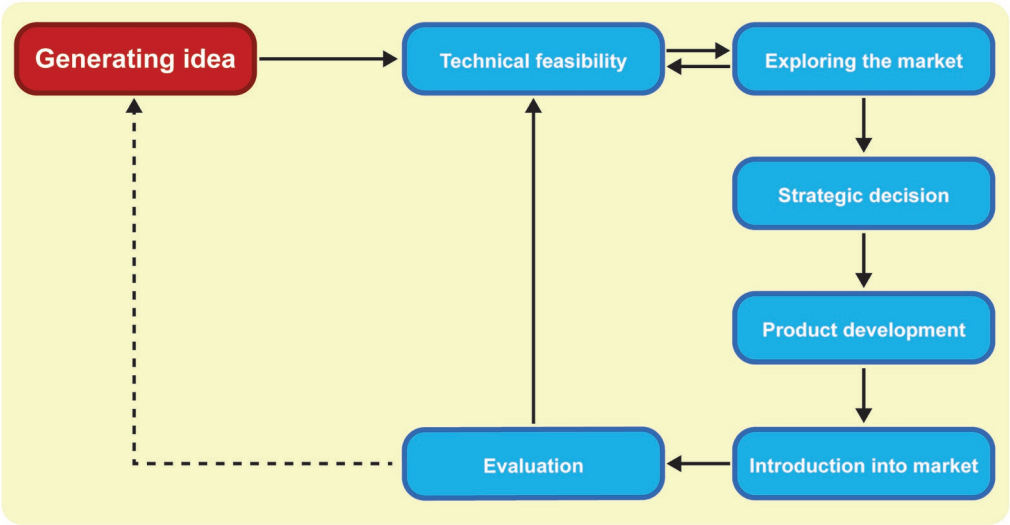


Figure 5) The business innovation cycle as employed in the SBP-track

Policy cycle

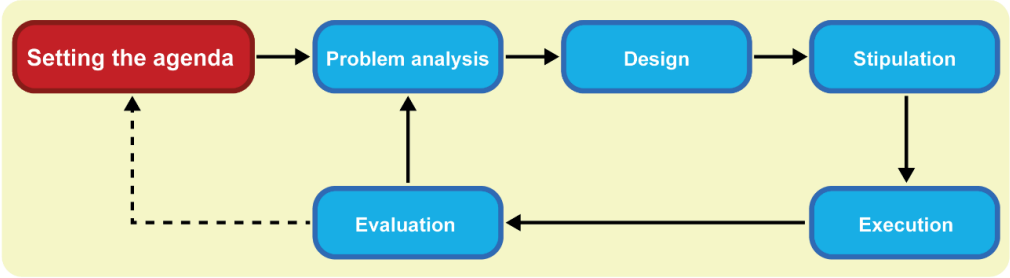


Figure 6) The policy cycle as employed in the SBP-track

Learning goals and competences

The learning goals and competences of the SBP-track (Ocasys course description, 2019) are listed in Table 1. Originally, the Bloom taxonomy of general learning objectives (1956), was specified in an academic context in which learning skills address the capacity of independent learning in the so-called Dublin descriptors (Bologna Working Group, 2005). We translated these descriptors so that they fitted the WBL-approach and included science advising capacities. The prerequisite for science advising is having a certain expertise within a specific science area, in which at least all Bloom objectives

and Dublin descriptors have been met. Students learn the craft of science advising by additionally studying new knowledge areas concerning technology, business and policy administration, and innovation management. When students combine their scientific expertise with those new knowledge areas, it will lead to an integration of these knowledge domains and the distinction of societal values of science.

In our view, especially the last three learning objectives (4-6, Table 1), which lead to independent learning skills in science advising require additional skills and attitudes that are generally not seen as characteristics of science students. We experience these as being critical for strategic and effective advising and communication, for an entrepreneurial attitude, for leadership and team-playing capacities, and for reflection on the different roles a science student can play in the process of science advising. Together, these six learning objectives are formulated to facilitate an optimal preparation for a successful science advising, with all its specific demands.

Hence, these goals and competences are set up to ensure students are fully prepared for a career in business and/or policy. Furthermore, these learning goals form the basis of the grading criteria. The main element in the final grading of WBL is the science advice report that the SBP-student writes. The SBP-instructor grades this report with a rubric (containing criteria to score the learning goals) and gets input from the daily supervisor and the science instructor. The main difference between the learning goals of research-tracks and the SBP-track is that research-tracks spend additional attention to disciplinary specialization while the SBP-track has an interdisciplinary focus and includes more on general competences. The learning goals did not change over the years (2003-2020).

Table 1) Learning goals of the Science Business and Policy track

	Learning Goals
1	**Getting acquainted with business and policy sciences**
	Students are able to write an independent advice with concepts from business and public administration, innovation management and Science and Technology studies.
2	**Personal development**
	Students have the skills to do project work in a group and alone.
	Students are able to show leadership that fits their personality and the needs of the group.
	Students have insights in their own strengths and challenges.
3	**Bridging fields of knowledge**
	Students are able to understand and to handle business and policy perspectives.
	Students are able to create synergy from multiple domains.
4	**Applications in social context**
	Students are able to judge their own discipline critically and in context to business or policy and society.
	Students are able to find a balance between the individual interest and the group interest.
	Students are able to act as a science adviser in an ethical way.
	Students know how to implement innovations in a sustainable way.
5	**Effective communication**
	Students are able to communicate in an effective way to target groups.
	Students are able to evaluate their advice so that it is implementable.
6	**Overall science advising**
	Students are able to consider their role(s) in science advising critically.

Alumni study records analysis

We describe the development of the student population and the background of 444 science alumni who finished the SBP-track during the first 16 years of its existence. In addition, using a directed content analysis, 289 study records of SBP alumni who graduated between the academic years of 2003/2004-2016/2017 were analysed on several other variables, including work placement characteristics and assignments, source and tool usage during the work placement. Students' grades on theoretical courses and science advice reports were explored for the academic years 2015/2016-2019/2020.

For each of the variables examined in this case study, we formulate what exactly we will examine, including potential outcome expectations:

1. Student population and background: we will examine how students are divided over the different science disciplines within the SBP-track. It is expected that biomedical science students form the largest group, since this is also the largest program within the faculty. Furthermore, biology students could be strongly represented because the origin of the SBP-track lies in biology. In principle, we expect the total population of students to grow due to increasing interest. This increased interest is not expected

to be reflected reliably due to capacity limitations of the SBP-track. However, if the program is in line with the demand of society and the interest of the students, we would expect an overall increase in the number of students.

2. Work placement characteristics: we will study the distribution of the work placements' type, size, location and sector. We expect sector to correspond with student's academic background. In addition, we expect all characteristics to also correspond with personal preferences (i.e., due to the design of the program students may arrange their own placement), without a specific expectation of which is the most common.
3. Work placement assignments: we will analyse the distribution of the work placements' type of assignment, and stage of the innovation cycle and policy cycle it relates to. On one hand we expect an emphasis on the scientific aspects because this is in line with the paradigm of the science students (after four years of full focus on science during their studies). On the other hand: the type of assignment and position in the cycles depend on the requirements of the work placement. Hence, placements outside the loop model are also expected since stages from the innovation cycle that focus on execution, implementation and evaluation (see Figure 5) also occur in the workplace. No specific expectations are formulated for which type of assignment occurs most.
4. Source usage: we will examine how many literature references and external contacts students cite in their advice report. Since all SBP-students are at the end (i.e., last year) of their master's program, you expect a proficiency in literature search use and thereby adequate and sufficient references to scientific literature. Although science students are generally not trained in the use of external contacts as a source, SBP-students are during SBP-courses. That is why we also expect that students will be less reluctant to refer to at least some external contacts per placement. Given the large number of stakeholders in policy issues (Kamann, 2003), we expect more references to external contacts in policy placements than in business placements.
5. Business, policy and loop model tools (absolute frequency): at the SBP-track, a variety of tools is offered, and we expect that the use of these tools fits the individual work placement and therefore will be very diverse. We also expect students to use the loop model but not every loop in every stage, as the work placement assignments can focus on one specific loop or a limited number of loops.
6. Work placement, business and policy grades: for the grade analysis, students' grades on business and policy courses, and business and policy work placements are correlated, to measure the relationship between theory and practice for both business and policy courses and their corresponding work placements. We expect business theory grades to correlate positively with business work placement and policy theory grades to correlate positively with policy work placements. Lastly, assuming an ideal situation, we expect the business theory grades to correlate most positively and highly with business placements and the policy theory grades to correlate most positively and highly with the policy placements.

Methodology

For investigating student background, data of all students who followed the SBP-track between the academic years 2003/2004-2019/2020 were employed. For investigating study records, data were extracted from the archive of the SBP-track, that contained study records of all SBP-students finishing a work placement between the academic years 2003/2004 - 2016/2017 (for these years we had complete records to our disposal). Study records included SBP-students' reports and grades, which served as units of analysis. For the grading analysis, only grade data between the academic years 2015/2016-2019/2020 were used, as grading practices were revised after 2014/2015. Before 2015/2016, students received a combined grade for business and policy, making it unable to measure the relationship between a business or policy course grade with a business or policy work placement.

Analysis of advice reports

A directed content analysis (DCA) was carried out to analyse the science advice reports of the SBP-students. This implies that a predominant deductive approach was applied in analysing the data while allowing for an inductive approach. Before the coding process, student names were replaced with student numbers to guarantee confidentiality. The variables being examined, as well as their categories, were predefined to the furthest extent possible before analysis. However, whenever data were associated with a certain variable but did not fit into a predefined coding category, the data were stored and in a later stadium coded inductively. An important advantage of DCA over a purely inductive thematic analysis is that DCA contributes more explicitly to theory formation. DCA allows researchers to concentrate on parallels or deviations with existing theory and are less likely to 'drown' in the details of the data: DCA brings focus (Van Staa and De Vries, 2016, Hsieh and Shannon, 2005).

All topics coding categories were categorical or binary in nature and were – before, during and after analysis - checked for mutually exclusiveness. The reports were examined by coders on the presence of coding categories, which were recognized by the inclusion of specific words or phrases (e.g., 'Biology' for 'Student background), and theoretically formulated themes (e.g., 'Exploring the market' for 'Position in stages of business cycle') in the reports. For the first type of coding, coders exclusively relied on the presence of specific words/phrases. For the latter type of coding, interpretation was needed to translate the data into a coding category and in some cases to inductively add new categories.

While the authors of the paper acknowledge that predetermined coding categories can bias analysis in favour of certain theories (Hsieh and Shannon, 2005) they are confident that in the context of this study, the initial coding will not affect the recognition of important content due to the nature of the data and the theoretical framework employed. That is, the theoretically formulated themes and coding categories match the theoretical framework students had to employ in their science advice reports.

Procedure

All coding topics and their categories were collected in a codebook, which served as a coding guide for the coders. Table 2 shows an example of the manner in which topics and categories were explicated in the codebook for two variables: 'Work placement size' and 'Position in stages of the policy cycle'. The codebook included for each variable its coding categories, how-to-code coding explanations, as well as references to articles and/or documents from which the categories/explanations were extracted. For the full codebook, the reader is referred to Appendix A.

Three student-assistants, which were SBP-students, coded the data together under the supervision of the authors of this paper. It was a deliberate choice to appoint SBP-students as coders. Because the coders had theoretical knowledge about the theories involved in this study, less intensive coder training was necessary to become an adequate coder. In addition, having SBP-students as coders may have improved the coding quality as it is reasonable to assume that having knowledge about the program makes coding more straightforward, evident and reliable in the context of this study. Because coding topics and corresponding categories were primarily predetermined, potential coder bias resulting from being familiar with SBP was minimalized. Still, it is recognized that the coders were students with a science background who were not familiar with quantitative nor qualitative coding practices, which are often carried out by researchers from social sciences. Therefore, before, during and after coding a research-assistant with experience in coding was available for additional training and consultation.

Whenever the coders disagreed about which coding categories the data should be assigned to, or were in doubt whether certain coding categories fitted the data correctly, one of the supervisors was consulted. Based on deliberation between this supervisor and two coders, coding categories were assigned to data or data were coded inductively. The coders coded the data during ongoing collaboration and calibration.

Table 2) Codebook example for work placement size, and position in policy cycle

Variable	Code	Explanation
Work placement size	1,2,3,4.	This variable needs to be scored for all science advice reports. The size of the organisation is based on the number of *all* employees on payroll at the organisation. 1 = micro-sized = 1-9 2 = small-sized = 10-49 3 = medium-sized = 50-249 4= large-sized > 250 The size of the organisation should be available in the science advice report. If the organisation size is not mentioned in the science advice report, contact one of the supervisors. They will retrieve the information on the number of employees and pass it on to you. The categories are based on the European Commission's Recommendation on classifying organisation sizes.
Position in stages of the policy cycle	1,2,3,4,5,6. & 0, 1	This variable needs to be scored *only* for science advice reports that were written in the context of a policy work placement. There are six categories in the policy cycle. These categories are referred to as *position in stages* in the policy cycle. Within a policy work placement science advice report, multiple stages can be mentioned and treated as such by the student. 1= Setting the agenda 2= Problem analysis 3= Design 4= Stipulation 5= Execution 6= Evaluation Decide for each chain whether or not it is: a) mentioned explicitly, *and;* b) explained correctly by the student. 0 = no, 1 = yes. Only score 1 when both condition a) and b) are met. The policy cycle and its chains are based on Howard (2005), Hoogerwerf & Herweijer (2014) , and Dunn (2018) .

Results

Student population and background

In this paragraph, the student populations within the faculty and SBP-students' backgrounds are outlined to document the interest in the track over the subsequent academic years, as well as the choice for the track, differentiated for the student's prior discipline. Because of the varying science backgrounds of the SBP-students we related the choice for the SBP-track to the total cohort numbers of students in the various disciplines.

In total, 444 students completed the SBP-track, starting their work placements between 2003/2004 and 2019/2020 (Figure 7). Subscription numbers have increased over time. In 2017/2018 and 2018/2019 the course program was fully enrolled (a capacity of 65 places). Some students signed in for only a single course in 2017/2018 and 2018/2019, resulting in a lower number (i.e., <65) of students completing the SBP-track. In the academic year

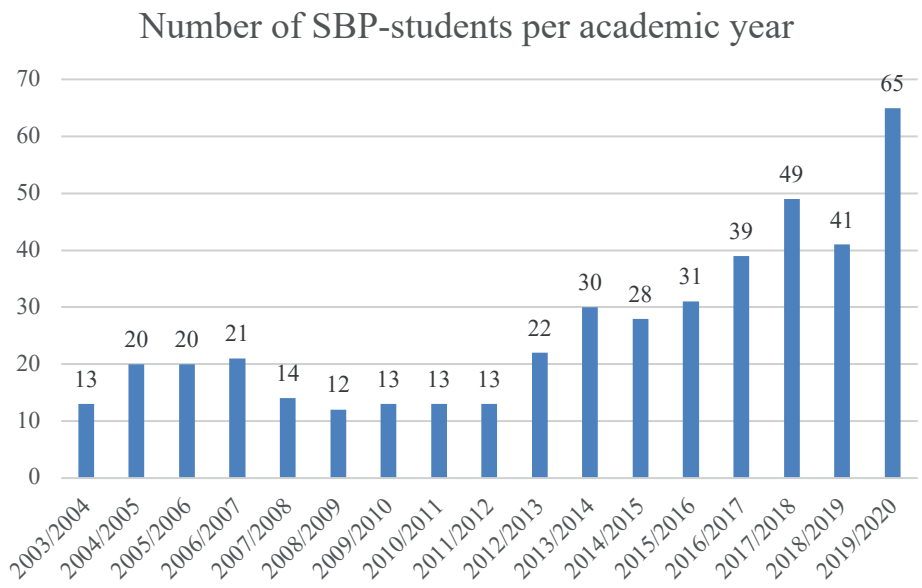


Figure 7) Number of SBP-students per academic year, 2003/2004-2019/2020, N_{total}=444.

2019/2020, all places in the SBP-track were completely filled. Currently, there is a waiting list to enrol in the SBP-track.

The scientific backgrounds of the students vary. All SBP-students are science students enrolled at the faculty of Science and Engineering. Engineering students are excluded from the SBP-track. The studies that are (or have been) compatible with the SBP-track are Chemistry, Physics, Computing Science, Mathematics, Molecular Biology & Biotechnology, Medical Pharmaceutical Sciences, Marine Biology/Ecology & Evolution, Biology, Biomedical Sciences, Energy & Environmental sciences (for the latter, enrolment is possible since 2019) and Behavioural & Cognitive Neurosciences (but not within a specific research master). Results show that the largest fraction of SBP-students has a science background in Biomedical Sciences and Biology (Figure 8).

The number of students in the studies that form the background of SBP-students differ in size. Science students choosing SBP make up between 2-11% of the entire science student population at the University of Groningen between 2003/2004-2019/2020. The remainder of science students choose a research-, or educational-oriented master's track (89-98%).

Figure 9 shows for each disciplinary background the percentage of students choosing SBP after their first master's year. Physics students and Computing Science students only occasionally choose SBP. Looking at the relative numbers compared to the total

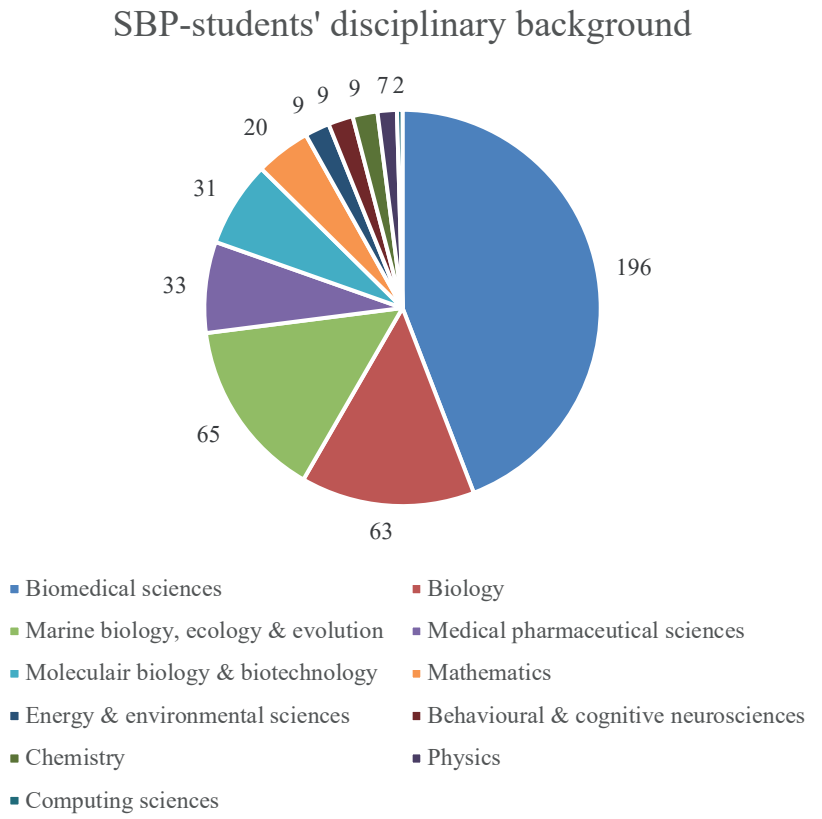


Figure 8) SBP-students' disciplinary background 2003/2004-2019/2020, N_{total}=444

amount of students in a track, Biology, Biomedical Science students and Marine Biology students choose SBP most often. Physics is more oriented on fundamental research then other FSE programs and Computing Science is mainly focused on programming. These students may not associate their future career immediately with business or policy. As such, SBP may seem a less logical choice for those students at first sight. Conversely, Biology, Biomedical Sciences and Marine Biology are fields more oriented on knowledge appliance in society. As such, SBP might be more popular among those studying in these fields.

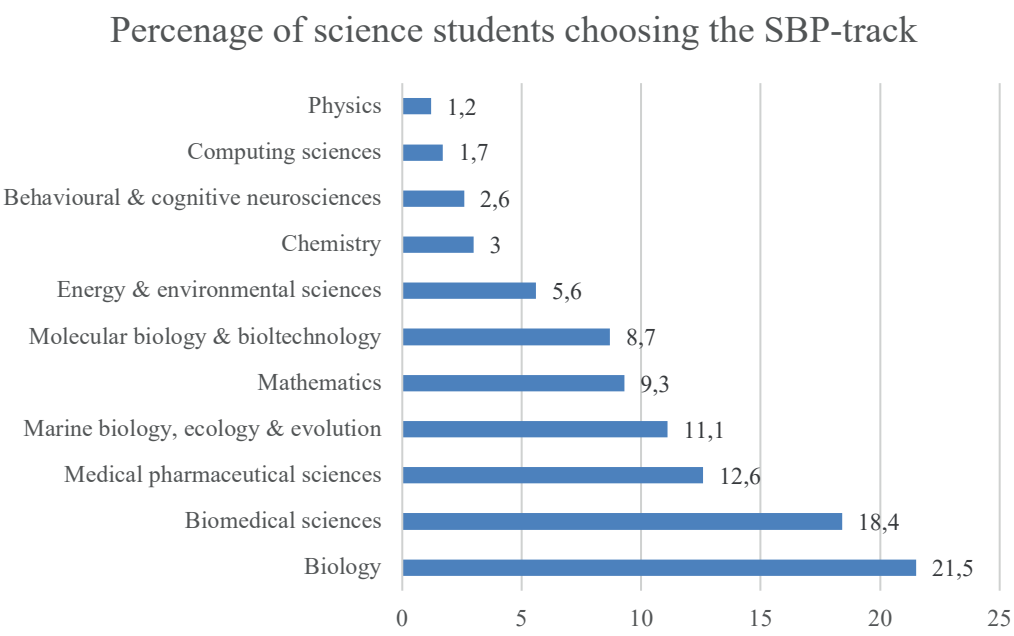


Figure 9) Percentage of the total disciplinary cohort of science students choosing SBP per background, 2003/2004-2019/2020

Work placement characteristics

Figure 10 A-D shows several work placement characteristics, including type, size, sector and location. Figure 10A shows that more than half of the 289 work placements analysed took place in a commercial setting: business placements make up 57% of all work placements. Policy work placements are the most common work placement after business placements: 38% of all students choose a work placement in a policy context. A minority of the students, 5%, have a NGO work placement.

About half of the work placements take place in organisations with 250 employees or more (Figure 10B). The other half takes place in small-, to medium-sized organisations, or SME (Commission of the European Communities, 2003) , where the number of employees of 14,2% of the placements are in micro (1-9 employees), 21.1 % in small (10-49 employees) and 13.5% in medium (49-249 employees) size enterprises or organisations.

The sector work placements most often take place in are healthcare & pharmacy and agriculture & environment (Figure 10C).

Focusing on geography, more than half of the SBP-students (57.4%) stay in the North of the Netherlands (Provinces of Groningen, Friesland and Drenthe). About 5% of the students choose a work placement in a foreign country (Figure 10D).

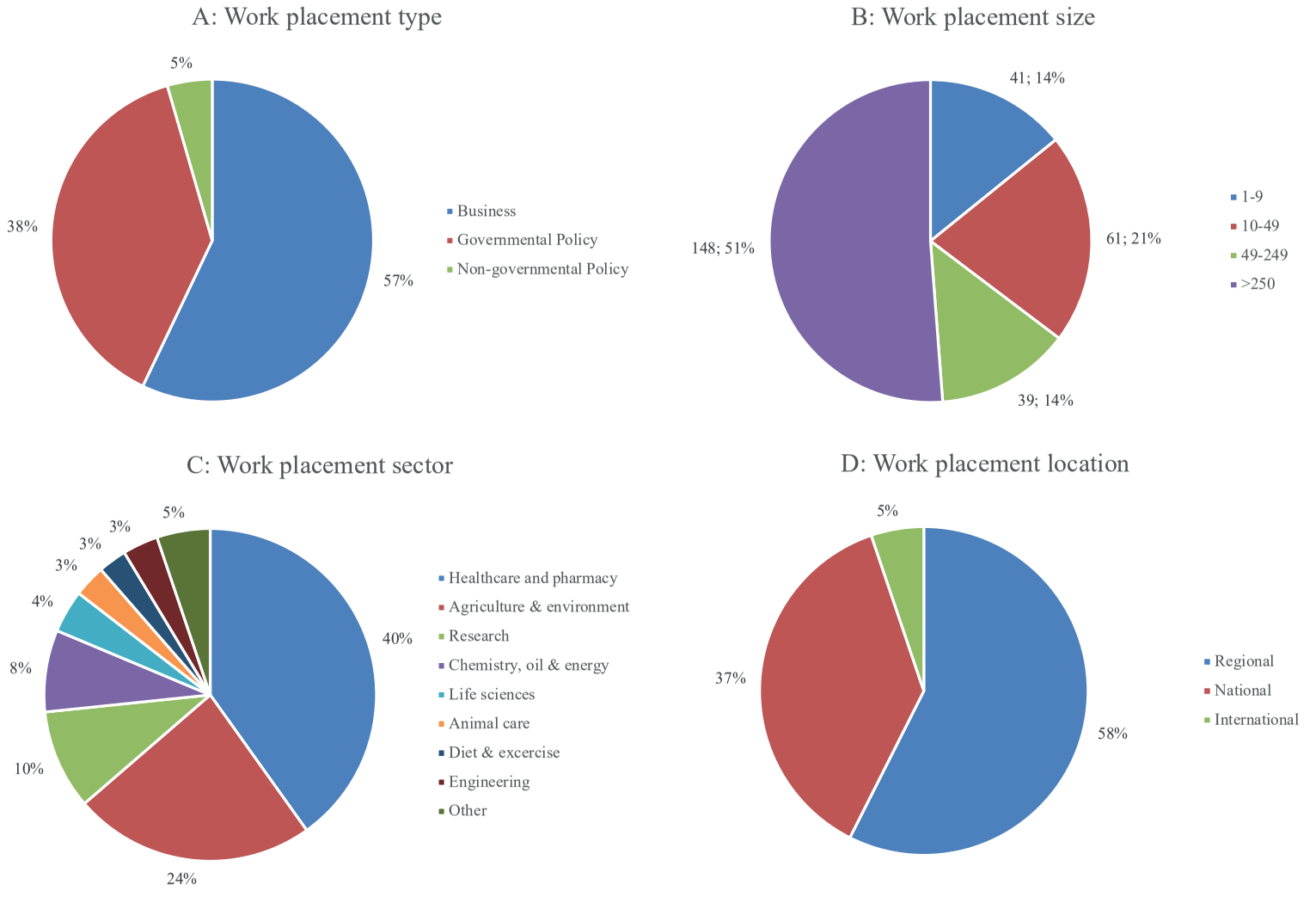


Figure 10A-D Work placement characteristics, 2003/2004-2016/2017, N_{total}=289

Type of work placement assignment & position in stage of cycles

The different types of assignments extracted from the content analysis of the executive summary of the science advice reports are shown in Figure 11. The most frequent types of assignments were implementation, feasibility evaluation, product/policy evaluation and market research advice. Communication strategy, organisational structure and market demand advice were included in the reports least frequently. In total, 336 types of assignments were present in 289 reports, implying combined use of types of assignments.

Besides the type of assignment, the position in the stage of the advices also varied. When placed in the business innovation cycle (Figure 12) or policy cycle (Figure 13), we see that most work placements with a business assignment are in the stage of analysing technical feasibility or market exploration. The policy placements are most commonly in the problem analysis or design and formulation stage.

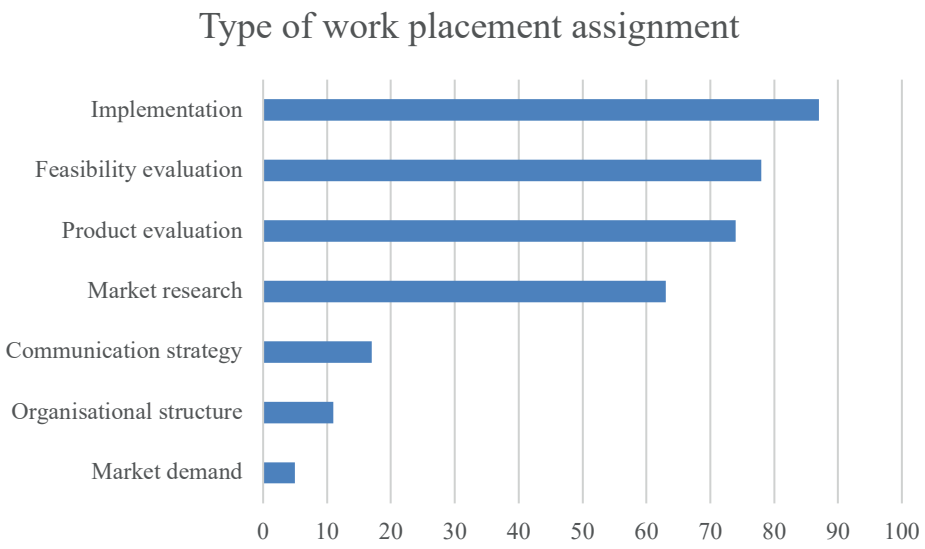


Figure 11) Type of work placement assignment, 2003/2004-2016/2017, $N_{assignments}$=336, $N_{students}$=289

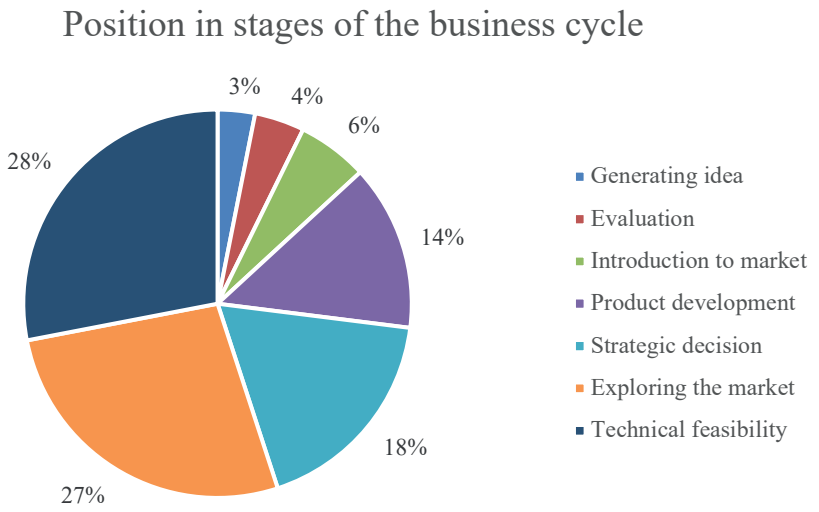


Figure 12) Position of stages in the business innovation cycle, 2003/2004-2016/2017, $N_{\text{business students}}$=165, $N_{\text{business innovation cycle stages}}$=289

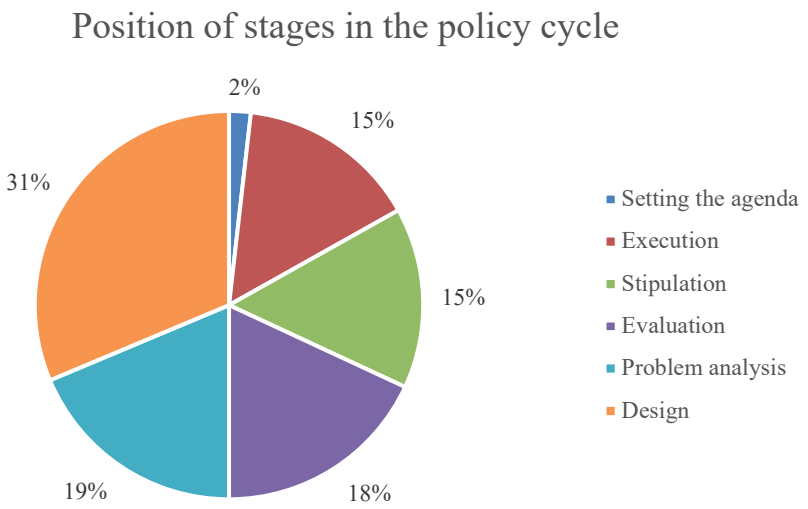


Figure 13) Position of stages in the policy cycle, 2003/2004-2016/2017, $N_{\text{policy students}}$=124, $N_{\text{policy cycle stages}}$=166

Source usage

In work placement reports between 2003/2004-2016/2017, 289 students cited 25140 literature references, which reflects an average of 87 per student. Besides (scientific) articles, students used other sources for information, for example collecting information by conducting expert interviews. It should be noted here explicitly that because SBP-students do not carry out their own conclusive scientific research during a work placement, they use external information sources only.

When external contacts explicitly had impact on the final result students had to report these sources in their advice report (e.g., an interview transcript added to an appendix). Figure 14 shows the number of external contacts used as information source. In total 1528 contacts were used, with an average of 5,3 per work placement. Most external contacts were used as information sources in work placements at NGO's, followed by policy placements, with the least input from external contacts at business placements.

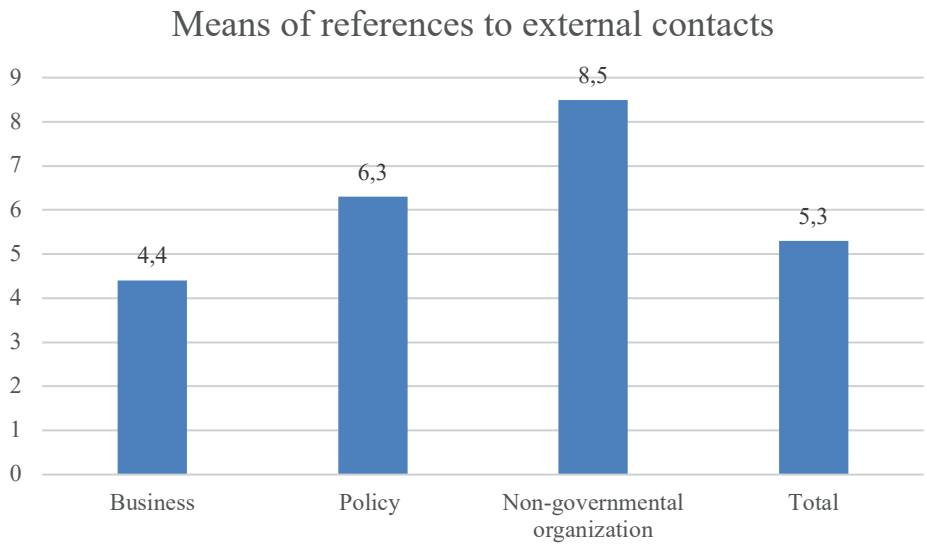


Figure 14) Means of references to external contacts per work placement type, 2003/2004-2016/2017, $N_{students}$=289

Business and Policy tools

Business and policy tools that were employed in work placements were scored. The scored models were those explicitly taught in the lectures during the preceding courses (see for example Figure 7). In the policy related placements (Number of students=124) the most frequently used tools are stakeholder analysis (N=50), the SWOT analysis (N=17) mapping of the organisation culture (N=15), and internal analysis (N=15). In the business placements, a more differentiated use of models could be observed. Table 3 shows the absolute frequency of tools used by the students in a business work placement.

Table 3) Frequency of tools used in business work placements, 2003/2004-2016/2017, $N_{students}$=165

Tool	Frequency business placements
SWOT analysis	69
Internal analysis (general)	58
Porter's 5 forces	52
Organisation structure	39
PESTEL	33
External analysis (general)	30
Stakeholders/actors	28
7S model	27
MCCBA / cost-benefit	19
Ansoff matrix	3
Business model canvas	2
Goal-resource analysis	2
BCG-matrix	2
Technology adoption lifecycle	1
Market share matrix	1
Customer buying cycle	1
Product life cycle	1
Total	368

Tools in loop model

In Table 4, the relative number of students who used at least one model in the loop is shown. The loops that are most often covered are loop 3 (61,2%) and 2 (51,5%). Loop 5 has not been scored because the SBP-track had not fully standardized the use of tools denoting implementation in earlier years.

Table 4) Relative frequency of tools used in business placements per loop in the societal domain of the loop model, 2003/2004-2016/2017, $N_{students}$=165

Loops societal domain	Tools	Percentage of students using at least one tool
Problem analysis & target Group	causal/fieldmodel, stakeholders/actors, Goal-resource analysis, Technology adoption lifecycle, customer buying cycle, product life cycle	27.9%
External analysis	PESTEL, Porter's 5 forces, External analysis (general)	51.5%
Resource analysis & Internal capacity	7S, Internal, BCG-matrix, organisation structure	61.2%
Feasibility & Strategy	SWOT, business model canvas, MCCBA/cost-benefit, ansoff matrix, market share matrix	48.5%
Acceptability & Implementation	n.a.	-

V.7. Grades

Table 5 shows the correlations, means and standard deviations for final exams and work placement grades (1-10 scale) of all SBP-students. All grades are positively and significantly correlated with each other. Business and policy exam grades (theory) are more strongly related than work placements grades to either business or policy exam grades. The mean grades are all above average and are scored on a 1-10 scale (pass at 5,5).

Table 6 shows the correlations, means and standard deviations for grades of SBP-students with a business work placement. All grades are positively and significantly correlated. The business work placements grades are more strongly and positively related to business grades than business work placements grades are related to policy grades.

Table 7 shows the correlations, means and standard deviations for grades of SBP-students with a policy work placement. All grades are positively and significantly correlated. The policy work placements grades are more strongly and positively related to policy grades than policy work placements grades are related to business grades. Policy work placements grades are more strongly related to policy grades than business work placements grades are related to business grades.

While policy exam grades seem lower than the business exam grades, and both the business and policy exam grades seem lower than the work placement grades, a multivariate ANOVA showed that there are no significant differences between business theory, policy theory and work placement grades.

Table 5) Descriptive statistics: correlation, means and standard deviations of student grades of all placements, 2015/2016-2019/2020, $N_{students}$=188

All work placements	Grade Theory Business	Grade Theory Policy	M Total	SD
Grade work placement	.299** (p=.000)	.355** (p=.000)	7.60	.70
Grade Theory Business	-	.542** (p=.000)	7.30	.93
Grade Theory Policy		-	6.91	1.00

* p=<.05 **p=<.001.

Table 6) Descriptive statistics: correlation, means and standard deviations of student grades of all business placements, 2015-2019, $N_{students}$=111

Work placement = Business	Grade Theory Business	Grade Theory Policy	M Business	SD
Grade work placement	.326** (p=.001)	.299** (p=.001)	7.59	.76
Grade Theory Business	-	.538** (p=.000)	7.25	.93
Grade Theory Policy		-	6.85	.88

* p=<.05 **p=<.001.

Table 7) Descriptive statistics: correlation, means and standard deviations of student grades of all policy placements, 2015-2019, $N_{students}$=77

Work placement = Policy	Grade Theory Business	Grade Theory Policy	M Policy	SD
Grade work placement	.251* (p=.030)	.462** (p=.000)	7.62	.62
Grade Theory Business	-	.555** (p=.000)	7.36	.92
Grade Theory Policy		-	6.99	1.15

* p=<.05 **p=<.001.

Retrospect, conclusion & discussion

In this paper, we described a case study of an academic (university level 7) work-based learning (WBL) master's program. This WBL-program, the Science, Business and Policy (SBP) track, is offered at a Dutch research university at the faculty of science and engineering. The track is developed to prepare science students for a science career in business or policy, and is a direct response to the Bologna Process (i.e., a reform of European education), serving as an alternative for a traditional research master's track. The SBP-track offers societal differentiation by including a work placement at a business

or policy organisation and a focus on science advising, as opposed to a research track, that mainly includes theoretical courses and has a strong research focus.

A major aim of this paper was to explain the build-up of, and the reasoning behind this WBL-program, including the explanation of the theoretical framework used to develop the SBP-track, as well as laying out the learning goals and tools derived from these frameworks. In addition, alumni records of the SBP-track from 2003-2019 were analysed, on student population and background, work placement characteristics and assignments, source and tools usage and grades for theoretical courses and work placements. The results of this case study indicate that several factors can be seen as relevant for a successful elaboration of an academic WBL-program.

Design and curriculum

In our view, six important factors can be distinguished that put emphasis on the success of SBP as a WBL example, due to its design of the curriculum. First, the SBP-track was specifically designed to function as a WBL-program, created by academics for academics, as a formal reaction to the Bologna process. This makes that the program has an explicit focus on narrowing the gap between the scientific and the professional field without compromising on the academic level and constantly monitoring this.

Second, the SBP-track is offered completely within the curriculum of a research university (level 7) science masters' and students receive the full amount of ECTS (120 ECTS) necessary to graduate. That is, the SBP-track fits in the typical two-year structure of science master's programs in the Netherlands. The SBP-track's courses (20 ECTS) and work placement (40 ECTS) are offered completely and exclusively within the curriculum. This creates the possibility for students to focus and gain substantial theoretical and scientific knowledge based on specialized disciplinary research in a first master's year (60 ECTS) and a focus on experience outside academia (60 ECTS) in a second (SBP) master's year. The efficiency of the work placements is enhanced by staff specifically devoted to the SBP-track, who support students in arranging and preparing work placements, reviewing during work placements, and evaluating after work placements.

Third, strict starting requirements, including a sufficient academic level and intensive disciplinary knowledge at entrée (i.e., a pass on a first master's year disciplinary thesis) contributes to the quality of the SBP-track. On the same note, students have to pass their business and policy courses before they are allowed to start the work placement. As a result, students normally do not fail their work placements (spare exceptions due to personal circumstances). Hence, a basis for an academic performance is given, since a previously completed master's thesis in research and a pass for the business and policy courses are required to start the work placement.

Fourth, the project approach that forms the core of the SBP-track facilitates students to fully engage in high-quality work-based learning, for instance by studying real-world topics in academic courses and practicing real-world topics through solving existing (i.e., real) problems during the work placements. To make students connect with prior academic knowledge, models that are similar to models already familiar to students (e.g., the empirical cycle of science) are used to approach policy and business (i.e., the loop model, the business innovation cycle and the policy cycle) during the SBP master's year. These models are specifically tailored to serve the practical goals of the SBP-track, along with supporting the academic level of SBP. That is, these models, based on academic literature, establish a broad theoretical framework for SBP-students.

Fifth, while the SBP-track does include theoretical courses in its curriculum, its main focus lies on the integration and implementation of knowledge. The SBP-track is designed to lead to integration at three levels: between different science disciplines, between science and business/science and policy, and academia and the professional work field ("town and gown"). This fulfils the criteria of WBL that theory is necessary, yet the main component should be learning in real life practice. The threefold integration within SBP seems important to match the requirements of the present-day career that education is interdisciplinary, practical applicable and competence-based. That is, there is a need to match the criteria of an academic educational institute with the ability to offer education that can be tailored to individual students, enhances critical thinking and meets the academic level (Lester and Costley, 2010). The SBP-track meets this academic level, and combines it with a systematic integration of complex information and gaining experience in the work field.

Sixth, the strength of the SBP-track originates in the appliance of learning objectives that are specifically formulated to match the WBL educational method in academia. These learning objectives are developed to let students achieve a common and generic academic final level. Within the university, the learning objectives have often been evaluated in recent years, with all parties involved - including business and policy experts. Perhaps surprising, in the course of 15 years teaching SBP there has never been risen a need for adjustment. The learning goals seem to still fit the requirements of academic WBL-practice.

Hence, based on these six factors, the SBP-track - as well as other properly-designed academic WBL-programs - can thrive well within the Bologna Declaration. A WBL-program is in this sense able to narrow the gap between academia and the professional work field without compromising on academic level.

Alumni study records

SBP-students' study records were explored for purposes of determining possible factors for quality and success of WBL-programs, as well as for retaining more comparable information on academic WBL-programs. First, exploration of the student population throughout the years, including student backgrounds showed that the SBP-track attracts a growing number of students, many of them having a background in biomedical sciences and biology. In total, 444 students followed the full track between 2003/2004-2019/2020. An increasing number of students is opting to spend their final master's year on SBP. From 2016/2017 to 2019/2020, the SBP-track's capacity has been fully booked. The actual demand is difficult to extract from the growth numbers since the program has a restricted intake capacity due to practical limitations. Still, it is becoming an increasingly common practice that potential new students are waitlisted for at least one year.

As the founders of the SBP-track intended, the results show that the SBP-student population is multidisciplinary. The largest cohorts are from biology and biomedical sciences. This is representative for the whole faculty, as biology and biomedical sciences form the largest science master's programs. In our personal experience the awareness of the existence of the SBP-track varied - and may still vary - between the disciplinary programs. In addition, it has to be mentioned that the amount of promotion made for the SBP-track between staff members from different disciplines varied - and may still vary - as well. Still, the enhanced interest of students from different disciplines within science in this societal WBL-program is noticeable. Growing student numbers from increasingly different disciplines may be an indication for the quality and success of the SBP-track.

Second, several characteristics of student's work placements were analysed, including type, size, location and sector of the work placement. These characteristics show quite a diversity of work placement characteristics, but also some trends. Based on work placement type and size, there are indications that smaller as well as larger organisations in the corporate world can benefit from the interest of SBP-students. For instance, more than half of SBP-students choose a business type work placement, and more than half choose a work placement organisation with more than 250 employees.

In addition, over half of all work placements take place in the North of the Netherlands, where the University of Groningen is situated. This finding seems somewhat remarkable because in the northern region of the Netherlands there are less large employers compared to the rest of the Netherlands. However, cities in Northern Netherlands, e.g. Groningen, actively profile the life science sector during national and international fairs, in order to attract investments and business in this sector (Gemeenterekening, 2018). This might partly explain why students tend to stay in the North of the Netherlands: life sciences work placements are available, mainly in smaller and medium sized enterprises.

This could also be a consequence of individual preferences since students arrange their own work placements. How this may be, the region profits from the availability of students of the SBP-track. As such, there are indications that SBP functions an economic impulse to the region. Work placements abroad initially have been exceptional but are becoming increasingly common. This may be attributed to the enrolment of more foreign students in the University of Groningen and the fact that the SBP-program recently became available in English (from 2016 onwards). Lastly, while work placement sectors are diverse, work placements in the sectors of healthcare & pharmacy and agriculture & environment are most popular. This coincides with expectations, given the science background of SBP-students – mostly in biomedical sciences and biology.

Third, work placement advice reports were screened, focusing on types of advice given, position in stages of business and policy cycle, business and policy tools applied, position of tools in phases of the loop model, and source usage in the report. As expected, there was a diversity in the stages in business and policy cycles applied in the advices. This underlines that various components of the business and policy cycle can be used effectively within advice reports, for different types of advice. In addition, multiple business and policy tools are used, as well as tools offered in several phases of the loop model. These results suggest that a tailored, yet broad theoretical framework for SBP-students supported the quality of their advice report. That is, in order to make individual work placement assignments successful for this master's track, there should be room for a variety of tools that can be used interdisciplinary, yet still fitting within the framework of science, business and policy. Besides the diversity of tools found in the advice reports, the alignment in, and the sufficiency of the offered business and policy tools strengthen this finding.

Furthermore, students integrated a large number of scientific references and external contacts in their advice reports. The data suggest that students carried out a thorough literature search for their advice reports. In addition, students' references to external contacts showed the expansion of their professional network with contacts who contributed to their science advice report. Please note that the real expansion of student's professional network might be higher, since only the explicitly mentioned sources have been recorded.

Fourth, work placement grades, and grades of business and policy exams were compared. It should be noted that there were slight changes in didactics due to the continuing development of the SBP-track. Although the learning objectives remained the same throughout the years, assessment methods (such as assessment rubrics) changed slightly. The results can therefore only be interpreted as explorative, and conclusions that are drawn are formulated with caution.

Grades of all SBP-components varied from sufficient to good. As students choose the topic of their work placement themselves, it was expected that work placement grades were higher than grades for compulsory courses. While differences were not significant, work placement grades tend to be higher than grades for theoretical courses. In addition, business theory grades seem to be higher than the policy theory grades. A possible explanation could be the information density and the nature of business literature, resembling more closely what students are used to during their prior science education. For the policy course, students had to read and disentangle policy documents, often ambiguous and novel. Thus, the policy course may be more difficult than the business course for science students. It could also be due to other (intrinsic) difficulties of the discipline or challenges associated with the way courses are organized.

Business and policy theory grades correlated positively, as well as the work placement grades did with both business and policy theory grades. The correlation values are moderately positive and only grade theory business with grade theory policy (.542 combined, .538 business placements, .555 policy placements) exhibit a considerable positive correlation. This is quite understandable as these are both course-based. Table 6 shows a small difference (.326 vs. .299) that seems to suggest that grade work placement for business placements is almost similarly correlated to both grade theory business and policy while Table 7 on all policy placements have a bigger gap (.251 vs. 462). While this should be kept in mind, still, correlations between work placements and matching theory grades were stronger than unmatching theory grades (i.e. business work placements with business theory & policy work placements with policy theory). As students choose the type of work placement that suits their expertise best, it is not unlikely that grades on theory courses that are more in line with their expected future career (i.e., in the area they carry out their work placement) correlate stronger. These results give indications that it is also possible to evaluate students' academic level by grading their work placement reports, as opposed to evaluating students only based on results on theoretical exams. That is, student quality in the area of business or policy is not only reflected by the results on their business or policy courses, but also by their work placement grades. Based on our results, this is especially true for the policy work placements.

Looking at the SBP-track, it can be concluded that the societal interpretation of the Bologna process has been implemented successfully, by closing the theory-practice gap with academic learning and furthering professional experience using a WBL-approach. This case study showed that a heterogenic population of science students (i.e., students of different disciplines) can address a heterogenic population of problems for business and policy organisations with a very diverse character, sector, size and region, by using a variety of tools and sources.

This diversity can form an educational challenge, since there is no one-size fits all approach possible. However, a WBL-approach, in this case translated to the SBP-track, seems to have the potential to include all the described variety. As such, academic WBL-programs could be an answer to the call from the work floor, but also from students to realize a better connection between achieving academic level and gaining hands-on-experience. In this way, one academic degree does not only comprise of science and societal aspects but is also earned by practical projects and actions that are needed to get there.

Future questions

Besides introducing the theoretical framework applied to design the SBP-track, this article aimed to share possible success factors for academic WBL-programs. Simultaneously, we provided some insights into the SBP-track's student population and their study records. We invite colleagues to share their methods and approaches used to develop academic WBL-programs. Being able to compare different case studies on fulltime bachelor's and master's level WBL-programs has the potential to form a more cohesive and extensive theoretical framework on quality assurance of academic WBL-programs.

In order to improve education, Lester et al. (2016) stress that more in-depth qualitative research based on real programs could also be employed to explore the extent to which different pedagogies and curricular structures support effective learning and develop capability and professionalism in different fields and contexts. This area of research would need to have a longitudinal element to look beyond end-of-program outcomes to the effect on careers and, where relevant, further study. It can also be useful to explore the long-term effects of WBL versus traditional programs on (prior) students. For that reason, we started to investigate SBP-alumni experiences with the WBL-program, and their careers after graduating, in relation to experiences from alumni who graduated in a research-oriented profile.

Furthermore, research about conditions that are needed for successfully implementing a WBL-program within academia can be examined. What does implementing a WBL-program mean for the organisation of education and the qualities needed of the teachers or instructors? An evaluative study is currently conducted with staff of the faculty of Science and Engineering at the University of Groningen to assess professors' perceptions related to the SBP-track.

Finally, it is also important to extend the analysis of the societal impact of WBL. Therefore, we are investigating experiences of the providers of the work placements. Does WBL really help in preparing students for their career and are students able to make a difference within business and policy organisations? Whether the desired societal impact is reached, is currently being verified by carrying out interviews with SBP-supervisors from the societal institutions involved with the SBP-student's work placements.

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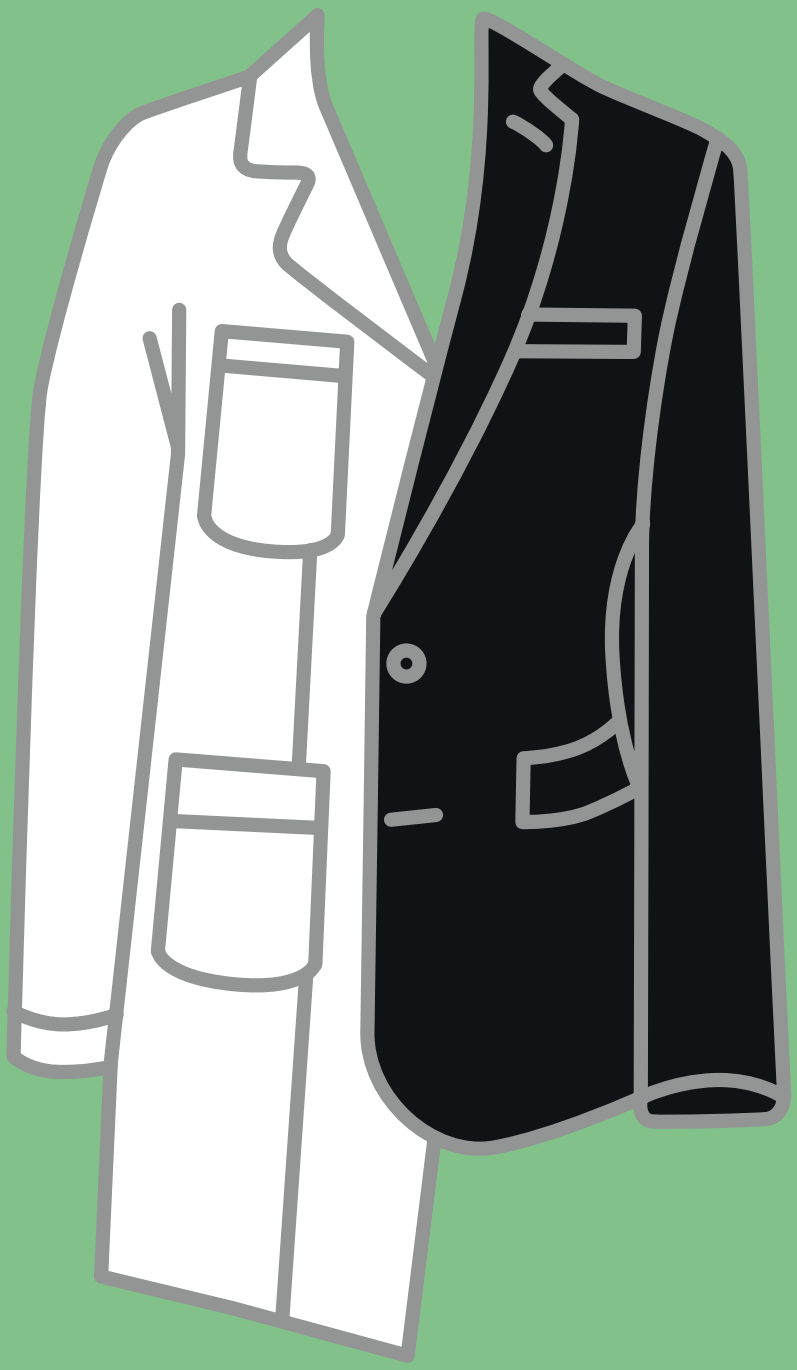
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3

Appreciation of an alternative: Dutch alumni look back on their science master, a work-based learning vs a research-oriented approach

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Abstract

The Science, Business and Policy Program (SBP) of the University of Groningen has been a work-based learning program for science master students since two decades. This program, a direct consequence of the Bologna declaration of education in Europe, has a distinctive position in European science curricula. Here we use a web-based survey (N= 242), comparing alumni perceptions on the SBP program (N=111) with a research oriented master (ROM, N=131). Alumni from both programs predominantly had a content-driven motivation to choose for either the ROM or SBP format. For SBP alumni, this preference was also inspired by the master's focus on society and a career outside academia.

We assessed self-perceived learning outcomes using an extended version of the Science Student Skills Inventory. Both groups were positive about the academic level of their program. Scientific content knowledge and practical research skills were perceived as sufficient by both groups, although significantly higher in the ROM group. Both groups were equally positive about obtained skills in academic reasoning, and would have preferred more disciplinary content knowledge.

The SBP group perceived their skills on teamwork, multidisciplinary working, leadership, ethical thinking and project work to be significantly higher compared to ROM alumni. The SBP group felt significantly more prepared for a career outside academia and the ROM group for a career in academia. Relatively the ROM group missed career preparation. Both specific work-based learning and classical research approaches were seen as valid ways to obtain a high- quality, science master level, although for different career ambitions.

Keywords: work-based learning; Science, Business and Policy; alumni perceptions; career; curriculum comparison.

Introduction

The Science, Business and Policy Program (SBP) of the University of Groningen has been a work-based learning program for science master students since two decades. This program, a direct consequence of the Bologna declaration of education in Europe, has a distinctive position in European science curricula (Grooters, Zaal and Gerkema 2021). The notion that science should focus on research only is no longer sufficient (Agre and Leshner 2010) and also applies to educational activities of universities. Classically, in many European countries, science education is mainly focused on preparing for a research career. Research training alone however does not facilitate the much-needed connection with the labour market (Bologna working group 2005). There is a call from society that education should be much more synchronised with the work field (Dutch Ministry of Education, Culture and Science 2014) and that students need different skills to be employable beyond academia (Hart 2019). This discrepancy between supply and demand on the labour market for higher educated science alumni (Sarkar et al. 2020) stretches a need for universities to bridge the gap between science and society (Matthews, McLinden and Greenway 2021).

A promising solution lies in providing work experience within the academic framework. Work-based learning (WBL) is an educational form enabling this. WBL is also criticized upon (cf: Lester and Costley 2010) but comparable information on WBL in practice is still not sufficiently available, making it unclear whether critiques can be generalized over other program types (Lester, Bravenboer and Webb 2016). In this paper we examine perceived differences by the key players of two science programs offered at the Faculty of Science and Engineering (FSE), University of Groningen, the Netherlands: students of a research-oriented master's (ROM) program, and students of a WBL master's program, the Science, Business and Policy (SBP) program. The SBP program is a work-based learning program that is classified as a European best-case practice of WBL (WEXHE). Because this program exists for almost two decades and the FSE offers a substantial number of alumni for both the SBP and ROM-program, a comparative evaluation of programs can be done.

Our main research question is: 'To what extent do ROM-alumni and WBL-alumni differ in the perception of their master's programs, specifically with regard to bridging science and society?'

More specifically, we want to know whether the WBL-program is distinctive, and qualitatively comparable to a ROM-program based on alumni perceptions; which skills alumni perceived to have acquired and missed during the master's program; to what extent alumni appreciated, and were satisfied with the program; and finally, did alumni feel prepared for the career they were heading for?

To answer those questions from a (former) student perspective, a web-based survey is conducted among alumni who graduated between 2 and 18 years ago. They answered questions comprising a long-term reflection on the content and experience of their master, using (partially) standardized questionnaire items suitable for comparison between programs.

ROM and SBP Master set-up

Situating the development of a European bachelor-master structure (Bologna Working Group 2005), a differentiation of science master curricula was initiated. For science education this included also an alternative society-oriented program that was initiated in the Netherlands in 2002 (Hermans and Vermeend 2002). The Faculty of Science and Engineering (FSE) of the University of Groningen developed a 60 ECTS program: SBP.

FSE students follow a 2 year 120 ECTS master program (ISCED level 7). In the first year, discipline-specific research courses are taken as well as a research thesis (of usually 30-40 ECTS). In the second year, students can choose between:

- A Research Oriented Master in which students do a second research thesis (30-40 ECTS), supplemented with an essay, a colloquium and more research courses. This route is aimed at acquiring scientific knowledge and preparing for an academic career.
- The Science, Business and Policy program in which students first do two courses with a theory part on Business and Policy and group projects for real clients in the business sector or with governmental agencies. The courses are followed by a relatively long individual work placement (six months, 40 ECTS). During this work placement outside academia the students learn on the spot to become a science advisor and apply academic knowledge to societal, (i.e.-business or policy) problems (for a more detailed description and learning outcomes: Grooters, Zaal and Gerkema 2021).

SBP can be described as a WBL-program. The educational strategy of SBP is to offer work experience within the curriculum to students at companies or (non-) governmental organisations where they can apply their academic knowledge and combine and integrate this with Business or Policy. Hereby students can work on their employability and skills required for a non-academic career.

Work-based Learning

The concept of work-based learning is explained in many different ways for many different groups. In this article, our focus is on science students in a conventional cohort of young full-time students who follow a regular study route (i.e. excluding adult learners) and we focus on the program of the last year of their master. We define WBL as: 'The term "work-based learning" logically refers to all and any learning that is situated in the workplace or arises directly out of workplace concerns.' (Lester and Costley 2010, 562).

The number of work-based learning programs offered at universities is rapidly increasing, which is not surprising given the multiple positive influences of WBL. First, WBL-programs have shown to effectively foster students' personal, professional and academic development. WBL students gain - next to the regular academic theoretical development - more practical expertise and skills and reported increased levels of confidence, competence, the ability to reflect and understand, as well as an ongoing desire to learn and develop (Stephenson and Saxton 2005; Costley and Stephenson 2008).

Second, WBL-programs can have distinct benefits for organizations that offer work placements. To start, the work placement project itself brings value when the WBL-student and WBL-organization match well. The work placement project adds knowledge to the organization's intellectual capital (Garnett 2007) and students' input can lead to organizational changes at several levels of the organization. Work practices may be changed and new business directions can be identified (Costley and Stephenson 2008). Furthermore, these organizations might also be the first potential employers after a successful work placement. For employers in general the WBL-programs seem to deliver suitable job candidates. Employers of small and medium enterprises seem to value WBL-programs and on the job experiences more compared to classical educational programs (Burgoyne, Hirsh and Williams 2004).

From an academic educational point of view an important argument for WBL is providing education that optimizes career perspectives and enables students to keep up with requirements from the work field. Modern education can thereby focus on the ability to train students in dealing with the ongoing changing environment, the enormous pace of technological change and complex context, as stressed important in literature (Brew 2010; Barnett 1998).

There are also a number of critiques concerning offering WBL at science education on a master's level. First, WBL in general is sometimes considered a non-academic practice. In the Netherlands gaining experience during a placement is seen as typical for applied education (bachelors, ISCED level 6) and not as master's level (ISCED level 7) education.

Critics mention WBL's absence of a proper curriculum, a lack of theoretical exams, written assignments and academic specialization (Lester and Costley 2010).

Second, by transferring part of the academic education to a place outside academia you also transfer control over the curriculum and learning outcomes, which might not be desirable (Powell and Walsh 2018). Adding to this, there are assumed uncertainties about learning objectives (Saunders 1995) and academic skills in WBL, that are unclearly formulated (Hughes, Moore and Bailey 1999) and poorly assessed (Brodie and Irving 2007).

The third point of critique is perhaps more specific for science education. From literature we know that science programs usually tend to value scientific content knowledge over skills required to apply the content knowledge (Wieman 2007; Wood 2009) and therefore it may not be surprising that large universities seem to be resistant to educational change within science education. (Wieman, Perkins and Gilbert 2010; Anderson et al. 2011)

Lastly, it seems difficult to organize WBL in practice in science education in such a way that it creates a sustainable difference. In literature multiple large projects funded by the government are described. These projects were in the United States (Dancy and Henderson 2008), the United Kingdom (Grove 2012) and Australia (Gannaway and Hinton 2011) respectively. They all had the aim to reform science curricula, but did not create a lasting persistent change.

Thus, although, there is a noticeable amount of evidence that WBL-programs can be an effective way of educating and are in fact a rather valued educational form, some critiques given may very well be real issues. In this current evaluation study we investigate how the pros and cons of a WBL-program are seen by alumni of the SBP program. Specifically, we want to learn how the WBL-program's academic quality and learning outcomes are perceived by the SBP alumni in comparison to ROM alumni.

Materials and Methods

To answer our research questions, a survey was conducted among alumni. This survey contained questions about perception of the study program, that are shown in this article and about career perception, which will be published separately. Permission for the distribution of the survey has been given by the ethical committee of the University of Groningen (CETO submission number 63104880).

Participants

In total 2,473 FSE alumni were approached (for the selection procedure see appendix A). The participants invited were all alumni of programmes that offer SBP and ROM in the second master's year. In total 242 alumni who graduated between the academic years 2001/2002 and 2017/2018 from the FSE of the University of Groningen completed the questionnaire and were included for analysis. More specifically, 111 SBP alumni (32.0% of approached SBP alumni), and 131 ROM alumni (6.2 % of approached ROM alumni) completed the questionnaire. Respondents were able to skip questions if they did not want to answer, therefore the number of participants varies per item.

General group features

Table 1 shows participants' age and gender distribution. On average, participants were between 29 and 32 years old. For the SBP group, there was a significant difference between the age of male and female participants ($F(1,109)=4.87$, $p=.029$). Male SBP participants were on average 2.27 years older than female SBP participants. There were no other significant differences found in gender and age.

Table 1. Age and years since graduation, per gender/program.

Age in years	**N**	**Min**	**Max**	**Mean**	**SD**
SBP	**111**	**24**	**57**	**31.13**	**5.48**
Male	61	24	57	32.15	5.78
Female	50	24	50	29.88	4.86
ROM	**131**	**24**	**41**	**29.84**	**3.60**
Male	64	24	41	29.61	3.79
Female	62	25	37	29.09	3.27
Other	4	25	39	31.80	5.07
Years since graduation	**N**	**Min**	**Max**	**Mean**	**SD**
SBP	**111**	**2**	**18**	**7.21**	**4.59**
Male	61	2	16	7.67	4.48
Female	50	2	18	6.64	4.70
ROM	**130**	**2**	**18**	**5.95**	**3.37**
Male	64	2	15	5.38	3.24
Female	61	2	18	6.43	3.39
Other	4	2	12	7.00	4.40

The alumni graduated on average 6.5 years prior to participation in the survey (Table 1). There is a significant difference between the SBP and ROM alumni for graduation year ($F(239,1)=94.06$, $p=.016$.) The ROM group graduated on average 1.26 years more recent

- prior to taking the survey – compared to the SBP group. Further exploration shows an interaction effect between alumni type and gender for graduation year (F(1,235)=4.03, p=.046.). Although within each group of alumni no effect were found for gender, a significant difference in years since graduation was found between SBP male participants and ROM male participants (F(1,123)=10.86, p=.001). Hence, among ROM male participants there were more recent graduates (on average 1,83 year more recent than SBP alumni). These biases have to be taken into account in the interpretation of further results.

Educational background

Table 2 shows the disciplinary backgrounds of the SBP and ROM group. Biology alumni form the largest group of respondents. The second largest group had a medical discipline, biomedical alumni in the SBP group and medical pharmaceutical alumni in the ROM group.

Table 2. Percentual disciplinary background of alumni, SBP group n=110, ROM group n=131.

Science Discipline	SBP	ROM
Biology	40%	22%
Biomedical Sciences	32%	12%
Medical Pharmaceutical Sciences	9%	21%
Chemistry	4%	4%
Physics/Astronomy	4%	16%
Mathematics	4%	9%
Computer Sciences/Artifical Intelligence	3%	14%
Energy & Environmental Sciences	2%	0%
Other	3%	4%

Design and optimalisation of the questionnaire

The questionnaire was based on previously developed standardized questionnaires in addition to non-standardized questions constructed by the researchers of this paper. All questions were checked on questionnaire design recommendations (cf. Dijkstra, Ongena and Loosveldt 2014) and were optimized through pre-testing. The pre-test comprised of cognitive interviewing (Beatty and Willis 2007; Collins 2003). The questionnaire was first tested by students during a course on survey design. Then, a revised version of the questionnaire was pre-tested again. Based on these results, the questionnaire was extensively discussed by all authors of this paper and finalized. Questions that turned out to be unclear during the pre-test where adjusted or removed. In Appendix C the pre-test procedure is further described in detail.

Questionnaire Items

Science Student Skills Inventory

Preceding academic quality assurance in general is the need for universities for each bachelor's and master's program to formulate learning outcomes for degree programs they offer (Mercer-Mapstone 2016). Matthews and Hodgson (2012) developed a tool, the Science Student Skills Inventory in order to measure science students' learning outcomes. It consists of several closed-ended questions on academic skills. We used the SSSI to explore to what extent SBP and ROM alumni perceive having gained several academic skills throughout the program and how these perceived skills compare across the two different master's programs.

To assess academic skills, all six original items of the SSSI were used: (1. Scientific content knowledge in your field(s) of study; 2. Communication skills (oral scientific presentations); 3. Writing skills (scientific writing); 4. Quantitative skills (mathematical & statistical reasoning); 5. Team work skills (working with others to accomplish a shared task); 6. Ethical thinking (ethical responsibilities and approaches)). The following question was asked for every skill: 'During the entire master's degree programme I followed at the FSE, I improved (skill)…'. Participants had to evaluate these statements on a 5-point-scale (ranging from I totally disagree to I totally agree).

Questions based on SBP learning goals and program satisfaction

To the SSSI four additional skills were added, based on the SBP's learning outcomes (7. Practical research skills (i.e. lab work and modelling); 8. Academic reasoning (i.e. analytical and critical thinking); 9. Project-based working skills (to achieve a certain goal with limited resources); 10. Leadership skills (i.e. guiding & managing a team)).

Furthermore, participants were asked to assign their master's program a general grade (ranging from 1-10), and to evaluate statements on a 5-point scale (ranging from I totally disagree to I totally agree) about their master's program in relation to its value in the faculty's curriculum and career preparation (Generally speaking, I believe the SBP track… 1) is a positive addition to the curriculum of master's programmes that can be followed at the FSE; 2) should remain available as an optional master's track within a master's programme of the FSE; 3) contributes to students' career preparation for a career in academia; and 4) contributes to students' career preparation for a career outside academia).

Open-ended questions

In the survey three open-ended questions were posed (Table 3). Responses were coded by two independent coders and an intercoder reliability (Cohen 1960) was calculated for each of the coded questions based on answers of 100 respondents. Table 3 shows the items that were presented to the participants, as well as the reliability of the coding process (Cohen's Kappa). These values suggest an intercoder reliability with almost perfect agreement (McHugh 2012).

Table 3. Open-ended Questions.

Topic	Question	Kappa
Motivation of choice	Do you remember the most important reason or reasons for choosing to follow the SBP track/ research track? If you do, please enter the reason/ reasons below.	0.96
Acquired Skills	What do you believe are the most important skills you still use in your professional life today, that you have developed (further) by following the SBP track/ research track?	0.97
Missed Skills	Think about the information and/or skills that you miss, or have missed during your professional life. What do you believe should have been included in the SBP curriculum that was not included'?	0.85

Data collection, procedure and analysis

The data were collected using survey software Qualtrics. Before participation, respondents were asked for informed consent. After giving consent, participants answered demographic questions and the open-ended questions. Then, items from the SSSI, additional learning goals and program satisfaction were presented to respondents. Lastly, participants were asked several questions on their first job after graduation and current job. The latter questions go beyond the scope of this paper and are part of another study. After data collection, any identifying information was removed from the data. Statistical analyses were carried out with statistics software SPSS. Depending on meeting assumptions, (i.e., normality, equality of variances), parametric tests (Univariate ANOVA's) or non-parametric alternative tests (Welch & Brown-Forsythe tests) were carried out.

For the open-ended questions, using an inductive coding strategy, participants' responses were coded based on non-predefined categories. The data was first coded by two student-assistants, not involved in the data collection. Then, overarching coding categories were created that merged similar coding categories (see Appendix B). Lastly, all data was coded based on these merged categories by the second author of this article. The first author double-coded 100 responses (50 SBP, 50 ROM).

Results

Motivation of choice

The SBP alumni and ROM alumni responded in a different way to the open-ended question 'Motivation of choice' (Figure 1). Study content was frequently mentioned by both groups. For the SBP alumni frequent motivations to choose the SBP program also included the focus outside academia and the focus on society. For the ROM alumni their choice was motivated mostly by the alumni's personal interest. The focus on academia (research) was a motivation for 14% of this group, among the SBP alumni nobody mentioned this. Other motivations were recommendation of others (1% for the SBP group and 14% of the ROM group) and career in general.

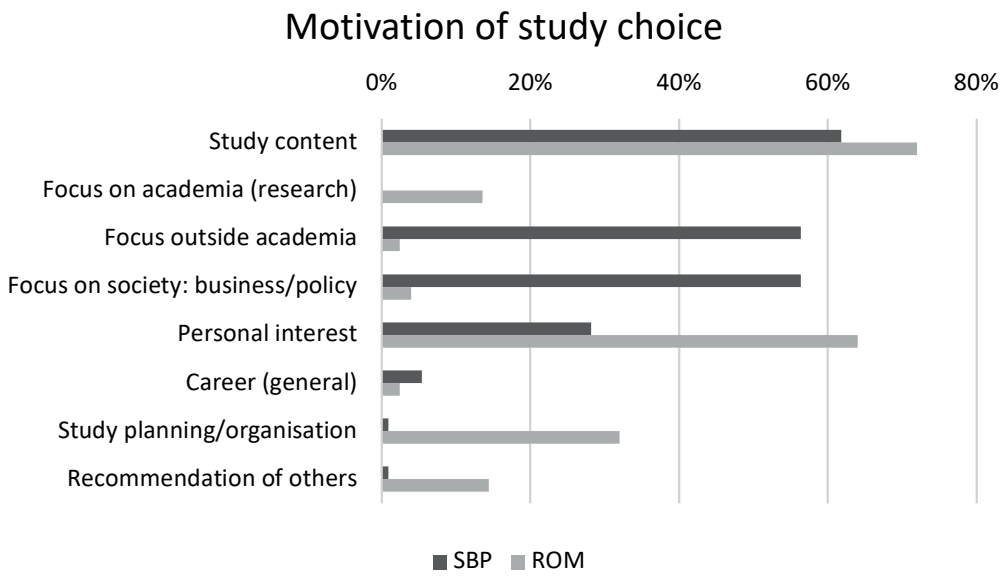


Figure 1. Motivation of choice of the study program, open-ended question, SBP group n=110, ROM group n=125.

Satisfaction with the study program

On average, alumni of FSE evaluated their education rounded an 8 out of 10 but ROM alumni give a slightly, but significantly, higher grade than SBP alumni (Table 4) when it comes to evaluating their master's program $F(1,238)=5.01$, $p=.026$.

Table 4. Grade alumni give to their study program, scale 1-10.

	N	Min	Max	M	SD
SBP	110	4.10	9.50	7.76	.87
ROM	130	3.80	10.00	8.00	.79

Table 5 shows means, standard deviations and percentage of agreement (participants who scored 4 or 5 on the Likert-scale) with statements on appreciation, academic level and career preparation. Both groups generally perceived their program is a positive addition to the curriculum. There is a significant difference between the different groups of alumni in their perception of whether their master's program should stay available in the curriculum $F(1,221)=9.04$, $p=.003$, $R^2=.04$). Robust tests of equality of means (Welch & Brown-Forsythe) confirm that there are significant differences despite of inequality in homogeneity of variances $(1,193.63)=9.07$, $p=.003$. The difference is also visible in the percentage of agreement were the SBP group had a higher percentage of agreement (95.5%) than ROM group alumni (84.8%).

SBP alumni only were asked questions on their satisfaction with the track and whether they would recommend their track to others. For both statements SBP alumni generally agreed with the given statements.

Table 5. Appreciation, academic level and career preparation of second master year, measured with a statement, agreeing on Likert-scale 1-5 (1 strongly disagree- 5 strongly agree) ** p <0.01, * p <0.05.

Statement	group	N	M	SD	Percentage agreement (4 or 5)
Positive Addition to FSE	SBP	111	4.44	.64	95.5%
	ROM	125	4.31	.81	88.0%
Should Stay available at FSE**	SBP	111	4.63	.60	95.5%
	ROM	112	4.32	.90	84.8%
Academic level is sufficient	SBP	111	4.06	.70	83.8%
	ROM	128	4.42	.87	91.4%
Preparation for Career in Academia	SBP	111	3.22	.98	41.4%
	ROM	131	4.39	.89	90.1%
Preparation for Career outside Academia	SBP	111	4.35	.63	96.4%
	ROM	126	3.08	1.09	39.7%
Satisfied about SBP track	SBP	111	4.16	.57	92.8%
Recommends SBP track	SBP	110	4.19	.66	89.2%

Perception of Learning outcomes

Academic level

In their perceived academic level of the program (Table 5), almost all participants scored 4 or higher. This shows that the alumni generally agreed with the statement that their master's program led to obtaining a sufficient academic level. There is a significant difference between the two groups, SBP alumni score a bit lower in their perception (M=4.06) than the ROM group (M=4.42), F(1,237)=12.11, p=.001, R^2 = .05.

Science Student Skills Inventory

Figure 2 the results of the SSSI, assessing the learning outcomes more specifically. Zooming in on the alumni's reflection on their learned skills, both groups indicate that they have increased their **scientific knowledge** fairly. ROM alumni thought they improved their scientific content knowledge during the whole master's program more so than SBP alumni (F (1,236) = 5.35, p = .022. R2 = .018). In terms of **writing skills** and **quantitative skills**, both groups indicated that they have increased properly. No difference was found between groups. Alumni experienced growth on **oral communication skills** (F(1,236)=6.53, p=.011. R^2=.023) and **teamwork skills** (F(1,236)=46.06, p=.000. R^2=.160),

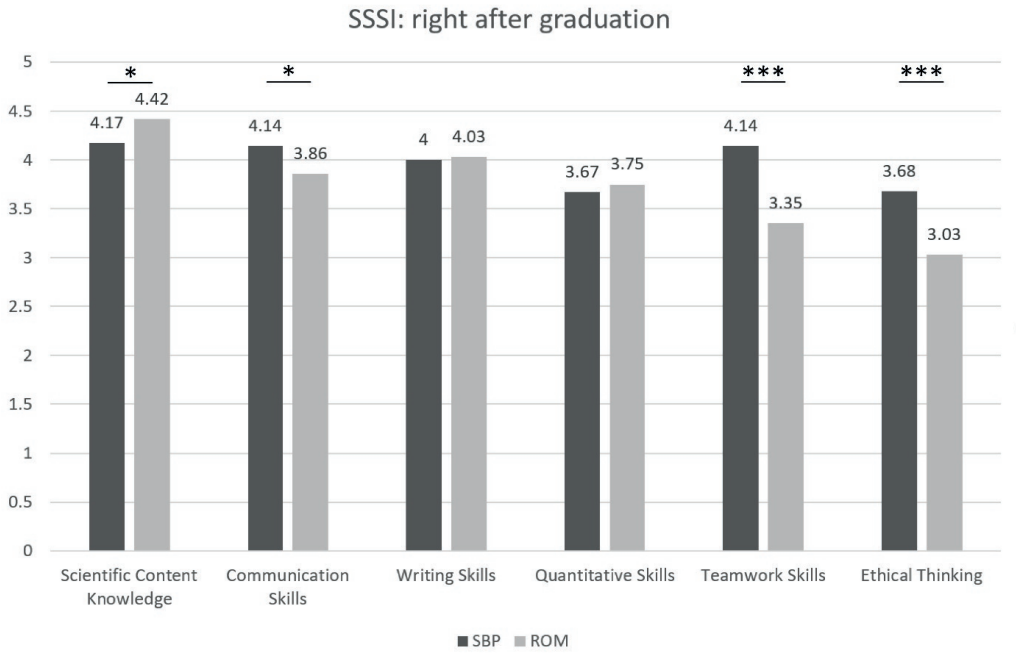


Figure 2. SSSI skills precepted by alumni right after graduation on Likert-scale (1 strongly disagree- 5 strongly agree). SBP group n=109-111, ROM group n=130-131. *** p <0.001 ** p <0.01, * p <0.05.

whereby SBP alumni felt that they have experienced more growth than ROM alumni. Robust tests of equality of means (Welch & Brown-Forsythe) confirm that for both these skills there are significant differences despite of inequality in homogeneity of variances (1,232.)=52.31, p=.000.). SBP alumni scored significantly higher on **ethical thinking** than the ROM group (F(1,236.40)=24.60, p=.000. R^2= .091).

Figure 3 shows the results for the added skills. For practical research skills (lab work), both groups indicated that they have increased fairly. The ROM alumni thought they improved their practical research skills during the whole master's program more so than SBP alumni, F(1,326)=4.51, p=.035, R^2=.015. For academic reasoning (i.e. analytical thinking), both groups indicate having increased skills and no difference was found between the groups. In terms of project-based working skills, growth was also mentioned, whereby SBP alumni felt that they have experienced more growth than ROM alumni, F(1,36)=12.85, p=.000 R^2=.048. Robust tests of equality of means (Welch & Brown-Forsythe) confirm that there are significant differences despite of inequality in homogeneity of variances (1,238.42)=13.07, p=.000. For leaderships skills there is also a significant difference, F(1,236)=54.41, p=.000. R^2=.195, with the ROM group finding they did not develop during the study. The SBP group scores M=3.20, which means only slightly more agreement

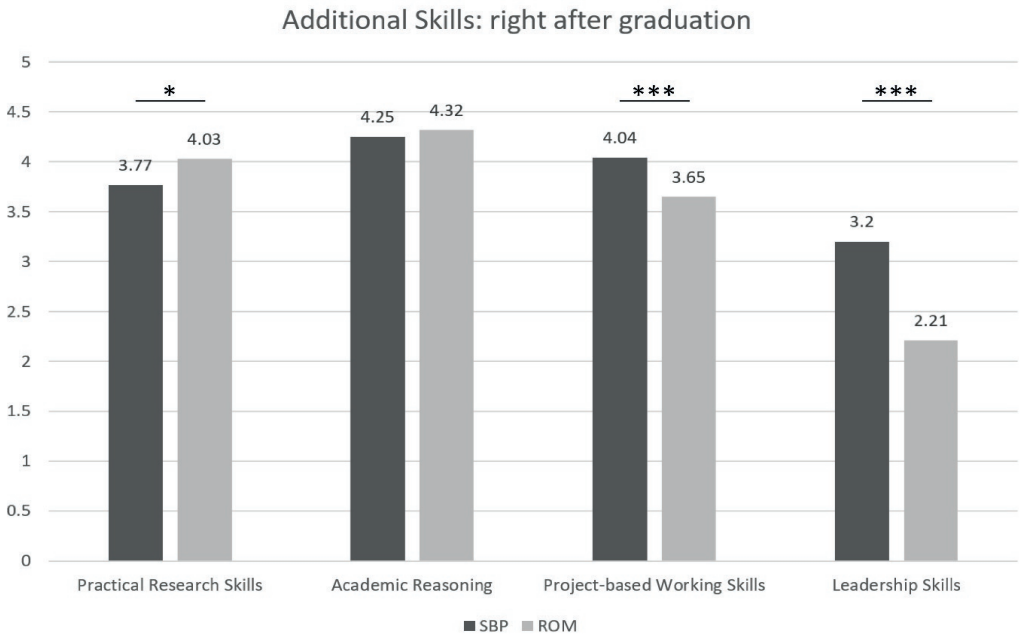


Figure 3. Additional skills precepted by alumni right after graduation on Likert-scale (1 strongly disagree- 5 strongly agree). SBP group n=110-111, ROM group n=131. *** p <0.001 ** p <0.01, * p <0.05.

on development. Robust tests of equality of means (Welch & Brown-Forsythe) confirm that there are significant differences despite of inequality in homogeneity of variances (1,214.31)=57.59, p=.000.

Skills acquired and missed

For the ROM group the most frequently mentioned acquired skills were scientific/ research skills, (Figure 4), followed by disciplinary content knowledge. For the SBP group the frequently mentioned skills acquired vary more and included teamwork, personal development, communication and disciplinary content knowledge.

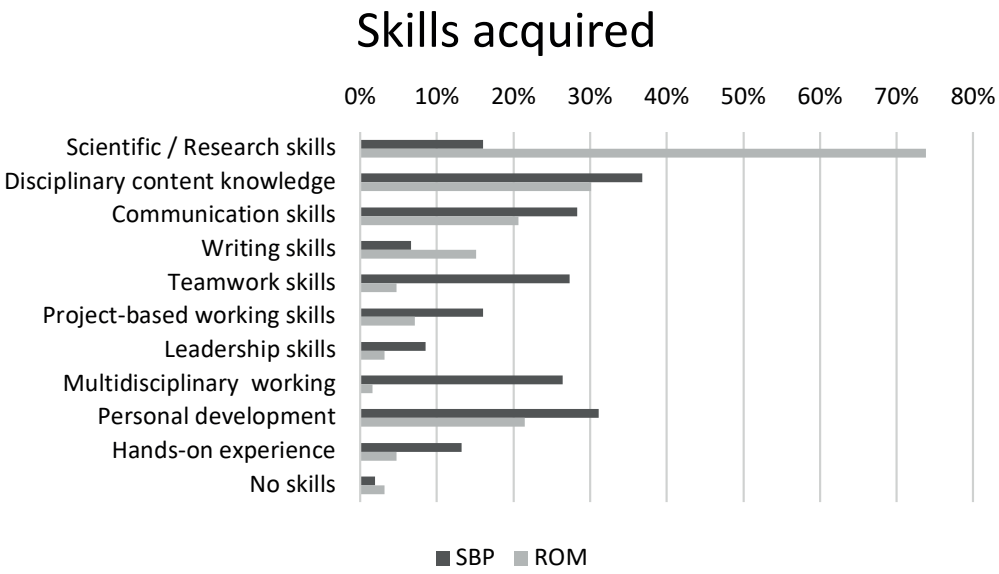


Figure 4. Acquired skills in final master year, open-ended question. SBP group n=106, ROM group n=126.

For the most important skills that participants missed that should have been included in their master's program (Figure 5), **disciplinary knowledge** was most often missed among SBP alumni (33%) and was missed almost equally by ROM alumni (29%). However ROM alumni most often missed **career preparation skills** (45%). A smaller percentage of the SBP alumni missed career preparation skills as well (29%). Other missed skills by both groups were on **communication**. A part of the SBP group also wanted to have acquired more **business skills** (25%).

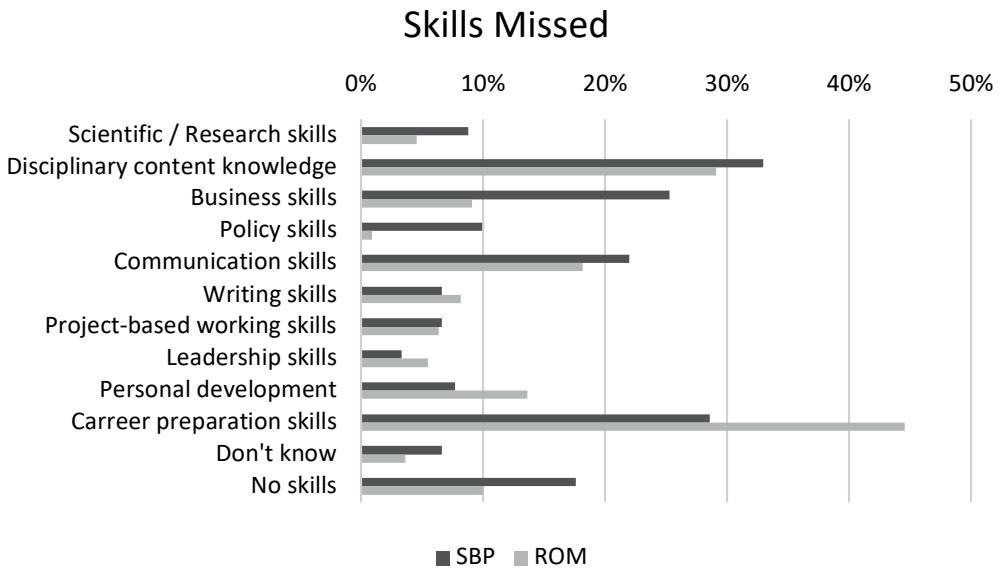


Figure 5. Missed skills after final master year, open-ended question. SBP group n=91, ROM group n=110.

Career preparation

When alumni reflected on career preparation (Table 5), both groups scored well for preparation for an academic career. However, there is a significant difference between SBP alumni and ROM alumni in their perception of being prepared for a career in academia, $F(1,240)=95.43$, $p=.000$, $R^2=.28$. SBP alumni thought that their master's program prepared them less for a career in academia than the ROM group. Conversely, ROM alumni thought that their master's program prepared them less for a career outside academia than SBP alumni $F(1,235)=95.48$, $p=.000$, $R^2=.33$).

Discussion

In this article, we aimed to find an answer from an alumni perspective to the question whether work-based learning (WBL) and research oriented master's (ROM) programs differ with regard to bridging science and society. Being a new educational development we wanted to find out if the work-based learning master's program Science, Business and Policy (SBP) offers sufficient basis for a successful societal science career. To answer this question, web-based surveys were conducted in two groups of alumni who had completed different programs at the same faculty and university, the SBP group (WBL) and the ROM group (research oriented master).

From SBP alumni's perception the WBL-program was considered distinctive, qualitatively good and on sufficient academic level. Participants appreciated SBP and reported that the program prepared the students well for a different career than the classic research program. It is perceived suitable for those who aspire a career outside academia, where experience in the work field is so important.

First, we had to check whether the SBP group is indeed comparable to the ROM group. Both group samples include well over 100 alumni. The response rate was higher in the SBP alumni group, which can be explained by the reminder email this group received. Possibly, SBP alumni felt more directly addressed or involved in improving the SBP program by participation in the survey. Diversity was the overarching theme in the participants' backgrounds. In SBP and ROM we find alumni with different disciplinary background, of different ages and gender. To review a multidisciplinary program, it is advantageous that alumni from various backgrounds have responded. Fortunately, we is found this in both alumni groups, with minimal differences between the groups.

There were however some noticeable differences between the groups in general characteristics. SBP participants graduated on average a bit more than a year earlier than FSE participants. This bias could be explained by the more intensive alumni-university relation of the SBP alumni. This is important information since they have had longer development time, might respond different due to longer involvement or had more difficulty to retrieve details about their education because of the longer time frame (Bradburn, Rips and Shevell 1987). The bias in years since graduation was particularly seen for males, and not for females among SBP alumni. Also, it could be that we are actually measuring a preference difference. Perkmann et al. (2021) suggests that academic engagement (explained as professional interactions between scientists and external organizations) is associated with personal characteristics, for example being male and being senior. Perhaps such engagement increased attractiveness of participating in the survey. Therefore, when interpreting the data, it should be kept in mind that the groups had different characteristics.

To the question whether SBP is perceived distinctive as a study program the answer seems confirmatory. The first argument is the consideration of students to choose for a specific program. Earlier on the diversity theme was already mentioned. Nowadays this goes beyond just choosing a different discipline. Literature shows that academic success is related to the learning style of the student, in which individual characteristics play a unique role (Busato et al. 2000). Learning form, a societal perspective and future ambition are also variables that can play a role in educational preference. This seemed to be visible in the difference between reported the motivation of study choice between both groups. Furthermore in study choice we see that ROM alumni chose the program

more often based on recommendation of others, for the SBP alumni who participated this was only rarely the case. There seems room for improvement with regard to the worth of mouth strategy in promoting the SBP program.

The SBP and ROM groups also differed in their perceived learning outcomes. Compared to the ROM group, SBP alumni reported more development of oral communication skills, ethical thinking, teamwork skills, project-based working skills and leaderships skills. These are all skills that are specifically trained during the SBP program (Grooters, Zaal and Gerkema 2021), but only incidentally in the ROM programs. The SBP group perceived they developed scientific content knowledge and practical research skills less than the ROM group, but in general still sufficient. This finding can be explained by the difference in focus of the study programs, but can also be partly due to an initial difference in the type of student (i.e. students might already prefer a program with a more 'commercial' style, or might already possess more talent for skills that are focused on in the SBP-program). For instance, it has been found that individuals with interest for basic research are less likely to collaborate with the industry (Abreu and Grinevich 2013), whereas individuals who are initially more interested in the applications of research are more likely to engagement with industry (Lawson et al. 2019).

Looking at perceived acquired skills we recognize similar dynamics. In line with the approach of the study programmes, SBP alumni reported more acquired skills in communication, hands on experience, project-based skills, multidisciplinary thinking, teamwork and personal development, where the ROM group mainly reported to have developed scientific or research skills. Furthermore, it is surprising that FSE alumni feel confident about their communication skills, since these are often weak in recent graduates (Geissler 2012). Overall, the outcome of perceived skills match with the SBP alumni's motivation to choose for SBP, a focus on society (i.e. outside academia).

We also investigated whether SBP, as a distinctive program, still was perceived as qualitatively comparable and up to standards on an academic level. Alumni in both groups feel that they have increased their academic skills in their program. For most skills, alumni felt that their program provided sufficient development. Exceptions to this are seen in the ROM group's leadership skills (moderate growth), whereas the SBP group did not score any skills insufficiently. For writing skills and quantitative skills, no differences were found between the two programs. Also, no differences were found for academic reasoning, a skill that is often considered responsible for academic level (Gaast van der, Koender and Post 2019). When the academic level is assessed directly both groups score high, though perceived attainment of a sufficient academic level is slightly stronger in the ROM group.

Besides appreciation for the academic level, the overall level of appreciation of both a classic research (ROM) program and an alternative WBL (SBP) program was highly positive. Alumni saw the program they have followed as a positive addition to the curriculum of educational programs. In line with this they also found that the program should remain available as an optional master's track, the SBP group even more so than the ROM group. Apparently, offering an alternative, more societal program is highly desirable for this group of students.

Focusing on perceived career preparation, we found different trends between programs. SBP alumni felt more prepared for a career outside academia, while ROM alumni felt more prepared for a career within academia. This is also what one could expect considering the programs' targets. It forms an argument to offer different types of education and to prepare for different types of careers. At the same time, career preparation skills were missed mostly by the ROM group, which also indicates the importance for the ROM group. SBP alumni also report missing career preparation skills but to a much smaller extent. In both groups around one third of the alumni wanted more disciplinary content knowledge. Surprisingly about one fourth of the SBP alumni wanted to develop even more business skills then offered within the program.

Overall, the SBP group indicated they would recommend SBP to others and were satisfied with the program. SBP Alumni seem satisfied with a work-based learning program as SBP where they can learn about other things than gaining knowledge and preparing for a PhD. This is also reflected in the literature where academic success is defined broadly by students as 'the accomplishment of the learning process; gaining subject knowledge; and developing employability skills '(Cachia, Lynam and Stock 2018). And especially the latter seems to be a process that differs from individual to individual in how this is achieved optimally.

The potential advantages described in literature (Stephenson and Saxton 2005; Costley and Stephenson 2008) of a WBL-program seem to be represented in the SBP format. Alumni report personal, professional and academic development in combination with practical experience. Hereby one can expect the WBL to contribute to making students employable, to connect academia with the work field and to bring science and society more together. What about the hurdles of WBL? Actual and future problems on organisation, like changing a science curriculum in general, increased online education and organising on a bigger scale are apparently possible to overcome. Based on the self-reports of alumni the critiques on WBL mentioned in literature seemed not to be experienced in the SBP group. The academic level is perceived well and learning outcomes and skills are different but abundant and highly valued. In the case of SBP, the University remains leading in grading and has pre-set learning outcomes and criteria (Grooters, Zaal

and Gerkema 2021). It can hereby control the academic quality. The history of the SBP program proves, by its existence over 20 years, that a science curriculum can be adapted in this way and that WBL can be a major part of a curriculum instead of an voluntary extracurricular task done in the students own time to boost a resume. The organization of WBL asks for a larger engagement of staff, but the development of the SBP program proves that it is feasible, also on a larger scale (Grooters, Zaal and Gerkema 2021).

All together it seems possible to offer science education in an alternative way compared to the classical approach without losing academic quality or decreasing academic level. A practice-oriented approach should have a place in science education and can be implemented in curricula that caters to the distinctive group of science students with interest in society. This would fit perfectly into the values of most academies to be a socially engaged institution (Lee 1998).

For a next step in the evaluation in WBL master programs like SBP, it would also be interesting to investigate how the SBP alumni performed after their graduation and to see whether the effects reported here continue to play a role in their professional live. This would allow to study the impact of WBL education in science on the career perspective. Furthermore, it will also be interesting to extend research (Lester, Bravenboer and Webb 2016) on this matter from the point of view of other actors, for example academic staff and work placement provider/employers. In a follow up of this study the impact of the implementation of WBL on the work floor and the academy itself will be researched.

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Appendix A: Selection procedure

SBP alumni participants were recruited from the SBP alumni subject pool of the Science, Business and Policy database. The SBP program keeps its own alumni database containing only alumni who granted permission to contact them (almost all). All of the SBP alumni from the database got an invitation to join if they graduated before 2019 (n=347). The SBP alumni also received a reminder. The ROM alumni, who followed a 2 year research program, were recruited from the general alumni subject pool of the University of Groningen (SBP students excluded). In total 2,126 invitations were sent to the ROM alumni, that granted permission for contact. They received an invitation once, i.e., no reminder. Programs that do not give access to SBP where excluded from the ROM group, i.e., all engineering programs and technical business administration.

For both groups invitations were send via email. In this email, participants were informed that they were invited for an online study about their perceptions of the master's programme(s) they followed at the FSE of the University of Groningen, that this study was aimed at improving the FSE's knowledge regarding teaching programmes, that it could be used for making evidence-based choices with regard to the FSE's future curriculum and for writing external reports. Participants had to grant informed consent before they could participate in the research. This consent also indicated the anonymisation and integer use of data. Partial completion of the survey was also possible. When finished, participants were thanked for their participation. There was no reward, bonus or compensation system for filling in the survey. Contribution to this research was completely voluntary.

Appendix B: Codebook

The coding procedure was as follows: the code was scored as present (1) or absent (0) in the answer of the alumnus due to the coding justifications. An example is given in Table A-1 for the question 'Acquired Skills ' (what skills did you acquire?). For 'Skills missed' and 'Motivation of study' choices similar justification tables were used. For all open-ended questions multiple answering options per respondent were possible, and therefore coding categories are not mutually exclusive, it is possible that one answer is coded into multiple categories.

Table A-1. Coding justifications 'Acquired Skills'.

Skills Acquired	Justification Code
Scientific / Research skills	Mastering scientific and research skills (within all facets of research). This includes: critical thinking, being able to analyse, logical thinking, but also policy and business analyses (being able to master tools) and lab work. Preparing for academic careers.
Disciplinary content knowledge	Having specific, professional knowledge within various components such as being able to program and perform for example a genetic screening. To be in possession of knowledge in the field of business and policy and to be able to bridge the gap between science and business / policy. To translate scientific knowledge into practice.
Communication skills	Having communication skills for different situations and target groups. The development of presentation and teaching skills. Being able to deal well with people / colleagues / customers by listening and connecting them. Having useful social contacts within and outside the study program. Have a network and can maintain it. To perform the role as (science) advisor. To be able to deal with different cultures. Being able to give feedback.
Writing skills	Conducting reports, writing advisory reports, but also academic writing, creating papers.
Teamwork skills	Working together, collaborating with others, but also less direct formulations are allowed: working with people / others. Finding a place in a group, adaptability, managing teams. Social skills.
Project-based working skills	Being able to work on a project or issue in a team or individually. Working towards a specific goal (with limited resources / time). Being able to provide structure to solving a problem.
Leadership skills	Role of supervisor. Being able to lead employees and / or fellow students and take responsibility in this. Daring to take decisions, making (difficult) decisions and being able to take responsibility for this. The ability to think in solutions and think strategically.
Multidisciplinary thinking / working	To have a broader view than your own discipline and to be able to approach matters from different perspectives and to be able to collaborate with others from different backgrounds or disciplines. Combining scientific knowledge with practice. Switch between science / practice
Personal development	Developments on a personal level, psychological changes, especially the development of soft skills, such as self-reflection, personal growth, being able to work independently, planning, becoming more assertive.
Hands-on experience	Experience in practice and / or practical experience during the internship. Being able to work application-oriented. Having (international) experience and being able to deal with different cultures. Using or applying skills (in practice).
No skills	Alumni indicates that he or she has not acquired any skills during the study.

Appendix C: Pre-test Procedure

Pre-testers were 30 bachelor students following the second year bachelor's course 'Questionnaire and interview design' of the study 'Communication and Information sciences' (from now on CIS) at the University of Groningen. Every CIS-student was instructed to carry out and analyse cognitive interviews based on a first draft of the questionnaire. The CIS-students received interviewer training and relevant literature (e.g., Beatty and Willis 2007; Collins 2003) to prepare them for carrying out the cognitive interviews.

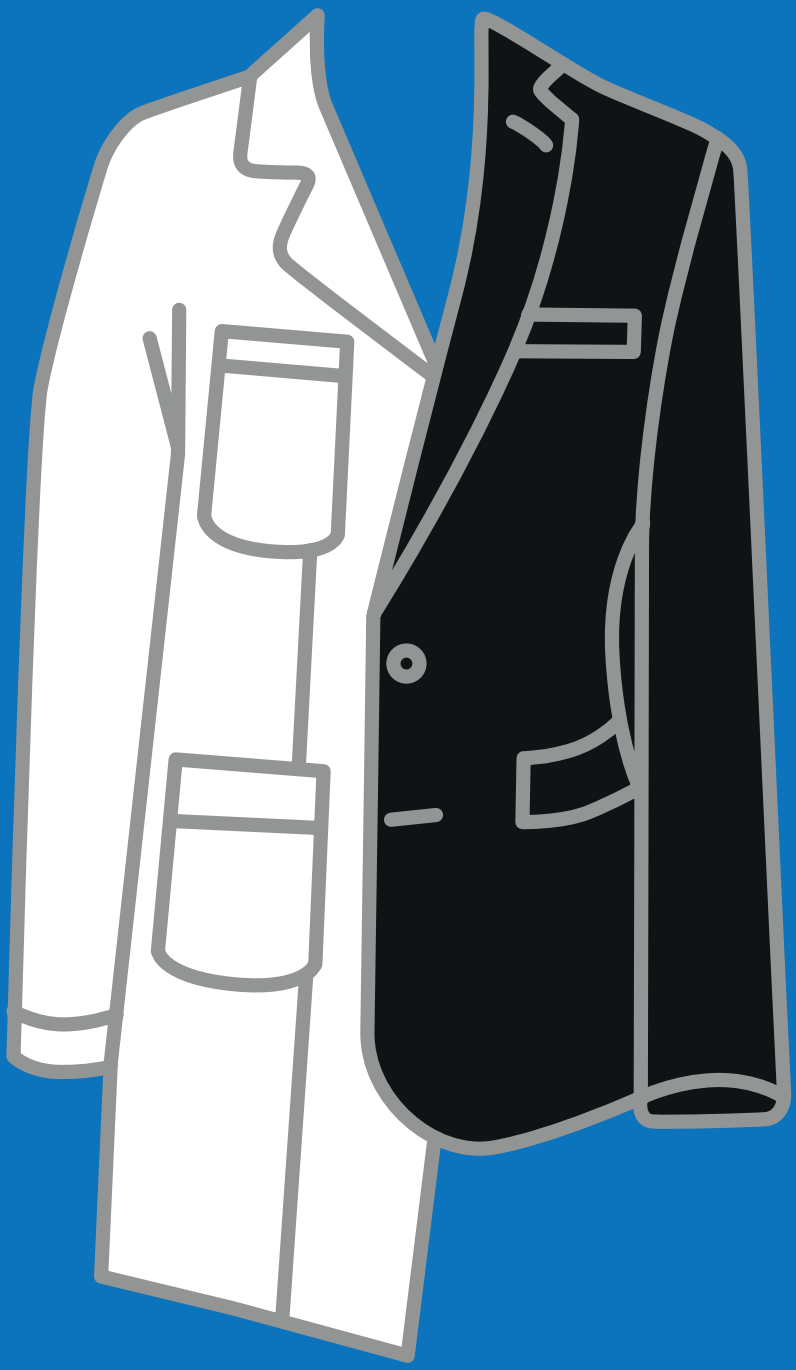
The CIS-students practiced with two methods of cognitive interviewing. First, the think-aloud method, which implies that participants are asked to evaluate a questionnaire by verbalizing all their thoughts during the entire process of filling out the questionnaire (Van den Haak, de Jong & Schellens 2006). Participants are asked in advance to focus on - for instance – comprehension of the question and retrieval of the information. Second, CIS-students practiced the probing method. Probes are questions aimed at retrieving how participants came to their answers. These questions can be asked during filling out the questionnaire, or after completion of the questionnaire (e.g., 'What does the term 'academic skills' mean to you?'). Probes are often predetermined and included in an interview protocol, but can also be spontaneously devised based on the verbal or non-verbal behaviour of the participant. CIS-students were obligated to employ the think-aloud method, but were free in their choice to include the probing method.

Participants were 29 - at the time of the interview - SBP students, 14 - at the time of the interview - master's students of an unrelated master program and 35 master's alumni (from different backgrounds). All participants were between their early twenties and late thirties and around seven out of ten participants were female and three out of ten were male. All CIS-students had to analyse three interviews. In total, 78 cognitive interviews were conducted, on which 90 analyses were carried out (i.e., some students analysed (recordings of) cognitive interviews that were conducted and also analysed by other students, thereby doubling some cases). One cognitive interview was never analysed more than twice.

The choice to carry out cognitive interviews with members of similar populations (e.g., other master's students and master's alumni) and not with actual members of the population of the final study (SBP alumni) was a conscious choice, based on the fact that the SBP population is relatively small, and the whole population is targeted in the actual study (i.e., no sample of the population was drawn).

Participants of the cognitive interviews were informed about the purpose of the study, and instructed and able to practise to think-aloud during filling in the questionnaire. Before the actual study started, all participants had to give explicit consent by filling out a consent form. After about 30 interviews data saturation took place. Still, all input from the pre-test assignment of the CIS-students was used by the (second and third) author of this paper to refine and optimize the questionnaire.

This optimized questionnaire was cognitively tested again by the (second) author of this paper and a student-assistant in a cumulative way: after each cognitive interview the questionnaire was adjusted based on the findings of the prior interviews). In this way, the adjustments that were made could be tested in the next cognitive interview to make sure the adjustments did not result in new cognitive problems or unclarities. The sequence of cognitive interviewing and adjusting the questionnaire was carried out until no cognitive problems or unclarities were found during the cognitive interview. After six of these cumulative cognitive interviews no new cognitive problems arose, and as such, the final questionnaire was constructed together with the other authors of this paper.



4

Do alumni practise what you teach? Impact of Science master-tracks: preparation for academic careers versus preparation for societal-oriented careers

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Abstract

Career development of Science students seems dependent on more than disciplinary education, such as the nature and focus of career preparation. In this study we compare graduate outcomes of science students at the University of Groningen, completing two master-level program streams with different focal points, by using career progress surveys from alumni (n=242) with self-reported societal development data. The first program is a classical research-oriented master (ROM), that aims to prepare students for a career within academia. The second program, called Science, Business and Policy (SBP) focusses on a societal profile and aims to prepare for a career outside academia.

SBP is different from ROM because it has a practical and multidisciplinary orientation (vs a theoretical and mono-disciplinary orientation in ROM) and it includes a long work-placement outside academia, a form of work based learning. The differences in the tracks translate to differences in career paths. Both profiles resulted in good but distinct career opportunities, corresponding to alumni's discipline and sector. Although ROM-alumni felt especially prepared for an academic career, only a quarter actually continued in academia and many we employed in education. In contrast, most SBP-alumni were employed in business or policy. Targeting specific job preparation seems more successful with a societal profile. Reflecting on skills, in both groups research-related skills decreased during careers while soft skills increased. Alumni were generally satisfied with their first job and also with their current job, with SBP-alumni scoring significantly higher on satisfaction with income, status, appreciation and perspective. It can be concluded that diversification in educational profiles changes the societal career paths of science students.

Keywords Science and society, master track impact

Introduction

Today's science students face more diverse career decisions during their studies than a few decades ago (Grooters et al., 2021b). The rather self-evident focus on a research career has been widened towards more societal oriented perspectives, leading to careers in business and policy. The Bologna process (Bologna Working Group, 2004) aimed at coherence in higher education systems across Europe as well as strengthening the quality and societal relevance of academic learning (Keeling, 2006). One of the consequences of the European Bologna Process for Dutch Science master programs has been an extension from a one-year to a two-year master curriculum. In view of the Bologna process, it seems logical for science faculties to broaden their educational scope and focus on more than only how to do research. Otherwise, a career fallout is likely created since there is no room to facilitate all master graduates with a PhD position (Enders, 2004). Inevitably master students will continue in jobs outside academia (Leyman, 2009), where there is a high demand for well-educated and well-skilled personnel (De Grande et al., 2014).

However, preparation for an academic career requires different skills compared to a career outside academia (Enders, 2004). Differentiating between programs thereby goes further than offering more disciplines, it is also about offering programs fine-tuned to different career perspectives including work based learning approaches (Grooters et al., 2021a). Consequently, three different science master profiles (all International Standard Classification of Education (ISCED) level 7) were introduced at the university of Groningen, the Netherlands, after the introduction of Bologna in 2002 with a research, an educational and a societal orientation. Whereas the interest of students for a societal orientation has increased over the years (Grooters et al., 2021a), an evaluation of how effective this policy aimed at a better alignment of higher education and societal demands, has been suggested (Integrating Entrepreneurship and Work Experience into Higher Education ((Integrating Entrepreneurship and Work Experience into Higher Education (WEXHE), 2019) but hardly undertaken.

This paper will compare the retrospective view on career perspectives of science master alumni from two different profiles within the University of Groningen. Alumni from a research-oriented master (ROM) program, and a societal profile, the science, business and policy (SBP) program, were surveyed on career and societal development and skills obtained during and after graduation. The ROM-profile corresponds to a classical research master's program, from which a comparable program is available at every science university. Currently this is the regular education form of science masters and the common way to prepare students for an academic career around the world. However, very few graduates will go on to be academics and often Universities offer some kind of alternative program to prepare students for a career outside academia (Enders, 2004). In

Groningen a very outspoken example of this alternative is the SBP-profile, that is aimed at applying scientific knowledge to business and policy cases in order to solve societal challenges. By exploring the differences between SBP and ROM, a broader translation to other educational settings or regions can be made. The results of this paper will therefore be of interest for science policy makers, educational staff and potentially future students of research-, and societal- master profiles.

Societal education profile: the position of students

A relatively high social engagement among people entering higher education (Egerton, 2002) is found, which implies a purported desire to tackle social problems within their degrees. This is in line with what we found in our own previous study in Groningen, where an important factor to choose a science degree program turned out to be the potential for those degrees to offer opportunities for disciplinary learning from a societal perspective and with direct societal relevance (Grooters et al., 2021a). Learning the right skills is important in terms of (future) job satisfaction, and a match of skills can be a good predictor for higher wages to be expected (Allen & van der Velden, 2001; De Santis, 2021). However, students often do not know which skills are required and are thus not sufficiently prepared for the non-academic labour market (Leyman, 2009). For instance, among doctoral candidates there seems to be an underestimation of the importance of transferable skills like project management and business skills (De Grande et al., 2014). There seem to be a remarkable lack of awareness of the mismatch in skills among students (Usher, 2002). For master students it is also important to make a well-timed decision for a career outside academia, since over-qualification in general, with for example a PhD, can result in negative outcomes on the labour market (Mavromaras et al., 2013). It is found that the industry prefers experienced and broadly oriented master students over doctorate holders, especially in smaller companies (Borrell-Damian et al., 2010).

More in general, policy institutions and the industry have a different appreciation of research skills compared to academia (Borrell-Damian et al., 2010). Besides research skills, governmental agencies and companies expect soft skills, like leadership skills. A combination of these skills can influence the future career perspective of the individual student, for instance by supporting knowledge validation in general (De Grande et al., 2014). Master students can play a big role in university-industry collaboration (Santos et al., 2020) and can help companies with the application of scientific knowledge, as recently also shown by de Wit-de Vries et al. (2019).

In the past, the main tasks of universities were focussed on conducting research and providing education on research. Recently, cooperation with companies and other

societal partners as well as valorisation, integrating social awareness and responsibility into broader university operations, and also into curriculum have become important additions. The University of Groningen added 'the use of knowledge' as the third pillar of its mission (University of Groningen Strategic Plan, 2015-2020) besides education and research, indicating its appreciation of transferring academic knowledge to society and direct application of knowledge. This approach fits an increasing trend of community engagement of universities (Chile & Black, 2015). Corporate social responsibility is becoming more important for universities (Ali et al., 2021) like most organizations. It seems to contribute not only to a positive brand but also to positive outcomes for individual students (Chile & Black, 2015). However, shifting towards a broader role and creating a social pact between academic science and society (Gimenez & Bonacelli, 2021) can be challenging to universities (Göransson et al., 2009).

The social responsibility of universities has, in a curious way, focused mainly on entrepreneurship. Academic transition towards entrepreneurship has been encouraged by governments now for two decades (as already described by Etzkowitz et al., 2000) and an explicit societal role has been stimulated simultaneously, as exemplified by the society profile in the Bologna papers (Bologna Working Group, 2004). Recent European policy initiatives comprise projects on work-based learning and entrepreneurship (Integrating Entrepreneurship and Work Experience into Higher Education (WEXHE), 2019), aimed on cooperation with small-medium enterprises, (Enhancing Staff Research and Innovation Capacity in Professional Higher Education (RECAPHE), 2021) and employability (International Teaching & Learning for Employability and Citizenship (INTELEC), 2018). All of these projects stimulate universities to pay attention to broad competences and skills of students by gaining onsite experience.

Universities often do offer programs to promote entrepreneurial skills of students (Etzkowitz et al., 2000). One can raise doubts on how effective these programs are, as these programs tend to focus too much on the economical side of running an own business. (Siegel& Wright, 2015). The translation of social responsibility of universities in only entrepreneurship seems too narrow. For academics, entrepreneurial engagement might be more feasible within policy and business institutions, in other words in an intrapreneurial context (Blanka, 2019) rather than in the role of the independent entrepreneur. Thereby stimulation of different transferable and career management skills, besides strict scientific skills, can be considered as social responsibility of universities. (Olesen et al., 2020). Still, transferable skills are often described in policy recommendations for universities as important values (European University Association, 2007), but are often absent in practise (Enders, 2004).

Societal program in practice: Science Masters in Groningen

Inspired by the Bologna process, the Faculty of Science and Engineering (FSE) of the University of Groningen asks master students to select both a scientific discipline (for example chemistry or biology) and a type of profile to adjust to their future career plans. So, a student not only has to pay attention to what to study, but also to how their choices influence their employment after graduation (Grooters et al., 2021b). The three types of profiles mentioned before that are available as two-year master programs are laid out here:

1. A research-oriented master program (from now on ROM), in which students spend both years of their master on research courses and carrying out large research projects (at least two master theses), colloquia and learning to write scientific articles. Students are trained to become a researcher. The employment perspective is one within academia, ideally continued in a PhD.
2. The Science, Business and Policy program (from now on SBP), that shares an identical first year with the ROM (i.e., research courses, thesis and colloquium). In the second year, business and policy courses based on work-based learning, and a long work-placement (experience on the work floor) are offered. By pursuing this option, the students can build their societal profile and are trained to become a science advisor and use scientific knowledge to solve problems in society. The matching careers are typically outside academia, as an intrapreneur in a company or a (non-) governmental organisation.
3. A communication and education program, with an identical first-year program and training on education and pedagogy or journalism in the second year. This program prepares students for careers as (high-school) teachers or for a job in science communication.

In this paper, we will focus on SBP and ROM only as we will evaluate the effectiveness of a differentiation between a research and societal profile, that leads to the main research question of this article, which is whether a track aimed at preparation for an academic career really leads to other career paths as a track that aims to prepare for a career outside academia. A comprehensive survey among SBP, and ROM-alumni was conducted on their career path after graduation.

Previously we reported on assessments in the same cohorts of alumni to investigate motivation for their master programs, self-perceived learning outcomes and skills, as well perceived preparation for a career within or outside academia (Grooters et al., 2021b).

This study showed that alumni of both SBP-, and ROM-programs felt well prepared for their career, although each for a different career. For a career outside academia, the SBP-alumni felt significantly better prepared and for a career within academia, the ROM-alumni felt significantly more prepared. But the question that remains is how this appreciation translates in their actual career. The current article therefore compares the reflections of ROM and SBP-alumni both right after graduation and the state of their current career. We will relate the outcomes to the employment expectation of the university's master profiles. Specific questions touch on aspects of employment (initial employment search time, initial and later employment sectors), on the development of skills during the career and on the satisfaction with the career development (e.g., income, status, appreciation, career perspectives). The final balance has to be made up whether the investments needed for the development of a specific societal and research profile (Grooters et al., 2021a) pays off, at least in view of the appreciation and wishes of (former) students.

Materials and Methods

The ethical committee of the University of Groningen approved the approach of alumni to participate in a web-based questionnaire (CETO submission number 63104880). The web-based survey contained two main parts, one on evaluation of the study program (Grooters et al., 2021b) and one on career progression (current article).

Participants

A total of 242 Faculty of Science and Engineering (FSE) alumni of the University of Groningen participated in the study, with 111 SBP-alumni and 131 ROM-alumni. In total, 2473 FSE alumni who graduated between the academic years 2001/2002 and 2017/2018 were approached. The response rate was higher in the SBP-alumni group (32.0%) than in the ROM-alumni group (6.2%). There are at least two possible explanations of the higher response rate among the SBP-alumni approached. First, SBP-alumni were approached by staff of the SBP organization, which former students may have perceived as more direct and personal than communications from the general alumni organization of the University of Groningen. As such, SBP-alumni may have had a greater tendency to participate in the survey. In addition, SBP-alumni received a reminder email that contained a second invitation to participate in the survey, whereas ROM-alumni did not receive a reminder. A total of 34.2% of all SBP respondents (n = 38) participated after the reminder email, making it likely that ROM responses would also have increased if they received a reminder to participate.

Table 1: Age and Years Since Graduation of Study Participants, per Gender/Program (modified after Grooters et al. 2021)

	Age in years			Years since graduation		
	N	Mean	SD	N	Mean	SD
SBP	111	31.13	5.48	111	7.21	4.59
Male	61	32.15	5.78	61	7.67	4.48
Female	50	29.88	4.86	50	6.64	4.70
ROM	131	29.84	3.60	130	5.95	3.37
Male	64	29.61	3.79	64	5.38	3.24
Female	62	29.09	3.27	61	6.43	3.39
Other	4	31.80	5.07	4	7.00	4.40

Table 1 shows descriptive demographic information for all participants, and for the SBP and ROM-participants separately. In the SBP-group, male participants were significantly older than female participants ($F_{1,109}$) = 4.87, p = .029). No other age differences between or within groups were found.

On average, alumni graduated 6.5 years before survey participation. ROM respondents participated 1.36 years significantly closer to their graduation than SBP respondents ($F_{1,239}$) = 94.06, p = .016). Hence, a slightly different timespan in career development is reported by ROM and SBP-participants. This may have caused differences in how they retrieved details about their first job (Bradburn et al., 1987) and current income and it needs to be taken into account while interpreting the results.

The disciplinary background of the students were comparable in both groups, and covered a wide range of disciplines. Biology was the most presented discipline for both SBP, and ROM-alumni, followed by Biomedical Sciences or Medical Pharmaceutical sciences (for further description see Grooters et al., 2021b).

In both groups there were participants who finished a PhD or postdoc after their master's program. There were more finished PhD and postdoc tracks in the ROM-group than the SBP-group. In addition, there were participants in both groups who were at the time of filling out the surveys still involved in a PhD or postdoc. These numbers were higher in the ROM-group compared to the SBP-group. Here, we perceive starting a PhD-track after one's master's program as the start of one's professional career, and not as an extension of one's educational program.

Questionnaire

The questionnaire contained standardized items as well as items designed by the authors of this paper. Questionnaire design recommendations were used (cf. Dijkstra et al., 2014) in constructing the questionnaire. In addition, the questionnaire was extensively pre-tested by means of cognitive interviewing (Beatty & Willis, 2007; Collins, 2003). First, thirty bachelor students carried out two or more cognitive interviews as part of a course on questionnaire design. Based on reports of these cognitive interviews, the questionnaire was revised. This improved version was pre-tested by means of cognitive interviewing again by one of the authors of this paper and a student-assistant. Problematic questions were altered or omitted from the questionnaire. Lastly, the final questionnaire was extensively discussed by all authors of this paper and finalized. More details and protocols are described in Grooters et al. (2021b).

The questionnaire used for this paper consisted of five different elements. First, demographic questions were included in the questionnaire (e.g., age, gender, academic background, graduation year). Second, questions were asked on the time participants needed to search for a job after graduation (employment search time), whether their first employment after graduation was their current employment, hours per week working in their first and/or current employment, and the sector of their first and/or current employment (business, policy, education, research or another sector).

Third, in order to measure perceived learning skills gained right after graduation and currently, we derived items from the Science Student Skills inventory, a tool specifically developed to measure science student's learning outcomes (Matthews & Hodgson, 2012). We used all six items from the SSSI: Scientific content knowledge in your field(s) of study, Communication skills (i.e., scientific presentations), Writing skills (i.e., scientific writing), Quantitative skills (i.e., mathematical & statistical reasoning), Teamwork skills (i.e. working with others to accomplish a shared task), and Ethical thinking (i.e. ethical responsibilities and approaches). In addition, we added items based on the learning outcomes of the SBP program that were not included in the SSSI: Practical research skills (i.e., lab work and modelling), Academic reasoning (i.e., analytical and critical thinking), Project-based working skills (to achieve a certain goal with limited resources), and Leadership skills (i.e., guiding & managing a team). Participants had to rate on a five-point scale their development on SSSI and SBP learning outcomes items based on skills they felt they had developed during their entire master's degree, and during their professional life until know (1= negative, and 5=positive about their development).

Fourth, we included items to measure participants' career satisfaction for their current and/or first employment and career perspective for the future. Participants had to give a grade (between 1=very bad and 10= very good) with regard to their general satisfaction,

income, everyday work activities, status, function, recognition received professional network and career perspective. Lastly, a question on participants income for first and/or current employment was included in the questionnaire. Participants were able to enter a rounded number for one of the four following options: 1) Gross income (before taxes), monthly; 2) Net income (after taxes), monthly; 3) Gross income (before taxes), annually; 4) Net income (after taxes), annually.

Since the income question included multiple options for filling in a salary, steps have been taken for calculating the income. First, the salaries were all converted to a 40-hour work week. For the conversion from gross to net, the gross monthly amount has been used and is deducted by the known taxes in the Netherlands, in this case a fixed tax for unemployment according to the guidelines of the tax authorities (Redactie Salaris rendement, 2019), followed by income tax (Belastingdienst, 2021). The final step was to calculate the general tax credit (Belastingdienst, 2020a) and the labour tax credit (Belastingdienst, 2020b). When salary was filled in per year, we took into account 8% holiday pay set by the Dutch government (Rijksoverheid, 2021).

Data collection, procedure and analysis

We used survey software Qualtrics for data collection. We asked respondents for informed consent before participation. If participants agreed to participate in the survey, they first were posed demographic questions. Then they evaluated items from the SSSI and added learning goals. Current employment questions were asked after this in the following sequence: employment search time, sector, working hours, income, job satisfaction and career perspective. If the current employment was not the first employment, participants received the same questions in the same order for their first employment. The program SPSS was used to carry out statistical analyses. These analyses were parametric (ANOVA's) or non-parametric (Welch & Brown-Forsythe test) depending on whether assumptions were met (e.g., equality of variances, normality).

Results

Start of career

When we look at how quickly FSE students found a job (Figure 1), about half of the former students already had a job before or at graduation. For the SBP-group this is even slightly more. The initial difference in cumulative percentages between SBP and ROM (23% vs 16%) disappeared immediately after graduation (52% vs 50%). Almost 90% of the alumni from both groups had a job within six months. After one year, 3% of SBP-alumni were still without a job, compared to 8% of the ROM-alumni.

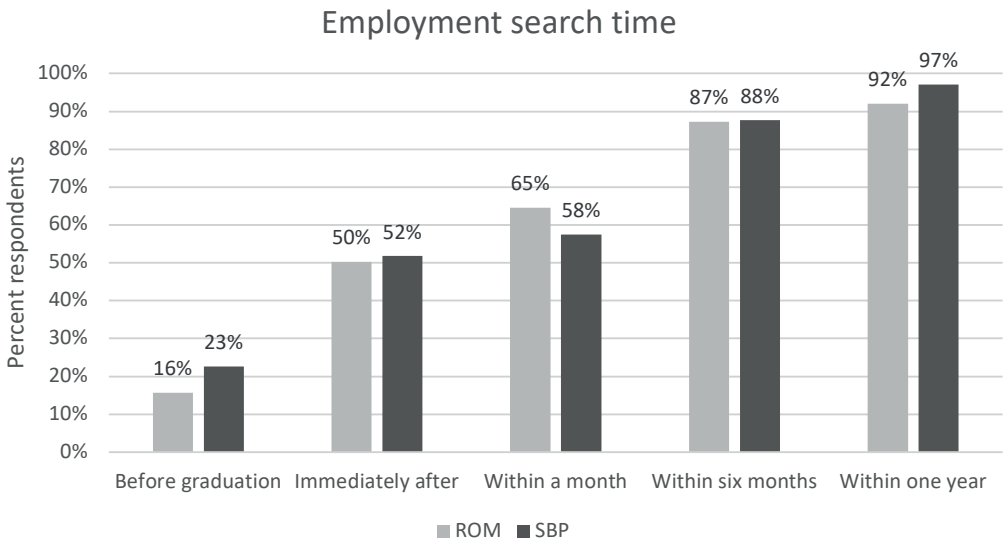


Figure 1. Self-reported Employment Search Time After Graduation from the ROM (n = 127) and SBP (n = 106) programs

There were several ways in which alumni obtained their first job, via: application, personal network or mediator such as talent scouts or employment agencies. Remarkably, 31% of the SBP-alumni got a job offer at their work-placement (and of those 78% accepts this offer). Most alumni started with an (almost) fulltime job, with an average of 35.6 hours a week for the SBP-alumni and 37.4 for the ROM-alumni (in the Netherlands a full-time job is 35 or more hours per week (Centraal Bureau voor de statistiek (CBS), 2021)). Almost all participants worked for an employer in their first job. For the SBP-alumni, this concerns 97% and for the ROM-alumni 100%. When progressing in their career the percentage of entrepreneurs or self-employed persons rises slightly, within the SBP-group from 3% to 6%, and within the ROM-group from 0% to 1%.

Career development

The majority of the participants switched jobs after their first employment, either continuing in different positions or working for different employers. From the SBP-alumni 43% was still in their first employment at the time the survey was held. For the ROM-participants, this was 39%. Ways in which participants obtained their current job were again based on applications, network or mediators. In their current position, alumni that switched jobs were again on average working full time, with 37.0 hours per week for the SBP-alumni and 37.5 hours per week for the ROM-alumni.

Acquiring a first employment in Business or Policy was more common for SBP-alumni than ROM-alumni, and this trend was even more pronounced in self-reported current employment. By contrast, ROM-alumni first employment was most often in research or education. In the current job, working in research decreased in both groups with an increase in educational jobs for ROM-alumni specifically. In the ROM-alumni the category other jobs is relatively large compared to SBP-alumni. Further exploration showed that employments in healthcare accounted for 18% of the 23% in the category other for first job, and for 12% of the 16% for current job.

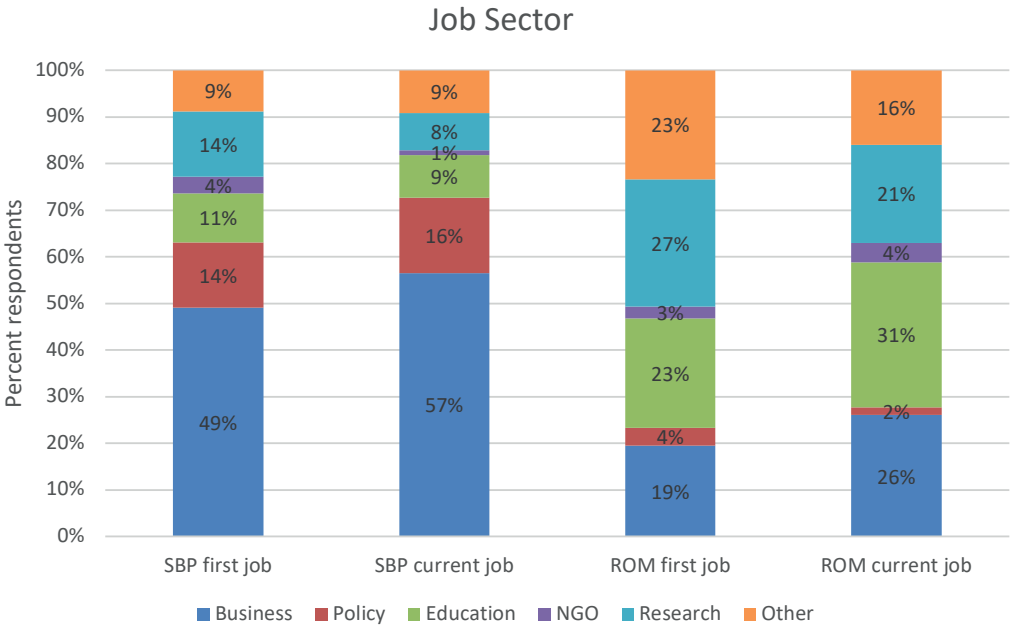
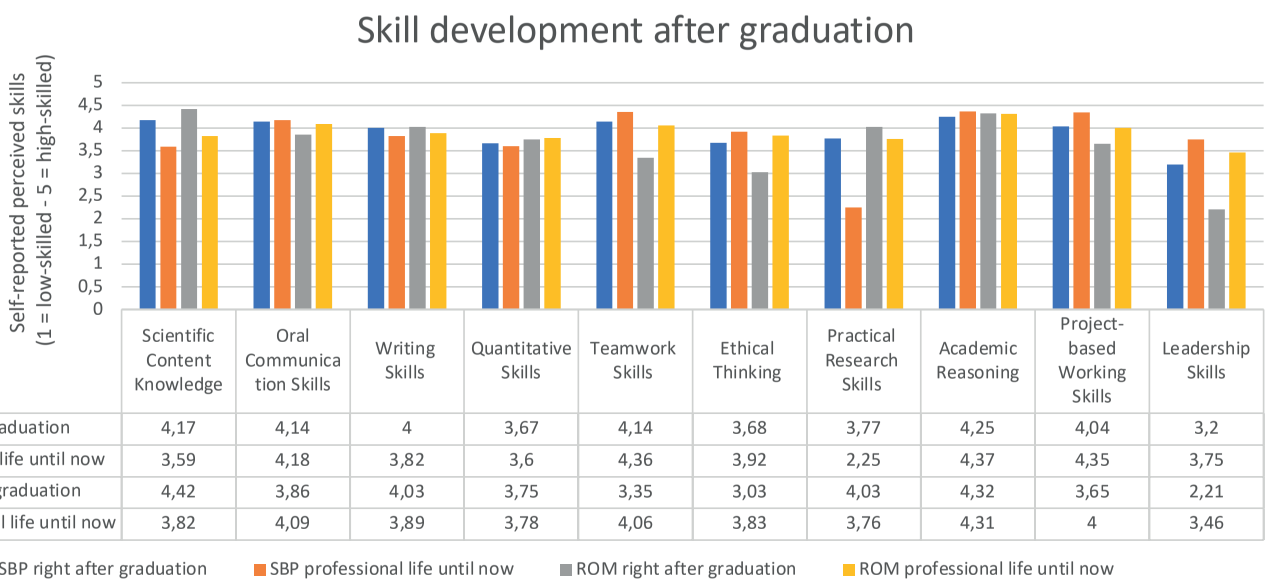


Figure 2. Self-reported Job Sector Employed in Immediately After Graduation and Current Employment for SBP Alumni (n = 57 & 99) and ROM Alumni (n = 77 & 127).

Alumni usually acquired employment that corresponded with the science discipline of their bachelor or master. For current employment, this difference increased in opposite directions for SBP-, and ROM-alumni. For SBP-alumni, working in a matching discipline dropped slightly from 67% to 63% whereas for the ROM-alumni a small increase from 81% to 84% can be observed. It should be noted that from the ROM-alumni only 27% continued within research in the first employment and this percentage drops to 21% in their current employment. These percentages are lower in the SBP-group but almost halved from 14 to 8%.



Significance	SCK	CS	WS	QS	TS	ET	PRS	AR	PWS	LS
Repeated Measure: Within Group	***	*	*	no	***	***	***	no	***	***
Interaction effect	no	no	no	no	***	***	no	no	no	***
Current Difference ROM & SBP	*	no	no	no	***	no	***	no	***	***

Figure 3. Alumni's Self-reported Perceived Skills Immediately After Graduation and Professional Life Until Now, on a 5-point Likert-scale (1 = low-skilled – 5 = high-skilled), with SBP-group n = 109-111, and ROM-group n = 129-131. With Significance at *** p <.001 ** p <.01, and * p <.05.

We compared the perceived level of skills right after graduation with the perceived level of skills in SBP- and ROM-alumni's current profession (Figure 3). A Repeated Measures ANOVA was performed with between-group factor participant group (SBP/ROM) and within-group factor the perceived level of skills (skills right after graduation/current skills). In addition, we carried out a MANOVA to investigate the potential differences in the level of perceived skills in the current employment between the SBP, and ROM-group.

First, we investigated the SSSI skills. Perceived Scientific content knowledge has decreased significantly for both groups ($F_{1,239}$) = 93.28, p <.001. The current level was considered acceptable by both groups (i.e., the means are above the mid-point of the scale), with the ROM-group rating their current scientific content knowledge in their field of study higher than SBP-alumni, ($F_{1,235}$) = 6.06, p =0.015. Robust tests of equality of means (Welch & Brown-Forsythe test) confirm that there were significant differences despite inequality in homogeneity of variances (1,217.1) = 5.69, p = .018. For Oral communication skills we found a small but significant improvement ($F_{1,239}$) = 4.31, p = .039 for both groups. In current perceived oral skills there were no differences between groups. For Writing skills we detected a significant improvement ($F_{1,239}$) = 6.29, p = .013 for both groups. In current perceived writing skills we did not find differences between groups. Quantitative skills seemed to have remained stable and did not differ between groups in the current employment. Teamwork skills improved significantly ($F_{1,239}$) = 54.53, p <.001, with an interaction effect ($F_{1,239}$) = 15.31, p <.001 showing that the improvement in teamwork skills was only significant for the ROM-group. For current teamwork skills, SBP-alumni perceived these to be higher compared to ROM-alumni ($F_{1,235}$) = 12.75, p <.001. Ethical thinking also improved significantly ($F_{1,239}$) = 62.91, p <.001, with an interaction effect ($F_{1,239}$) = 16.12, p <.001 where perceived improvement was again only significant for the ROM-group. We found no differences between groups for their perceived ethical thinking skills in the current employment.

Second, skills based on learning outcomes of the SBP program were investigated for both groups. Strikingly, perceived Practical research skills decreased significantly in both groups ($F_{1,239}$) = 30.00, p <.001. Current perceived practical research skills were significantly higher in the ROM-group compared to the SBP-group ($F_{1,235}$) = 17.75, p <.001. Robust tests of equality of means (Welch & Brown-Forsythetest) confirm that there were significant differences despite of inequality in homogeneity of variances (1,215.89) = 17.31, p <.001. We did not find any differences for perceived Academic Reasoning skills. Perceived Project-based working skills increased significantly for both groups ($F_{1,239}$)= 28.14, p =0.000. SBP-participants rated their current project-based working skills significantly higher than the ROM-participants ($F_{1,235}$) = 15.46, p <.001. Leadership skills improved significantly ($F_{1,239}$) = 151.48, p <.001, with an interaction effect, ($F_{1,239}$) = 22.57, p <.001, showing that the improvement in perceived leadership skills was only significant

for the ROM-group. SBP-participants perceived their current leadership skills higher than ROM-participants ($F_{1,235}$) = 7.46, p <.001. Robust tests of equality of means (Welch & Brown-Forsythe test) confirm that there were significant differences despite of inequality in homogeneity of variances (1,238.24) = 6.86, p = .009.

Career satisfaction

Job satisfaction was graded with 1 (lowest possible) to 10 (highest possible) on several aspects. Participants gave an overall grade, and graded income, daily activities, status, function, appreciation and professional network separately (Figure 4). A repeated measures ANOVA was carried out with participant group (SBP/ROM) as between-participant factor and job satisfaction (first employment/ current employment) as within-participant factor. For all job satisfaction items, the grade for current employment was higher than for the first employment with no interaction effect for participant group (p <.002 for all items). Subsequently a MANOVA was carried out to investigate differences between the SBP and ROM-participants on job satisfaction with regard to first employment. No significant differences were found.

For current job satisfaction, again a MANOVA was carried out. Box's test of equality of covariance matrices is significant (p <.001). Therefore, all items were checked separately



	General Grade	My income	My everyday work activities	My status	My function	The recognition I receive	My profes-sional network
Job satisfaction first job SBP	7.36	6.8	6.93	6.93	7.11	6.86	6.91
Job satisfaction first job ROM	7.38	6.75	7.38	6.77	7.15	6.73	6.86
Job satisfaction current job SBP	8.05	7.75 **	7.78	7.85 *	8.03	7.79 *	7.68
Job satisfaction current job ROM	7.94	7.39 **	7.78	7.43 *	7.8	7.28 *	7.33

Figure 4: Means of SBP and ROM Alumni's Graded (1-10) Job Satisfaction with an Overall Grade, and Grades on Income, Everyday Work Activities, Status, Function, Recognition Received and Professional Network. * = significant at p <.05, ** = marginally significant at p <.10.

for Levene's test and visually checked for equality in variances. None of Levene's tests were significant, implicating equality in variances. The groups did not differ significantly from each other in their overall grade. Both alumni groups were also equally satisfied about their current function, their everyday work activities and professional network. With regard to current status, SBP-alumni were significantly more satisfied than ROM-alumni, ($F_{1,201}$) = 5.06, p = .026. SBP-alumni also perceived received recognition at work higher, ($F_{1,201}$) = 13.73, p = .010. In addition, SBP-alumni were more satisfied with their income compared to ROM-alumni, reaching a marginally significant difference ($F_{1,201}$) = 3.00, p = .085.

Income

Table 3 shows means and standard deviations with regard to participants' first employment income and current employment income after controlling for outliers (displayed for participant group and gender separately). Because SBP-participants graduated 1.26 year earlier than FSE participants on average, the relation between years graduated and income was explored for the groups.

Univariate analyses of variance were carried out with academic year graduated and participant group as independent variables and current income as dependent variable. There were no differences between the SBP, and ROM-participants, or academic year graduated with regard to the income of the first employment. For current income, the ANOVA showed main effects for participant group ($F_{1,180}$) = 7.06, p = .007, and year graduated ($F_{1,180}$) = 13.94, p <.001, and an interaction effect ($F_{1,180}$) = 3.06, p = .001. While it seemed that SBP-participants received a significantly higher income than ROM-participants, more data is necessary because there are no clear trends in income received when we zoom in on the main effect of year graduated or the interaction effect. That is, it was not the case that the longer participants were graduated, the higher the income, or that SBP received significantly more income than ROM-participants within all specific graduation years. In addition, no gender effect was found for first and current income.

Table 3: Self-reported Income in Euros Net Per Month of SBP and ROM Alumni, Based on Fulltime (40h) Work Week

	First employment			Current employment		
	N	M	SD	N	M	SD
SBP	44	1996,86	411,45	74	2923,40	1080,28
ROM	57	2001,39	384,76	101	2638,77	664,53
Male	51	2006,06	424,68	97	2850,03	993,62
Female	48	1991,16	367,50	81	2648,22	695,15

Career perspective

Alumni were asked to reflect on how satisfied they were with their future career perspectives (Table 4). SBP-alumni were marginally significant more satisfied with career perspective compared to ROM-alumni ($F_{1,201}$) = 3.74, p = .055. To the question whether alumni want to keep working in their current position 57 % of the SBP-alumni answered with Yes, 14 % with No, and 29 % with maybe or I don't know. From the ROM-alumni a similar percentage answered with Yes, 58%, 22% said No, and 21 % was still in doubt.

Table 4: Perceived Satisfaction with Future Career Perspective for SBP and ROM Alumni, Graded from 1-10

Career perspective	N	Min	Max	M	SD
SBP	98	3.40	10.00	8.12	1.36
ROM	119	1.80	10.00	7.79	1.51

Discussion

The impact of a societally oriented master profile and a research-oriented master profile on the career development of science students is examined in this paper. Does the profile of science master education matter, with more or less emphasis on soft skills and on research skills respectively, for the first steps in a career? We examined a classical research-oriented master (ROM) program and a program that has a societal-profile, the Science Business and Policy program (SBP). Alumni from both programs filled in a web-based survey regarding their perceptions on career progress, and thereby societal development. Do alumni really practice what you teach?

The first important conclusion is that both groups have good and fast career prospects, since alumni find a job quickly and are generally satisfied with their job. The alumni scored their satisfaction within their current job as higher than within their first job in terms of satisfaction, which indicates a positive development. General impression, position, work activities, professional network and career until now all improve with no difference between the groups. Income, status and the appreciation and career perspective also score well for both groups, but SBP-participants give here significantly higher grades than the ROM-participants. In the actual income we see no clear difference between groups. This corresponds to previous research of Borooah (2009), in which is found that for job satisfaction, income is not the most important factor but internal aspects of a job, like responsibility, doing something useful and having a nice social environment seem to be most important. SBP students often have a kickstart in their career in the form of a job-offer at their work placement. Combined with the career satisfaction of the

SBP-alumni, a societal focussed education program therefore certainly does not seem to reduce opportunities on the labour market.

The nature of the jobs is similar for both groups in terms of fulltime working hours and working for an employer. Entrepreneurship is rare to non-existent in both groups but training students as intrapreneur seems to fit their actual career path, since the majority continues in a job in a company or organisation. The results of this study are in line with Blanka (2009) that focussing on intrapreneurial skills is needed for better career preparation. This also seems like a better way for universities to take responsibility for knowledge validation compared to investing in entrepreneurial skills like universities did often in the last decades (Etzkowitz et al., 2000).

When profiles are translated into career paths, SBP-graduates felt more prepared for a career outside academia (Grooters et al., 2021a). This seems to be reflected in employment, where the majority (63%) finds a starting job in business and policy, and an even larger percentage (73%) had a job in a company or (non)governmental organisation in their following career. The ROM-alumni on the other hand felt especially prepared for a career within academia. This does not seem to give any guarantees as only 27% start a career in research after graduation and this percentage lowers (21%) when progressing into further jobs. This finding matches the idea that it is simply not possible to facilitate all master graduates with a PhD (Enders, 2004; Gemme & Gingras, 2012;) and after the PhD changes on pursuing an academic career are even smaller (Waaijer, 2017). The percentage of ROM-alumni that work in education is quite high and increases in the current job. This is remarkable since a specific profile for teaching is also provided. The results suggest that targeting specific preparation for a job is more successful when there is a focus on societal careers than on research careers. A consideration that alumni practise what you teach seems to be true for the SBP-alumni but less for the ROM-alumni. Thus, SBP-alumni have a more optimal fit between their profile and their career. This is perhaps also confirmed by the finding that the percentage of SBP-alumni that were still in their first job is higher than in the ROM-group (even though the ROM-group graduated more recently on average, which even strengthens this effect).

An improvement in such a fit seems also desirable for other profiles. It would be fair to prepare students for the potential fall out of their career perspective. In case of a ROM program this means informing ROM students they have a high chance to enter a career in education. This is even more relevant since there is a special master profile for education. More in general, it should be clear it is an intrinsic property of academic programs to prepare students for different career routes, since academic education is used as preparation for many different work fields. This is actually seen in the careers of the alumni, since there are still SBP-alumni that continue in academia (doing PhDs for

example) and ROM-alumni that work in Business or Policy. Thus, there is no exclusion of a certain sector by study choice, reflecting flexibility and all-roundness of both study programs. As a suggestion for further research, it would be interesting to pull in evidence from other generalist vs specialist program graduate outcomes to compare, and to discuss the concept of the importance of both broad skills development across master's programs and communicating possible career pathways to students.

Concerning skills needed for the career paths, both profiles seem to differ in how skills change over time according to alumni. ROM-alumni perceive research skills like Scientific content knowledge and practical research skills to be higher than SBP-alumni in their current employment. At the same time, these perceived skills decreased in both groups compared to right after their graduation. Perceived academic writing skills also decreased in both groups, with no differences in current perceived writing skills. This is remarkable because one could expect people with an academic education to improve on these types of skills if they continue in a professional career on an academic level. This might suggest alumni are at their top right after graduation in terms of the former mentioned skills regardless of their profile. It could be that these skills are perceived to 'rust' if one does not use these skills in professional life. Looking at the remarkably negative postgraduate skill development it seems a necessary and logical demand for universities to start and offer specific research skill training for those who continue in academia or want to keep up their research skills (for example offering refresher courses rewarded in micro-credentials (Andersen et al., 2021). Another explanation could be that these skills not actually worsened, but one's perceptions about having these skills were higher right after graduation compared to their current perception. Or in other words, alumni potentially needed to keep practicing these skills in order to feel they were on top of them. Additionally, their perception of what constitutes a 'research skill' may differ from what they are actually executing in their roles. Both options are interesting points for further investigation.

In the dynamics of soft skills, we found that that ROM-participants perceived to have significantly improved their ethical thinking, teamwork and leadership skills from graduation on, but that SBP-participants still perceive their current teamwork and leadership skills to be higher compared to the ROM-group. Both the ROM-group and the SBP-group perceive to have improved on Oral communication skills and Project-based working skills, with again the SBP-group perceiving their project-based working skills to be significantly higher in their current employment.

These results suggest that the SBP-group right after graduation perceived a number of soft skills (teamwork & leadership skills) already to be relatively high, as their ratings remained higher in their current job despite of the perceived growth of the ROM-group.

In addition, for almost all soft skills the SBP-group scored higher, with the exception of ethical thinking and oral communication skills. Skills needed for a societal career differ from skills needed for a career within academia (Borrell-Damian et al., 2010). Also, employers expect more soft skills besides research skills (Green et al., 2009) which can influence the future career of the individual student, but also relevant for knowledge validation in general (De Grande et al., 2014) or to more specific to a relevant industry sector (Hammer et al., 2021). Hence, SBP-alumni seem to offer a higher level in these soft skills. We suggest here that soft skills could be characterised as 'practice makes perfect' skills that get better during work experience. In order to be maximally prepared for a societal career it makes therefore sense to start as early as possible with soft skill training in the societal profile.

For gaining soft skills it is known from literature that not only the development needs attention but also the awareness of the importance of these skills, so they can become more visible in the curriculum (Kensington-Miller et al., 2018). This way, the student skills can match the expectations of the workplace and can change with the changing professional context in which alumni constantly find themselves (Oliver & de St. Jorre 2018)

Two perceived - more general - skills, Academic Reasoning and Quantitative skills follow a different dynamic and remain the same in time, for both groups. Hence, more general skills that are learned during academic education might be really stable.

In sum, the ROM profile improved a number of research skills right after graduation, which decreased after their education. The SBP profile resulted in alumni already being proficient in soft skills right after graduation that were sometimes even improved further after training. The reported skills of SBP-alumni seem to match the needs from the industry where non-academic skills are often lacking (Borrell-Damian, 2010).

Policy stipulates that European universities include transferable skills in their curriculum (European University Association, 2007) since these are often missed (Enders, 2004). In the SBP curriculum these skills are present, and alumni continue to improve on these after graduation. The group characteristics should be taken into account here; SBP-alumni seem better at SBP skills, but they have also been working in their profession for a longer time on average. Since these skills seem to improve with gaining experience, you might expect the ROM-group to score higher the longer they are working, making the gap smaller. Perhaps this also works the other way around for the reduction of the research skills, perhaps those of the SBP are only worse now because they have been working for longer and therefore these skills have been decreasing for a longer period of time. The

dynamics in postgraduate skill development might need a more central role in curriculum development for both profiles, since they seem crucial for career development.

To evaluate the exact meaning of the difference in skills and the dynamics of this, further research is recommended. Suggestions for further research are based on attitudes and appreciation of the work floor towards the transition of preparing more students for careers outside academia. The need for different skills (Borell-Damian, 2010) has been discussed, so finding out whether a societal profile offers the answer for the demand of employers in business and policy organisations from their point of view would be interesting. From the university perspective DeGrande et al. (2004) are suggesting a need for change in attitude within the academic world towards non-academic careers. Whether this suggestion has been followed would also be an interesting topic for further research. An even more specific question concerns how to get practices like SBP to be more generally implemented, so it will not be an alternative but a main route, as seems logical when looking at the final career path of most alumni.

Altogether, a societal profile of a science master leads to a different career path, one that can be better predicted compared to a research profile. The dynamics in postgraduate skill development are more positive for SBP-alumni compared to ROM-alumni. The different skills that are used and required during a societal oriented career path seem to match the societal master's profile, while the research profile seems to decrease in matching skills. No clear differences were found between groups in terms of income and employment searching time. Job satisfaction seemed to grow over time for both the research profile and the societal profile, with SBP-alumni being even more satisfied in terms of current income, status, appreciation and career perspective. Summarizing, based on the actual career perception of alumni, offering a societal science master seems a good idea and can contribute to bridging science and society and to establishing a broader university.

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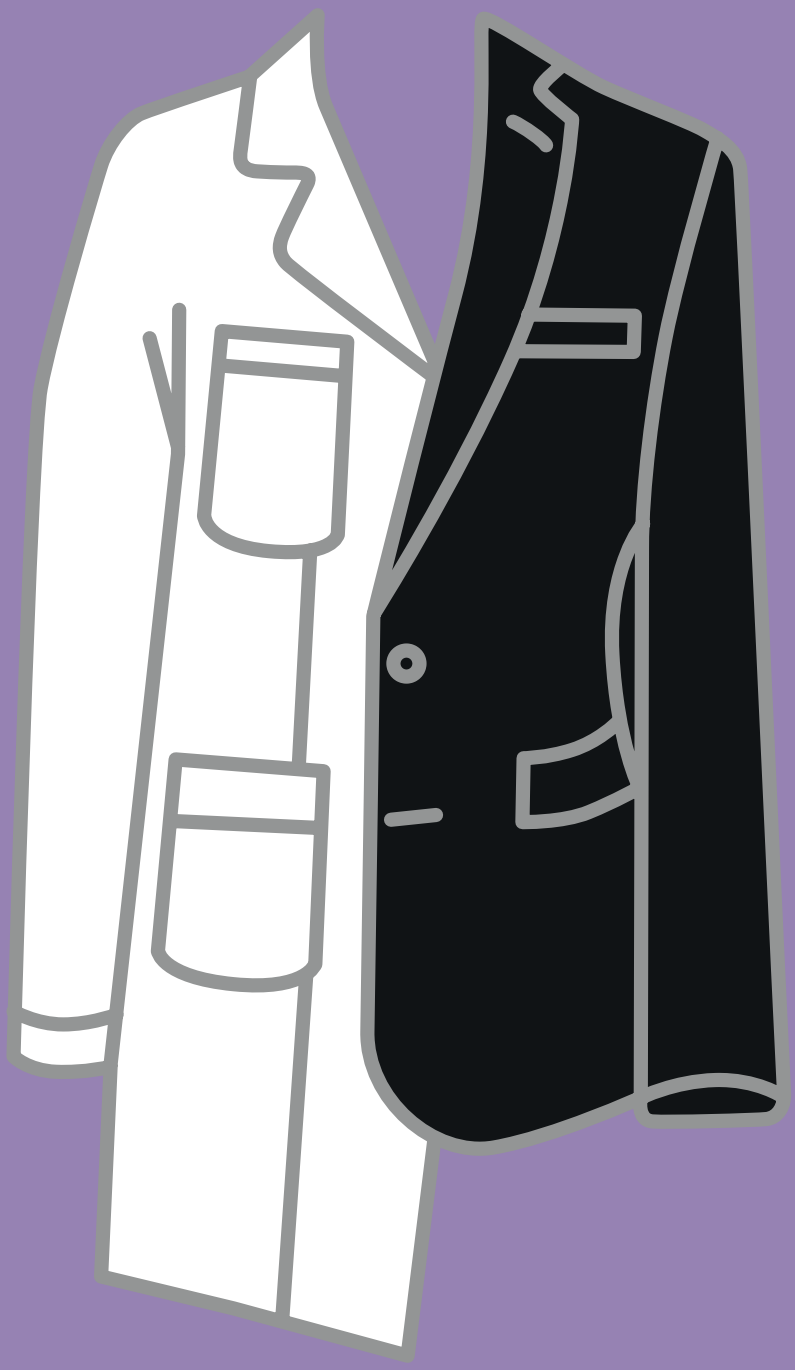
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5

Beyond entrepreneurship, raising broad academic professionals: Work-based learning in science from the employer's perspective

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Abstract

The need for employees in the exact and natural sciences sector with both work experience and academic qualifications, especially combined with an entrepreneurial mindset, is rising. The University of Groningen offers an alternative Master's program entitled Science, Business and Policy (SBP). SBP combines entrepreneurship education with the integration of a disciplinary science domain and thereby prepares students in science advising. This includes a work placement of six months, provided by companies, policy organisations and NGOs. To examine the impact of work placements from the perspective of the employer, this article analyses 20 semi-structured interviews with providers of placements. The results show that employers judge students who have undertaken a work placement as attractive future employees, and the quality of science advice given by students is seen as high. From a work floor perspective, work placements are a strong component in the optimal education of future employees. Integrating academic theory and experience in practice contributes to the employability of science students. The impact of work placements goes further than employability, since employers also indicate a direct effect on work dynamics and see the direct impact of advice reports in their organisation. The work-based learning approach chosen to achieve this specific entrepreneurship education fits the need of industry and other non-academic employers.

Keywords: Science, Business and Policy program, work-placements, work floor perceptions, career, professionalisation

In industry there is a need for employees who combine a science background with a broad view (Borrell-Damian et al., 2010) and for professionals who possess different skills than those are needed for an academic career (Pang et al., 2019; Hart, 2019). This increases the need for universities to extend their education beyond preparation for a career in research, preferably as an integral part of the curriculum (Moira et al., 2018). In this context, Abreu et al. (2016) signal a global trend in which universities tend to profile themselves as entrepreneurial entities. Uyarra (2010) defines the regional importance of universities and their connection to the rest of the economy, requiring a revision of their role and their interactions and different mechanisms of engagement. It is argued that universities should strengthen their social engagement to respond to societal needs, and for this multiple models are available (Cuesta-Claros et al., 2021).

After obtaining their Master's degree, in reality most graduates pursue non-academic career paths. Of those who do continue the academic path and undertake a PhD, the majority still do not ultimately pursue a career in academia (Etmanski, 2019). These graduates encounter problems like experiencing organisational culture shock (Skakni et al., 2021) or having skills that do not seem to be transferable from academia to the work floor (Pedersen, 2014; Enders, 2004). Despite the needs of employers and the career paths of most graduates, current mainstream science education at the Master's level still focuses on disciplinary theory, content knowledge and skills needed for an academic career (Sarkar et al., 2020). There is a need for professionals with a new type of expertise in the domain where science and business meet (Retra et al., 2016).

The above situation creates a functional employability gap, with higher-educated students still lacking essential professional skills (Jackson, 2010; Sarkar et al., 2020). Universities have different approaches to increasing the employability of their students (Winkel, 2010), but so far curricula do not systematically cover elements in terms of the theoretical and practical learning of entrepreneurship (Blankesteijn et al., 2021).

Gaining real work experience has been suggested as a key factor in bridging the employability and skills gap (Chi and Gursoy, 2009). Since education and expectations from the work floor do not always match in practice (Gomes and Yasin, 2011), it is crucial to ascertain whether academically designed work-placements actually align with the skills needed on the work floor (Matthews et al., 2021).

The Science, Business and Policy (SBP) program of the University of Groningen is designed specifically to bridge this gap. SBP trains science students as science advisors and broad entrepreneurial professionals, connecting academia with the workplace. It has a multidisciplinary approach and a focus on broader skills, such as teamwork and project management. It is based on gaining experience through a work-based learning (WBL)

design with a focus on entrepreneurship education. From a student's perspective, SBP students feel better prepared for careers outside academia compared to those from a classical research Master's program (Grooters et al., 2022a). The question is whether this is also the view of societal organisations and industry. In this study, we carried out 20 semi-structured interviews with providers of SBP work-placements (called clients in SBP). We interviewed the daily supervisors of the work-placement, who are all professionals working for companies, policy organisations or NGOs.

The main objective of the present research is to map the client-perceived societal impact of the alternative science Master's SBP program. When it comes to bridging the academic–practitioner gap, the point of view is often that of academia or policy makers; practitioners' voices are often neglected. Our research questions therefore are the following. How do clients experience SBP and WBL, and, more specifically how do they experience the learning outcomes, skills and the work-placement? What is the impact of the work-placement? And finally, is the SBP student distinctive and employable? We hope the answer to these questions will contribute to bridging the employability and skills gap.

Entrepreneurship education

Entrepreneurship education was originally designed to foster start-up firms. Many universities seem to focus on this aspect (Etzkowitz 2003). However, the meaning of entrepreneurship has since, such that it does not relate solely to starting and running one's own company but is seen in a broader perspective. For instance, the concept now includes a so-called 'entrepreneurial mindset' (EM) (Hagg and Gabrielsson, 2019). It is precisely this EM that is interesting for industry and for other employers, because it can be a highly relevant element in the training of a broad scientist (Jones, 2005). The problem with EM is that the concept is ill-defined (Robinson and Gough, 2020), and thus so are the competencies, skills and cognitive abilities derived from this mindset (Larsen, 2022), which often form the basis of educational learning goals.

Intrapreneurship is used to describe entrepreneurial behaviour in existing organisations (Antoncic and Krathwohl, 2001). A major difference between intrapreneurship and entrepreneurship is the financial risk (Antoncic and Krathwohl, 2001), since the intrapreneur operates in an existing company and therefore does not take a personal risk with their own investment. On the other hand, the skill sets of intrapreneurs and entrepreneurs seem to be strongly related (Smith et al.,2016) and also relevant in the corporate world (Coulson-Thomas, 1999). Recently, the term intrapreneurship has been described as outdated (Smith et al., 2016) and is now included in the much broader definition of entrepreneurship (Kuratko et al., 2013).

Larsen (2022) stresses that entrepreneurship education should take a critical position and provide a theoretical foundation for the educational strategies that institutes choose to impart an EM. To streamline this process, she explains that the EM can be conceptualised in three different ways, each of which is hypothesised to have different consequences for the educational set-up. The first conceptualisation implies the recognition of the cognition component underlying a supposed mindset (how to think as an entrepreneur). This enlargement of knowledge can be based on traditional lectures and practising cognitive skills. The second conceptualisation of the EM is as a frame of mind (a positive attitude towards entrepreneurship) that can be taught by, for example, reflection and simulation. The third and last conceptualization is of an EM as capability (the assets, skills and competencies needed for entrepreneurial behaviour), which can be taught, for example, with experiential learning which includes real-life projects and situations in which entrepreneurship is really done and practised.

Larsen (2022) also notes that developing an EM is a time-consuming process. In the SBP program, there is the luxury of having a complete study year and thus the time to unfold an educational approach that is a hybrid of all three conceptualisations. SBP starts with two courses, which both begin with learning entrepreneurial theory, to expand the knowledge of business and policy acquired through classical lectures and an exam (conceptualisation 1). The next element in the courses are group projects in which students are trained in the process of change and reflect together and by themselves (matching the aim of conceptualisation 2). The final goal of SBP is to prepare students to be able to display more integration and practice-oriented behaviour on the work floor, and to bridge science and society. Therefore conceptualisation 3 of the EM is the main objective of SBP – to equip the students with the capabilities they need to become a professional This is reflected in the curriculum were individual and long (40 ECTS) work-placement are offered.

Another way of defining the EM concept is by looking at the learning goals. The SBP learning goals (described in details in Grooters et al., 2021) are formulated using the Bloom taxonomy (Anderson and Krathwohl, 2001), arriving at the highest level in which students have to create their own science advice. This can be met only when an EM has been developed, with the EM conceptualised as capability and the matching skills and competences substantiated (conceptualisation 3).

Beyond entrepreneurship education

In the SBP program, the entrepreneurship education goes further than teaching an EM, or obtaining a general degree of entrepreneurship. SBP goes beyond entrepreneurship because it is about the building of an entrepreneurship education against the background of the integration of different domains – in this case the domains of science and business

or policy. This approach differs from that of a classical research-oriented science Master's program, in which the focus is on disciplinary education (e.g., biomedical science, or more specific mechanisms in oncology).

The SBP program aims not only to increase knowledge about the student's own discipline but also to teach them how to use this knowledge to create solutions for societal issues. This can be achieved only through the integration of both domains. An example would be the development of a policy for population screening in oncology. This approach creates an educational program that has a different career aim, as is shown in Figure 1. In practice students are not familiar with the overview of the labour market. Presenting this figure creates an awareness of potential professions and the matching educational programs available. The careers in the bottom row (7,8 and 9) are covered by a classical research Master's program, while SBP covers professions for which the integration of science with business or policy is needed or for which students have gained an EM.

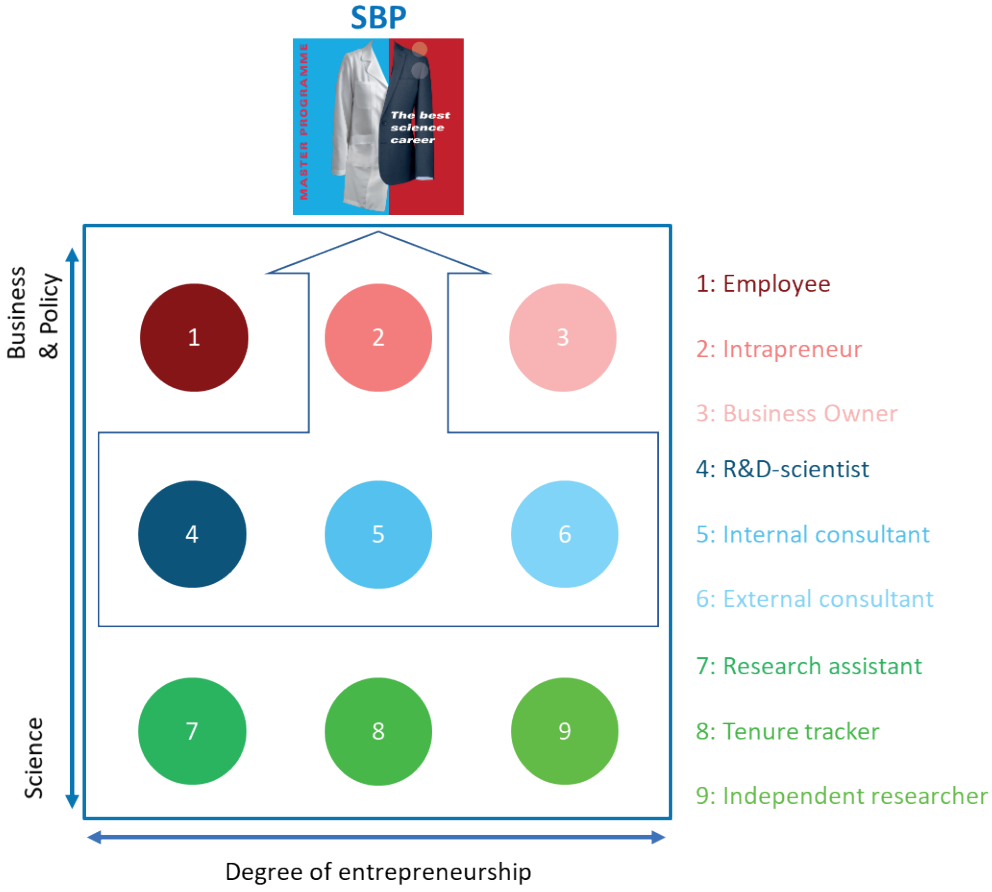


Figure 1. Matrix of professions .

In science advising, students deal with multiple stakeholders. This is one of the skills developed by working with actual clients (Foster and Yaoyuneyong, 2016), increasing the needed workplace competencies (Cooke and Williams, 2004). In preparation for a professional life, it is also important that students learn to function in a complex situation (Dede, 2005), to work in different teams (Geissler et al., 2012) and to deal with ill-defined problems (Lombardi, 2007).

The SBP program

Bridging the employability and skills gap can be achieved using the work-based learning (WBL) method, with students gaining working experience in real professional settings, for instance in work-placements. In the SBP program, students gain practical experience through a long work-placement at the employer's location. This work-placement falls entirely within the curriculum. WBL is described in the literature as an important approach (Raelin, 2008; Lester and Costley, 2010) and has been used for some time, but is rare at the Master's level (Graf, 2016). The Netherlands seems to be advanced in implementing WBL (Perusso and Wagenaar, 2021), and business and engineering are the disciplinary areas in which WBL appears to be most developed (Perusso and Wagenaar, 2021).

At the University of Groningen there are three options for within the two-year science Master's degree (EQF level 7): the classic research-oriented Master's (ROM) with two research internships, an education Master's variant (which is not considered further here), and the SBP Master's variant. The SBP variant is the same as the classic variant in the first year and in the second year the focus is completely on SBP. During this SBP year, the various science students form a multidisciplinary cohort; for example a mathematician, a marine biologist, a pharmacist and an astronomy student all do the same program. This cohort starts in the second (SBP) year, which is entirely WBL-based. It contains two courses (both 10 ECTS) on business and policy, including entrepreneurship aspects, which both include multidisciplinary project education in groups. The literature confirms that similar projects prepare students well for workplace environments (Foster and Yaoyuneyong, 2016) and are more effective than traditional methods (Keppell and Carless, 2006). The courses are followed by a long work-placement (40 ECTS), which is the focus of this article (for a more in-depth description of the curriculum, see Grooters et al., 2021).

Work-placements in SBP are individual and full-time, and take place at an external location (i.e., the location of the client) which may be a company, a policy organisation or an NGO. Local, regional or international placements are all allowed. An individual project should deal with a relevant and current topic and must be completed within six months. During this time, the student is project owner and has full responsibility for the project.

The content of the work-placement is always based on the scientific discipline in which the student was trained. An example would be a biomedical student looking at whether a certain vaccine should be added to a national vaccination program. The scientific findings are integrated into business and/or policy plans to create a solution for the client's problem. The student's final product is an advisory report for the client containing a solution based on the integration of different disciplines, a consideration of different scenarios and an implementation plan. In this way the student gains experience as a science advisor, with a potential impact on society.

During the work-placement, interactions between four different players are obligatory – that is, between the student and three supervisors. Each student has a supervisor from SBP, who is an expert in the field of project education and integration. An additional university teacher serves as discipline supervisor, an expert on the science topic of the project. The last supervisor is from the workplace and is responsible for the daily supervision. Due to this interplay of supervisors, the university has control over the quality of education (Grooters et al., 2021). A second way to control these interactions is through curricular education in the placement process. There are three pre-set events, starting with two preparatory weeks on campus. During these weeks, the students make a plan of action for their work-placement; this is followed by workshops at which they get to know about each other's projects through presentations and peer reviews. This preparatory phase is followed by a six-month block on location, broken by a week's return to the university in the middle of the period. During this mid-term evaluation, adjustment and input from peers are collected. The last educational event of the work-placements is a conference in which all SBP students present their science advice to the public (consisting of clients, supervisors, fellow students, family, potential employers and other interested parties). In addition to final presentations, there is room for networking. First career offers are often made at this closing congress.

During this whole process, the student is seen as an important partner and an active player. Science students can hereby take a different educational approach and use their scientific knowledge and academic skills to contribute to solving problems in real life. This can be illustrated also by the way the placements are arranged: students have to do this themselves. This ensures a proper fit of interest and an internal locus of control (a work-placement does not happen to you, but you arrange it yourself), both of which benefit the quality of education (Naude et al., 2016).

Method

This interview study is approved by the ethics committee of the University of Groningen (CETO submission number; 69813564). All tables are available as supplemental data, referred to in the text as supplemental table with number (ST#).

Participants

20 SBP work-placement supervisors (also referred to as clients) who had supervised one or more students in 2017, 2018 or 2019 participated in a semi-structured computer-assisted personal interview (CAPI) study. 13 participants were business placement supervisors (N_{male} = 8, N_{female} = 5) and 7 were policy placement supervisors (N_{male} = 4, N_{female} = 3), which reflects the division of actual business and policy work-placements (Grooters et al., 2021). Based on a random number generator, participants were randomly selected from a database that contained contact information on 129 work-placement supervisors. 47 supervisors were invited before we reached 20 participants. Of those who did not participate, the majority did not respond to the invitation. 5 potential participants (10.6%) worked in the frontline of the COVID-19 pandemic or did not have time to participate due to COVID-19 for other reasons, while explicitly noting that otherwise they would have liked to participate. 5 potential participants (10.6%) did not work at the work-placement organisation any longer and could not be contacted via the work-placement organisation. Excluding these potential participants, our response rate was 54.1% (i.e., based on 37 invitations). Interviews took place between April and June 2020. 19 interviews took place in Dutch, and 1 in English.

Questionnaire, data collection and procedure

A questionnaire was constructed and pre-tested by means of cognitive interviewing. Based on the outcomes of six cognitive interviews (which served as a pre-test, not included in the results), the questionnaire items were discussed by all authors of this paper. Questions that turned out to be unclear or wrongly interpreted during the pre-test were adjusted or removed. The revised version of the questionnaire was pre-tested again with a cognitive interview. No comments were made during this test interview, so the same version was used for the twenty final interviews. For data collection, we used the survey software Qualtrics. Before participating, respondents had to give informed consent. When consent was given, participants were first asked to conceptualise their perception of SBP and work-based learning. Then, they were asked to evaluate the students they supervised. When they supervised multiple students, we asked them to provide an average evaluation of all supervised students. After this, participants received questions on the quality of the advice report and the perceived societal impact of the SBP work placement. Lastly, respondents were thanked for their participation in the interview and were asked whether they wanted to receive the results of the study and

whether they had any comments or questions about the interview. All interviews were transcribed in full (available on request) and the transcriptions were used as the basis for coding the data.

Content analysis

We used a combination of conventional content analysis (CCA) and directed content analysis (DCA) (cf: Hsieh and Shannon, 2005). For most questions we used CCA, a primarily inductive approach for which coding categories were constructed by the coders themselves. This coding practice consisted of two rounds: an open coding round, in which themes were connected to text fragments of the interview, followed by an axial coding round, in which the assigned codes were compared with each other and combined in an overarching code. In addition, for some questions we used DCA, which meant that we based coding categories on existing theoretical knowledge. Based on theory, we devised a set of predetermined codes while still allowing for additional categories that did not fit in this code set (i.e., using CCA). For instance, when we asked participants to define academic skills and academic level we used coding categories based on the Science Student Skills Inventory (SSSI), an instrument developed to measure science students' skills (Matthews and Hodgson, 2012). In addition, we used skills based on SBP's learning outcomes (e.g., Grooters et al., 2022a). We also allowed for additional categories, as these coding categories were not expected to be exhaustive because SBP students are not "common" science students (e.g., because of the program's additional focus on entrepreneurship).

Initial coders were Master's students and a research assistant, all of whom had training and prior experience in quantitative and qualitative coding. We determined the trustworthiness of the codes based on intercoder reliability using Cohen's Kappa (for the questionnaire topics for the open questions, items used and Cohen's Kappa per question, see ST1). To do this we let two independent coders code 30% of the data again, based on the coding categories determined in the axial coding round and a codebook that explained these codes for the coders (for an example of the codebook, see ST2). Quotations from individual employers have been added to the results section when they have added or illustrative value.

Student evaluation, closed-ended items

Next to the open-ended questions (ST1), we asked participants to evaluate the SBP students' skills on a five-point Likert scale. More specifically, they were asked to evaluate statements about the learning goals they perceived the average SBP student had achieved during the entire work placement (1= I totally disagree that the student has developed skills, and 5= I totally agree that the student has developed skills). In order to measure the perceived learning skills gained, we used items from the SSSI (Matthews and

Hodgson, 2012): scientific content knowledge in your field(s) of study; communication skills (i.e., scientific presentations); writing skills (i.e., scientific writing); quantitative skills (i.e., mathematical and statistical reasoning); teamwork skills (i.e., working with others to accomplish a shared task); and ethical thinking (i.e., ethical responsibilities and approaches). In addition, we added items based on the learning outcomes of the SBP program that were not included in the SSSI: practical research skills (i.e., lab work & modelling); academic reasoning (i.e., analytical and critical thinking); project-based working skills (to achieve a certain goal with limited resources); and leadership skills (i.e., guiding and managing a team).

Results

General perception of SBP program/WBL education

The most prominent characteristic of SBP mentioned by employers was the combination of theory and practice (ST3). A business supervisor specified this, commenting:
"I think it's a very nice way to ensure that people with a somewhat numerical background come into contact with the business community."

A more general view was given by a policy employer:
"It is precisely this connection from science to policy and implementation that can actually have an effect on society, that I think is very important. So I think it's a bull's eye."

The more explicit theme of "bridging the gap between academia and the work floor" was mentioned by 25% of the clients. From a business employer's perspective came the observation:
"And then SBP came along and gave them the opportunity to get to know companies with people like me who say to an academic question "yes, but how are we going to earn money from this?'"

Another comment translated the way SBP strives to overcome the academia–work floor gap from a student's perspective:
"I've seen it a bit like giving the student tools that might make them an ideal project manager in large complex development projects with a strong science component and ultimately whatever you develop that you bring to market. That's what the industry is all about. […]If you are able to talk to all customers at a substantive scientific level and thanks to that you can estimate what the business needs of that customer are and how the company they work for, organisation, how they will fill in and can support that. Yes, I think a good foundation is being laid."

The overall evaluation of SBP was that it was interesting and valuable more often in policy than in business work placements (ST3). Three clients mentioned that the program is unknown to the outside world.

Focusing on definitions given by employers of work-based learning, the combination of learning and working is present in most answers (75%, ST4). As an employer from a policy background commented:
"Well, that's acquiring knowledge while you're working actually. So not everything in advance, in principle you try to gain as much knowledge as possible in a scientific education, but if you apply the term you use, you also have to pick up skills while you are already more or less at work."

More directly, a business employer stated:
"[It's} reading books, but understanding that you don't get that far with books. So also put into practice and try to express that theoretical knowledge there. Cycling, say with training wheels, while during your studies you often only read about cycling."

More specifically, the application of theory in practice was mentioned as well as project-based working skills and gaining hands-on experience.

As the main positive points of SBP (ST5), employers mentioned: connection with the labour market; its multidisciplinary nature; the application of theory in practice; project-based working skills; the societal value; the combination of science and entrepreneurship; and business insight. Negative (ST6) factors mentioned were a reduction in in-depth knowledge and gaps that were sometimes still present between theory and practice and in knowledge. Incidental comments referred to a less executive attitude, insufficient work-placement and career preparation, too high a degree of independence and insufficient supervision.

General perception of the SBP work placement

Overall, clients were very satisfied with the SBP work placement and satisfied with the extent of preparation of the SBP student (ST7). Most of the clients (90%, ST8) would recommend a SBP student to another company or organisation. A business supervisor said: "Yes sure, well. I would certainly give a positive reference." The majority of clients (70%, ST9) would offer a work placement to SBP students again within the next 6 months; some others would do this only at the request of the student. A small group would not offer a work placement again: reasons given included COVID-19, the placement had been too demanding for them, or they not working in a scientific function anymore (ST9).

The main reason for offering work placements was because of demand and supply (35%, ST10), as literally stated by a policy supervisor ("Yes, it is also a question of supply and demand"). Another reason was to provide education (29%), illustrated by a business client:
"The developments of students [...]. I think I can offer good daily guidance and fun projects that really add value to students."

Other important arguments for offering work placements contain codes on research possibilities, knowledge development of staff and to have extra capacity (all 24%), and to recruit new staff (18%). Two clients (12%) indicated that they offered work placements because of their ambition, the knowledge levels of the student, recommendations from others, for fun, or to connect to university.

The most important factor that made a work placement a success, as perceived by the clients, was he combined supervision of the university and the company or organisation. (58%, ST11).

A policy client said:
"I think that one of the most important factors, may I add, is the direct contact between the supervisors of the university and in this case the municipality. It was really very good."

A business client added:
"Good daily guidance. So the guidance from the internship."

Furthermore, ambition (37%) seems to be a success factor, as stated by a business instructor:
"Both the student and the company must have real ambition around the project. If that ambition is there from both sides, you will find a way to make it a success."

Other success factors that appeared in the answers of multiple clients were general skills (37%), scientific content knowledge and the matching of the assignment (both 26%), the matching of the work placement itself and independence (both 21%).

Beside success factors, clients also deliberated on factors that could contribute to an unsuccessful work placement (ST12). Similar causes appear, like bad supervision (41%), lack of ambition (41%) or lack of knowledge and skills (29%). Sometimes these causes were found literally in the answers of the clients: "Poor guidance, poor student skills." Mismatch was also a recurring item: an employer with a business background stated, "Mismatch in any case." This was more often ascribed to mismatch of the assignment (53%) than to mismatch of the work placement (24%), the latter illustrated by another

business employer: "Not a good fit with the usual organisations where students will work in the future."

Learning outcomes

Clients were generally satisfied with the academic level and the academic skills of SBP students (rated respectively at 7.8 and 7.7 on a scale of 1–10, ST13). As a operationalisation of academic level and academic skills clients also reflected on the learning goals, which were perceived as met (Table 1).

Table 1. Achieved learning goals perceived by clients, scale 1–5.

In the entire work-placement period, the average SBP student achieved the learning goal of:	Mean score
independently write advice with core concepts from business and policy	4.05
doing project work in a group and alone	3.63
develop leadership that fits their personality	3.16
have insight into their own strengths and challenges	4.26
understand and use business and policy perspectives	3.95
create added value from multiple knowledge domains	4.15
critically assess own discipline in relation to business/policy and society	3.33
finding balance between the individual interest and the group interest	3.56
act as a science advisor in an ethical manner	4.10
implement innovations in a sustainable way	3.15
communicate effectively to target audiences	3.53
evaluate the advice in such a way that it is practicable	4.00
critically consider their own role in scientific advice	3.95

When employers assessed the skills that SBP students obtained during their work placement, as shown in Table 2 they perceived an increase in all skills except for leadership skills. How important these skills are to the employers was also assessed and all skills that students developed were seen as relevant and important (last column in Table 2). The three most important skills according to the clients were, respectively, oral communication (mean of 4.84), teamwork (4.74) and academic reasoning (4.53). Practical research skills were perceived as the least important in professional life (mean of 3.39).

Table 2. Achieved progression in skills perceived by clients, scale 1–5.

In the entire work placement period, the average SBP student improved on:	Mean score	Importance Mean score
scientific content knowledge	4.42	4.32
oral communication skills	4.00	4.84
writing skills	4.05	4.32
quantitative skills	3.78	4.11
teamwork skills	3.63	4.74
ethical thinking	3.71	4.00
practical research skills	3.38	3.39
academic reasoning	4.32	4.53
project-based working skills	4.16	4.32
leadership skills	2.38	4.11

Impact of the work placements

The majority of the employers saw the impact of the SBP work placement on the dynamics of the work floor (ST14). This was seen (ST15) in terms of a better working environment (54%), the gaining of knowledge and skills (31%) and new inspiration (31%). A business supervisor explained:
"She brought a skill set but also a certain energy that we didn't have, which was very good for the group dynamics."

A proportion of the clients (21%) did not see a direct impact on the work floor. For example, a policy supervisor commented:
"Not on the work dynamics, but in the outcome of our work. Ultimately, this student did produce a report that was used for further policy development."

When zooming in on the advice reports, the employers seemed very satisfied and gave a high average grade (8.1, ST16). Most clients (79%, ST17) reported an influence of the SBP report on the organisation. In the short term (ST18) influences included the implementation of science advice (33%) or new customers, products, insights or knowledge (all 13%). Long-term effects (ST19) included the implementation of science advice (38%), change in workflow and a general inspiration for change (both in 23% of the answers).

Distinctiveness of the SBP student

When we look at how distinctive SBP students are (Table 3), we see that the majority of work placement providers thought that SBP students differed from ROM students (61%) and from applied university students (90%) and that their work was also different from that of consultancy firms (82%).

Table 3. Difference between SBP students and ROM students, applied university students and consulting companies.

Difference	Yes	No	Don't know
SBP student vs ROM student	11 (61%)	4 (22%)	3 (17%)
SBP student vs Applied University student	18 (90%)	0 (0%)	2 (10%)
SBP student vs consultancy company	14 (82%)	3 (18%)	0 (0%)

When we zoom into those differences, we see that, compared to ROM students, SBP students (ST20) are perceived by supervisors to be more versatile (noted by 42% of the clients) and to have a different focus (58%). Also, a difference in skills was noted by employers, with SBP students perceived to have better soft skills and ROM students better scientific content knowledge.

Compared to students of the University of Applied Sciences (EQF level 5 or 6, ST21), SBP students (EQF level 7) were perceived to have more academic skills, a higher academic level and better academic reasoning. Clients characterised SBP students (ST21) as more independent and as having higher scientific content knowledge. Applied science students were sometimes seen as executive only (32% in our sample).

Some companies (18%, Table 3) did not see differences between the advice report written by an SBP student compared to that of a professional consultancy. A large majority of employers, however, did note differences (82%, Table 3), citing various factors (ST22), including, for example, the higher costs of hiring a consultancy firm (25%). It is noticeable that differences in other categories are ambivalent. SBP, compared to consultancy, was seen as slower (19%) or faster (6%), as more independent (19%) or less independent (13%). Consultants were perceived to have a higher knowledge level (25%) and better practical execution (31%) than SBP students, whose work was variously reported to be more academic (13%), more original (6%), better suited to the needs of the organisation (13%), and more in-depth (19%).

Employability

Most clients (60%, ST23) offered the student a job after their work placement. When there was no job offer, reasons varied from "no vacancies" to "personal misfit" to "student wanted to continue studying".

The majority of supervisors (73%, ST24) thought that the university was responsible for letting students gain experience on the work floor. The responses, however, show a remarkably large range (from 2 to 10), so not all supervisors agree. Additionally, the majority (64%) also thought that there was responsibility on the part of the consumer, the student in this case.

All employers agreed that it was important for the university to offer work-based learning programs like SBP (ST25). The most prominent reasons given were the connection to the labour market and the opportunity for an all-round education. A business client illustrated this by commenting:
"Yes that stems from the fact that I think that far too many people with a technical education are trained as researchers and that this is not at all in line with the needs of the labour market. You could say that I think it is essential that you have people with a technical education (Bachelor). That you also train those towards management positions. People who have completed their PhDs have sometimes gone so far in depth that they are also difficult to fill in generic team roles afterwards. […] In summary, connecting with the labour market and also broadly training smart technical people so that they can still be deployed in positions wherever they thrive."

Discussion

Based on the interviews with employers from industry and governmental organisations, the experience on the work floor with students from the SBP program was positive. Employers were generally satisfied with the work placements and saw the program as valuable and its students as positively distinct from applied science students and research-oriented science students. Overall, employers indicated that they would like to hire SBP students, and this is seen in practice, with job offers often made immediately after the placement. Furthermore, clients are usually happy to offer work placements again. All 20 employers agreed that it was important to offer programs like SBP at an academic level.

These findings suggest that there is a need for an academic program that produces professionals. SBP seems to meet the current high demand for employees with a theoretical science background combined with an entrepreneurial mindset and experience on the work floor. It is important to note that the work placements within the SBP program form a very specific niche: all are placements in which science can provide answers for problems in society – these which can be very diverse, ranging from innovative technical products to health policy to energy consultancy, but all require an academic-level response. An entry requirement for a work placement is a work floor supervisor who has been trained at least to Master's level, but who in practice has often obtained a higher degree. The conclusions set out in this paper are therefore limited to this market, which is very specific on the one hand but on the other constitutes a large segment of the career opportunities for science Master's students. For this market, the functional employability gap (Retra et al., 2016), describing the lack of highly educated professionals (Jackson, 2010; Sarkar et al., 2020), might be bridged by using WBL

education that includes work placements leading to a strong connection with the labour market.

The positive aspects of WBL experienced by employers are in line with the university's view, in which the integration of theory and practice is considered most important. The integration of different knowledge domains and the importance of a good match are also noted by employers. This is in line with the literature, in which a proper fit of interests is found to be beneficial for educational quality (Naude et al., 2016), as is enabling students to choose and own their own project (Larsen, 2022). The most important success factor is good supervision of the work placement, for which cooperation is emphasised. The views of the academic supervisors on this matter are very relevant for further research.

The skills gap (Pedersen, 2014; Enders, 2004) seems to be bridged through the use of SBP education. In order to achieve this, the match between what is needed and what is learned should be optimised (Matthews et al., 2021). The three skills seen as most important by the employers were, respectively, oral communication, teamwork and academic reasoning, while practical research skills were viewed as the least important for professional life. In a study on the career development of SBP students (Grooters et al., 2022b), using an alumni survey, we see that in the SBP group and in the ROM group practical research skills were perceived to decrease after graduation and soft skills tended to increase. This is interesting because it reflects the difference between the SBP and ROM programs.

With regard to SBP, the skills students are supposed to learn are seen by the clients as achieved. SBP seems to be narrowing the skills gap while ROM students seem to be less prepared for a career in industry. The exception is, interestingly, leadership skills. While the supervisors perceived these skills as important, they did not find that SBP students developed them during the work placement, unlike the other soft skills for which significant improvements were reported. Perhaps this could point to room for improvement in the program, where the time spent on developing leadership skills is minimal. Further research is needed to discover how these leadership skills can be trained in a way that will align with employers' perspective. It would also be interesting to further evaluate how employers define leadership, which is a term that can be interpreted in many ways (Kort, 2019).

Zooming in on learning outcomes, the SBP learning goals were also perceived as well met by the employers. This is a relevant finding because entrepreneurship education is still an upcoming and turbulent field (Hagg and Gabrielsson, 2019) in which different models or approaches can be chosen (Uyarra 2010 and Cuesta-Claros et al 2021), with multiple interpretations of goals and definitions. The entrepreneurial mindset (EM), which is one of these constructs, seems key in entrepreneurship education but educators have the responsibility of defining it and clarifying its meaning this for all parties (Larsen, 2022). Thinking about the conceptualization of the EM and theorising the offered education before it starts should be a basic requirement for entrepreneurship programs. The SBP program is in a fortunate position since the students who choose it already have an internal company or policy interest and start with a positive attitude towards entrepreneurship – and the EM as cognition is formed during the courses. With this factor as a starting point for the SBP work placement education, the conceptualization of EM as a capability is clear. The idea is to teach students all they will need as entrepreneurs and to train them to develop their knowledge, skills, capabilities and competences for a professional entrepreneurial career.

Clearly defined learning goals by the university are a tool to do this. It is crucial that all parties understand and commit to those goals and that they are met. As a quality check for entrepreneurial education, universities can ask if work-placement providers think that their interns reach the learning goals.

The impact of SBP for the work floor seems to go further than enhancing the availability of suitable employees, bridging skill gaps or improving the entrepreneurial mindset after graduation. It also relates to the integration of science and societal aspects and this integration seems to occur during work placement, so that interns are already of interest for organisations before they become available on the job market. The development of an entrepreneurial mindset is judged by most supervisors to be valuable for the dynamics of the work floor, helping towards a better working environment, an increase in knowledge and skills and new ideas. The final advice report in the SBP curriculum has an impact in itself because of the implementation of science advice, leading to the acquisition of new customers, product development, new insights, workflow adjustments and/or a general inspiration for change. All these benefits seem to be results of entrepreneurial mindset that is combined with the ability to integrate science with business or policy. Overall, we believe that SBP as science education meets the expectations of employers and has been seen to go beyond entrepreneurship.

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Ethics statement

For this study the general principles of research involving human participants were applied. Ethical approval was given by the ethical committee of the University of Groningen, which approved the approach of the study and thus asking alumni to participate in a web-based questionnaire (CETO submission number 69813564). The CETO has established that the research protocol follows internationally recognised standards to protect the research participants.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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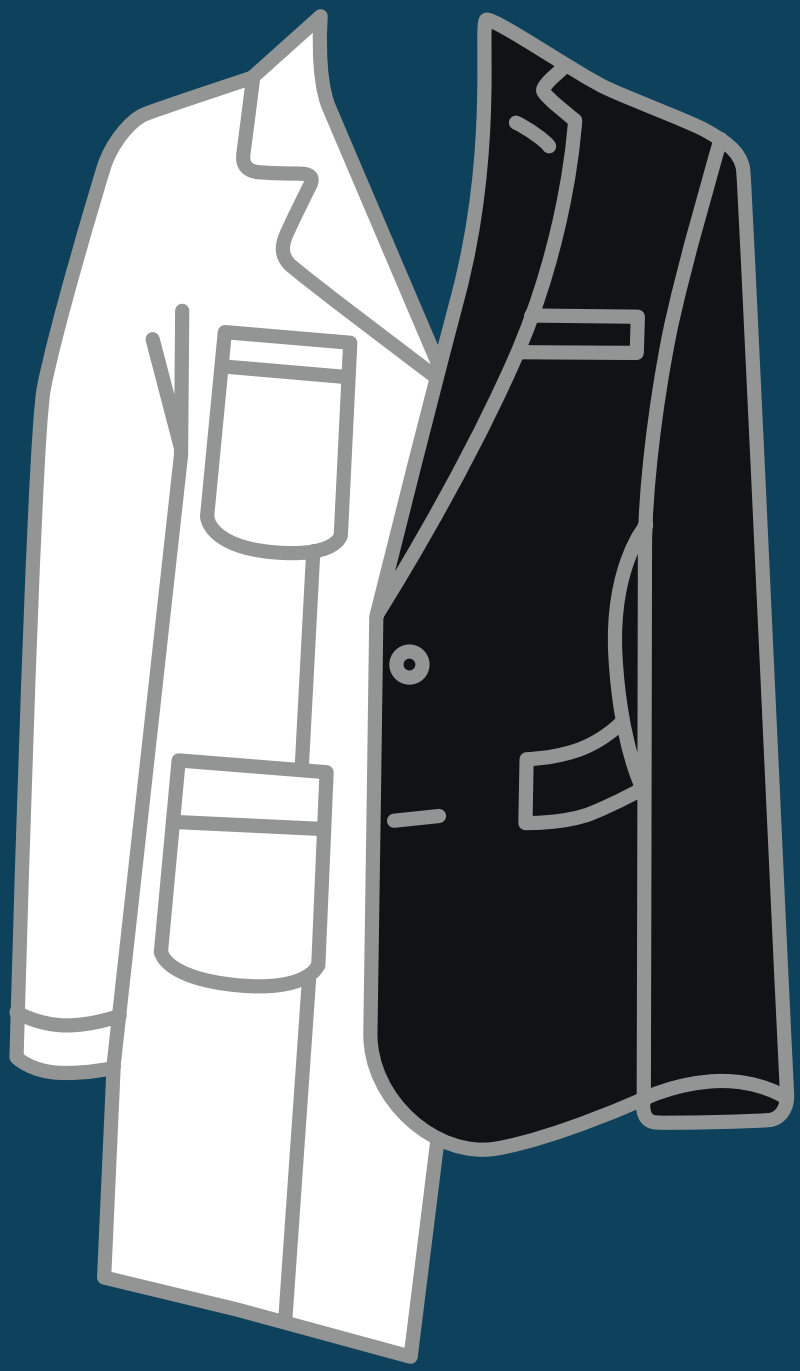
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6

Start of the Work-Based Learning revolution? The impact on academic quality of Dutch science masters, perceived by university professors

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Abstract

Work-Based learning (WBL) is a form of practical learning that is still rare, yet upcoming in academic education. It differs mainly from classical approaches because work experience forms a key curriculum element. To enable WBL, a cultural change in academic landscape seems required, which depends on views and support of academic staff. We carried out a case study, in which we interviewed 20 Dutch science professors to examine their vision on the master track Science, Business and Policy (SBP), a WBL program offered for over 15 years. Generally professors are positive about its added value and recommend the track, especially for students with career ambitions outside academia. WBL is perceived to have a positive contribution to academic level. Professors indicated that for academic skills development, compared with a traditional master's program, SBP is evaluated neutral to positive. Altogether the current climate at the university of Groningen towards WBL seems predominantly positive. The educational change towards a solid inclusion of WBL in the regular curriculum seems supported by one of the key players, the professors. This track could thereby be an example for other WBL programs worldwide.

Introduction

In development of science curricula worldwide changes are seen (Sarkar et al., 2020). Students need to keep up with a rapidly changing employment sector, to match the expectations of the work field (Hill et al., 2019). This in turn is dependent on employability skills and practical experience (Kondo & Fair, 2017).

The classical approach of universities (that is mainly research focussed) does not seem sufficient to supply these skills and experiences (Perez-Encinas & Berbegal-Mirabent, 2023). There is a tendency to shift the focus towards programs with more attention for professional skills (Matthews & Mercer-Mapstone, 2018) and employability (Sin & Neave, 2016). On a pedagogical level, shifting from traditional approaches towards more problem-based education could contribute to this (Sarkar et al., 2020; Burnham, 2019; Ng et al., 2022). This shift not only has an implication for students and employers but also for the academic landscape. Academic teachers and staff are very important in how students perceive and develop their employability (Petruzziello et al., 2023). Even though the importance of staff is recognised, specifically valuating their opinion on curriculum design and sharing this in publications is not common practice. Without commitment of the academic teaching staff the transition appears impossible, and therefore the main focus of this current study is to investigate staff's perceptions on rapidly changing needs in professional skills.

The Science Business and Policy (SBP) program of the university of Groningen, the Netherlands, is a science master program (level 7) that aims to close the gap between expectations of employers and skills needed by graduates. SBP is a Work-Based Learning (WBL) program in which students do real life projects and a semester-long work placement all within the academic curriculum. SBP exists for over fifteen years, and as such can function as case study about academic commitment of this alternative and upcoming type of education (Grooters et al., 2021). WBL is defined here as any type of education on a higher level which could involve the following Work-Based Learning types; learning through work, learning for work and learning at work (Lester & Costley, 2010)

Academic Science Curricula and WBL

Dutch academic science education starts with 3 years of bachelor education (level 6, undergraduate), followed by a master (level 7, graduate) of 2 years. The master education is divided by discipline (e.g., Biomedical Sciences, Chemistry) and classically focuses on research. This program prepares typically for a career within academia (Phd, Post-Doc, Professor).

Modern education has different working methods. From the perspective of the European Union, there is increasing attention for WBL. Work experience, the foundation of WBL, is known to close the skills gap with the work floor (Chi & Gursoy, 2009) and used often in applied education. However, WBL is rarely offered at universities in the EU at an academic level (Perusso & Wagenaar, 2021). The WBL educational program SBP is a one-year track that can be followed within several 2-year master programs of the Faculty of Science and Engineering at the University of Groningen, the Netherlands (for more information about the curriculum: Grooters et al., 2021). In this track, students learn about key aspects in business and policy. Instead of writing a thesis in the second master year, they apply disciplinary knowledge they gained during their bachelor and the first year of their master's and combine this with the knowledge from the Business and Policy courses from the SBP year. They do this during an internship in which they solve real problems formulated by an existing company or organization. The SBP students apply their disciplinary knowledge and translate it into business or policy advice. In the SBP track, students learn to bridge the world of science, business and policy. SBP is regarded a best-case practice for WBL (WEXHE, 2017-2019), specifically because it does not only contain WBL elements but it is the main educational method and as such completely integrated within the curriculum.

Change management in Science education

Change in Science education seems to be difficult (Borrego & Henderson, 2014). Change strategies that are successful involve changing beliefs of involved people and take the place in the organization into account (Henderson, 2011).

A reason why WBL is not commonly used within universities might be that in order to offer this form of education the role of the teacher is different than in a classic curriculum. In order to make WBL possible in a worthwhile manner, the vision of professors (by professor we mean in this paper a high level academic, who actually have influence on curriculum design, rather than executive lecturers) and their commitment towards it is relevant because a cultural change seems required for this educational innovation.

A way to examine this change process is by using a change model as a framework. In this case we chose to use a very established change model by Kotter (1996), the reason we chose this classical model is simply because it is one of the most change models in Dutch change management and thereby easy interpreted by those who strive for change, however other change models could have been suitable as well. A second reason is that we are especially interested in lasting change, and very often change models describe how to initiate change, while this is not matching the current phase, since SBP already exist for a longer period of time. The model of Kotter describes 8 steps in creating lasting change (Figure 1). It starts with an urgency for change, a coalition to do this and

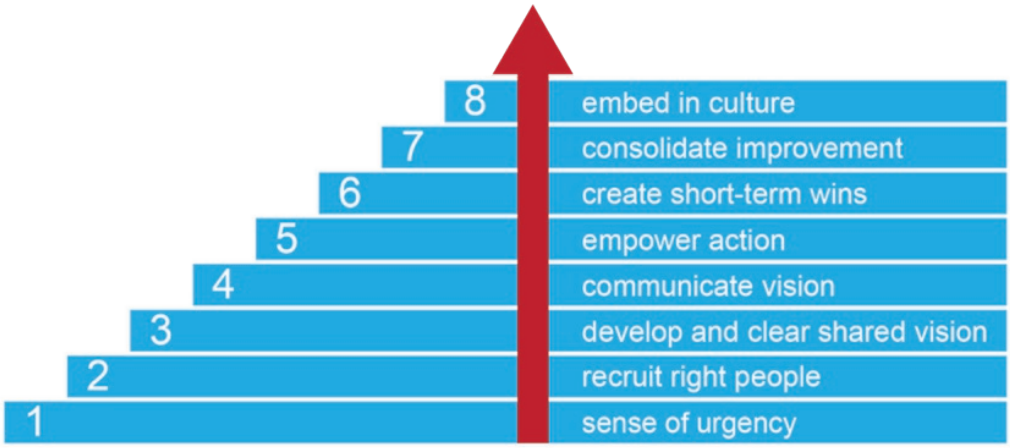


Figure 1: Kotter's 8 step model of change (After Kotter, 1996)

a vision on how to communicate this. Then a phase of empowerment starts followed by short-term successes and building on the change. The final step is to incorporate the change into culture. We applied the Kotter model to examine educational changes, using the SBP program as an example of the transition towards WBL in higher education.

History; starting point of Science, Business and Policy

SBP is offered for over fifteen years and was designed as answer on the Bologna process (Bologna, 2005) which called to create a societal profile for science masters. Kotter's first step was initially forced by European education policy. In order to get an idea of this process we interviewed (in writing) two initiators of SBP: Henny van der Windt and Menno Gerkema, who formed the guiding coalition as described in Kotter's second step. They developed an educational vision (step 3), communicated this and designed and implemented the SBP education (step 4 and 5). The SBP program became successful (i.e. it is now an official track with high student numbers (between 60 and 100 each year), scores high on external audits and on student evaluations and is valued by offerors of work placements) and is still growing and every year small improvements are made (step 6 and 7).

The final step, to incorporate this new program in the academic landscape seemed problematic in the first years of the existence of SBP. The interviews revealed they often missed commitment of the academic staff, SBP was perceived as not suitable for master education and there were doubts about the academic level and skills. A founder noted that the development team itself even had doubts about the academic level sometimes, and a colleague even stepped out because it was too practically oriented. There seemed

to be an attitude among professors that SBP was "a good place for the weak research student". One initiator believed this attitude is explained by a hyper focus on their own development and situation, which is a research career as a starting point for all education. Also both interviewees perceived that professors often failed to point out SBP as a serious option to students and the common opinion was that industry should not have a say in academic education. Step 8 of the Kotter model seemed far away.

Change of view?

But how is the situation two decades later? We still expect the initial resistance and scepticism to be present. However, the SBP program has grown and internationalised (Grooters et al., 2021), and is popular among students (Grooters et al., 2022a) and employers who gladly offer placement, Grooters, et al., 2022b). It seems that the WBL method found its place within science master education. Did change also take place in internal perceptions and acceptance among professors when it comes to their view on SBP's academic level and taught skills? In order to answer our main question we interviewed 20 professors of the faculty of Science and Engineering about their vision on professionalization in academic teaching and the value of SBP and WBL in general to investigate whether the requirements of change in academic landscape and the incorporation of this change in the academic culture has taken place. For the rationale of the study it is important to say that the SBP program forms a requirement to offer two-year science masters for the University of Groningen, regardless of its perceived quality and the outcome of the interviews of the professors. The aim of this paper is not in any way to secure the place of a specific programme in the university.

Method

This interview study is approved by the ethics committee of the University of Groningen (CETO submission number; 68918626). Supplemental data, containing more detailed information, are available in the form of tables referred to in the text as supplemental table with number (ST#).

Participants

Twenty professors from the Faculty of Science and Engineering (from now on FSE) of the University of Groningen, the Netherlands, participated in a semi-structured computer assisted personal interview (CAPI) between February and May 2019. 19 interviews took place in Dutch, 1 in English. All analysis (coding process) was done in Dutch. Afterwards quotes from the interviews were translated into English and checked by a native speaker. The sample of SBP professors was drawn from a formal list of all professors working at the FSE at the time of this study. We invited potential participants by an email that

asked them to answer a series of questions about their background, and on how they felt and thought about issues and activities related to the FSE's master programs. Potential participants were stratified based on the master program they worked in, so that the actual distribution of master programs at the faculty was represented. A random number generator was used to select potential participants within the strata. When potential participants refused to participate, new potential participants were approached randomly until we reached sufficient participants for each discipline (see ST1 for distribution of respondents per discipline).

Eleven respondents in the sample were professors involved in the Science, Business and Policy master's program (from now on SBP+), their involvement in SBP consisted of supervising the disciplinary content of one or more internships. Nine respondents were professors who were not involved with, and who may or may not have been familiar with the existence of the SBP master's program in the FSE curriculum (referred to from now on as SBP-). Participants in both groups consisted of professors between 42 and 71 years old (M=56.25, SD=7.09), with more male (N=15) than female participants (N=5) (see ST2 for age distribution per group & gender). This reflects the actual situation in the Netherlands, as men are still overrepresented among professors and people often become full professors later in life, at an average age of 49 (Rathenau institute 2023). Some participants worked at the RUG for a short time, others for a long time (min= <1 year, max=47 year, ST3). Around half of the respondents had experience working outside academia (N=8, ST4). The respondents who worked outside academia worked for a minimum of 1 year and a maximum of 29 years outside academia (ST5).

Questionnaire, Data collection & Procedure

A first version of the questionnaire was constructed based on brainstorm sessions, pre-formulated research goals and prior research (e.g. Bologna., 2005, Grooters et al., 2021). This draft version was elaborately pre-tested. First, the questionnaire was internally reviewed by the authors of this paper and three student-assistants by means of discussing the content of the questionnaire question-by-question. Based on this discussion, questions that were missing were added, questions that were unnecessary were removed and where needed, question-formulations were improved. A second version of the questionnaire was pre-tested by the three student-assistants following a think-aloud protocol, in which participants were asked to verbalise all of their thoughts on the questionnaire. Participants of the pre-test were six students of a Dutch University. Based on their comments the questionnaire was incrementally (i.e., after each pre-test) adjusted. All comments were related to how questions were formulated and interpreted. No major changes were needed based on the pre-tests. Then, one pre-test was carried out with a professor of the Faculty of Science and Engineering (i.e., an actual member of the population being interviewed), who had no comprehension or recall issues.

Interview questions were integrated in survey platform Qualtrics. Three student-assistants carried out the interviews. They received interviewer training by the second author of this paper. Interviewer training consisted of reading literature on best interviewing practices (cf: Dijkstra et al., 2014) and practical assignments. An interviewing protocol was composed (available on request) which interviewers used during each interview.

Before the interview, all participants had to consent explicitly to participate in the study. The consent form included information about the interview's procedures, risks and benefits of participation (no risks nor benefits) and the confidential and voluntary nature of the study. To prevent author bias risk ,as the first author of this paper is involved in the SBP program that is investigated in this study. We made sure that an independent research assistant specialized in questionnaire and interview design and specifically social desirability bias (i.e., the second author of this paper), was involved in composing and pre-testing of the questionnaire as well as carrying out the interviewer training and analysis. In addition, staff participating in the research were - before the interview started - assured that there were no right or wrong answers and that data was anonymized before analysis. Participants were not aware of the involvement of the first author in this study before participating.

After giving consent, participants were informed about the topical order of the interview. First, participants had to answer questions about their demographic background. Second, they answered questions on how they defined the concepts of academic skills and academic level and they were asked to evaluate the academic skills and levels of themselves and their academic environment. Third, they answered questions on their perceptions regarding the role of the university in professional development and their perceptions with regard to Work-Based Learning (all participants received a short description on a definition of Work-Based Learning) and the SBP track (whenever participants were not familiar with the SBP-track, they were provided with a short description). Fourth, they answered questions on career perspective and study choice in the context of master programs offered at the faculty. Lastly, participants were thanked for participating in the study and asked whether they had any comments or questions. Each interview was fully transcribed by student-assistants. Transcriptions served as the basis for a content analysis.

Analysis

For the open questions, we combined conventional content analysis (CCA) and directed content analysis (DCA, cf: Hsieh & Shannon, 2005). CCA is a primarily inductive coding method. To do this coding categories were composed by the coders themselves in two rounds: an open coding round, in which text fragments from transcriptions were converted into themes, followed by an axial coding round. In this last round, themes

were compared to one another and in the end, overarching categories were constructed. Besides CCA, we also used, DCA for some questions. Here coding categories are based on existing theoretical knowledge. For example, for defining academic skills, we established collections of predetermined codes, while still allowing for new codes to be constructed (i.e., by means of CCA). Coders used a predetermined set of codes based on the Science Student Skills Inventory (SSSI), a measure of science students' skills (Matthews & Hodgson, 2012) and based on SBP's learning outcomes (e.g., Grooters et al., 2022a). The construction of additional codes was allowed, as we did not expect the predetermined set to be fully exhaustive as the SBP program is not a "common" science program with an additional focus on entrepreneurship.

Initial coders were student-assistants (i.e., MA students) together with the second author of this paper, all of whom had training and prior experience in quantitative and qualitative coding. Based on a code book with coding categories determined in the axial coding round, including a description of the codes, two independent coders (also MA student-assistants) coded 30% of the data again (for an example of the codebook, see ST6). Cohen's kappa was used as a reliability measure with Mean k=0.87. All kappa's were acceptable to perfect (ranging from .74 to 1). For Cohen's kappa per question, see ST7.

The closed-ended questions were on 7-, and 10-point scales (for closed-ended questions, see ST8). For these questions, we calculated descriptive statistics (means, standard deviations, minimum and maximum values) for the full sample, and for SBP+ and SBP- individually. Please note that we did not carry out (non-)parametric tests to investigate potential differences in means between groups (i.e., samples were too small and this was not the specific goal of our study).

Results

General perception of the SBP track

By most professors SBP was perceived as "not traditionally academic" (ST9). SBP was seen as different from the conventional, research-based, academic route (ST10), more practice-oriented, broadening and orienting outside academia. Participant 17 specified: "It has its own niche in that it teaches skills and knowledge that are not covered in regular programs and that are important for careers outside university research." Negative associations were also mentioned, related to a reduced focus on research and an academic career (e.g., PhD, post-doc, teaching) after the program.

The image of SBP was viewed in varying, but mostly positive ways. SBP was regarded as attractive for doubting students, being positive for the faculty or as a program that meets

student needs. Some professors perceived their colleagues to have a more negative image of SBP. For example, "I think it's just going really well. Of course, there are some older scientists who think that the whole world consists of science. But it is absolutely not the case that the faculty is still thinking about abolishing the SBP program (participant 4)."

There is a strong consensus that SBP is an academic program, suited to be taught at the university (ST11). A general view was given by participant 4: "And so I think what the university of applied sciences does is application, but not by definition of science. So SBP does academic science and it is applied." Professors strongly agreed that SBP is a positive addition to the curriculum (7-point scale, M=6.40, SD=0.60, Min=5, Max=7, all positive, ST11). No professor explicitly saw SBP as a negative addition (M=1.40, SD=0.60, Min= 1, Max=3, ST11).

General perception of WBL

When asked to define WBL, professors mainly described WBL as learning through practice (ST12). Specific associations were solving problems, research, critical attitude, doing an internship, continuous learning, practice-oriented, interaction, independence, applying knowledge, business, creativity, allowed to make mistakes and project-based. There were only 4 participants completely unfamiliar with WBL. The term mostly evoked associations on working with stakeholders outside academia: "I think that we (the university) should not position ourselves on an island in society (participant 15)."

The multidisciplinary nature is considered positively and important by the majority of the participants. One of the participants stated (ST13): "Eventually, out of this group of 50, 8 Nobel laureates emerged. Those were all people who are so very independent, creative and off the beaten track, thought about certain issues and also in strong interdisciplinary collaboration, that was really formative for the example of those people (participant 14)." Other associations with WBL mentioned: societally oriented, generalists and modern. Nine professors gave practical examples of well-working multidisciplinary collaboration between different research areas or between academia and society. Eight professors explicitly indicated that they supported multidisciplinary collaboration. Eight professors also mentioned tension with the scientific specialism and/or multidisciplinary at the expense of the discipline: "I think that those are very good, multidisciplinary courses. Yet, I do realize that this is at the expense of the specialist knowledge of one specific field. (participant 5)." Only one professor explicitly mentioned multidisciplinarity to be harmful for a scientific career.

Academic level

To discuss academic level professors were first asked to explain what they thought an academic level was (ST14). Some participants struggled with this question: "It's strange that you've been working for 37 years and actually have no idea (of what an academic level entailed, participant 3)", others had a clear idea: "academic level is for me, as I came from industry back to academia, also the independent way of thinking. So not to be afraid, let's say, of saying something that's not mainstream and that really doesn't fit the common way of thinking (participant 9)."

Keywords mentioned most frequently are independence, critical attitude, high intellectual level, analytical attitude, creative thinking and an ability to conduct scientific research. How an academic level is developed was up for debate (ST15). According to the majority, ways to increase your academic level was by doing research and teaching, by scientific writing or by interaction and collaboration with others.

Professors were satisfied with their own academic level and of their academic environment (ST16). The average score (10-point scale) was M=7.72 for the faculty, M=7.94 for their institute, M=8.26 for their department and an M=8.44 for themselves. Within this there is a reasonable consensus (low SD's, ranging from 0.54 to 1.28) and not one insufficient grade was given. The closer the evaluation was to themselves, the higher the academic level was estimated. One professor even underlined this finding: "you can write down that I said most intelligent people are here. Yes, the level is basically higher here (participant 13)."

When specifically focused on educational programs, a research master program was perceived to be academic (ST17). This belief was stronger for SBP- than in SBP+. According to the professors a master's program that is not focused on research can still be academic but less so. The opinion of a SBP- participant: "yes, that's good, a lot of contact with companies and institutes. And it's actually quite good if you don't listen too much to companies, because that's application, that the academic side of it is preserved. So you have to be careful as a university, you have to be careful that you also monitor the academic side (participant 7)" How master programs can contribute to reaching an academic level appeared ambiguous to professors (ST17, 7-point scale). In general, the classical writing of a thesis was considered to contribute less to the academic level (M=4.05) than WBL (M=4.75) and SBP (M=5.55). Furthermore SBP+ saw less benefit in a thesis than SBP- (M=3.37 vs. M=4.44), but also less benefit in WBL (M=4.00 vs. M=5.67) and SBP (M=5.00 vs. M=6.22), specifically as contributing to reaching an academic level. SBP+ professors seemed more critical about attaining a sufficient academic level. SD's were also larger for SBP+ (ranging from 1.67 to 2.37), indicating less consensus in scores compared to SBP- (ranging from 0.67 to 1.74) .

Academic skills

Besides academic level professors also reflected on academic skills. An example of a definition of academic skill given by a professor: "That is being able to logically analyse a problem statement and a possible sub-problem. […] And then distill an approach to solve that question (participant 3)."
Academic skills (ST18) that were most often mentioned by professors were: critical thinking, analytical thinking, research skills and goal-oriented communication. Strategic thinking, written presentation, processing literature, independence, teamwork and problem-solving thinking were also mentioned frequently. There seems to be a difference between professors with and without SBP experience in how they perceive academic skills. SBP- mentioned more focus on critical thinking, analytical thinking, research skills, written presentation and processing of literature. SBP+ emphasized matters such as targeted communication, independence, teamwork, objectivity and ethical responsibility.

In line with the results for academic level, professors also seemed very satisfied with their own academic skills, no professor scores themselves below 7 (10-point scale, with max=10, ST19) with M=8.58. This was about one point higher than how they rated their students in terms of skills (M=756), where again there were no scores lower than a 7.

About half of all participants indicated that developing academic skills is a continuous process (ST20). Education during the study, during a PhD, master or bachelor program, were also mentioned as moments of development. The majority thinks development of academic skills largely takes place at university, with only two respondents indicating that this also happened outside the university. The combination is nicely illustrated by a professor: "I think I developed those skills to a very large extent during my master projects and doctoral research periods, but also when I was not in Groningen but at other universities and other institutes. Where you were on your own and therefore forced to have conversations and to make decisions very independently. …where you simply tried yourself or discovered through direct feedback what works and what doesn't. And not because of the pre-cooked program in your own study program. So I think for a large part outside my own education (participant 1)."

The ways to develop these skills were perceived as divers (ST 21): doing research, interacting with others or your environment in general, presenting orally, teaching, attitude/character, feedback, collaborating with peers, written presentation, practical experience, applying knowledge, interaction with academics are mentioned. Many of the activities mentioned were similar to those of developing academic level. Critical and analytical thinking were seen as a major part of both.

Focusing on education, professors often believed that academic skills can be developed by WBL, both groups agreed similarly on this, 6.4 on a 7-point scale (ST22). When the focus is on the SBP program instead of on WBL in general, participants were very positive about the contribution of SBP to the development of academic skills, with consensus between both groups (small SD). Compared to the development of academic skills with a traditional master's program, SBP scores neutral to positive for both groups. SBP is considered contributing positively to the development of academic skills and equal to or better than a traditional program.

Role of University in Professional development

Professors disagreed slightly with the statement that the university should focus on careers for students within (M=3.37) or outside (M=3.47) academia (ST23). They were more positive about the time university spends on career preparation and were much more positive about the time spent on preparing for an academic career than on preparation for a non-academic career. The evaluations of statements on this topic were diverse indicating a large range of opinions on career preparation (Min=1, Max=7, SD's ranging from 0.47 to 2.01).

Most professors indicated during the interview that they valued the gain of work experience and practically-oriented academic education (ST24). They mentioned: important, academic skills can also be applied outside the academy, regular study components are also career preparation, focus on career preparation belongs within the academy. Less participants thought that gaining work experience is not the responsibility of the university. This is illustrated by participant 4 who mentioned: "I think you should work on that yourself (as a student), that's called academic [...] I don't believe that we should focus on career preparation. We have to teach courses in certain disciplines but not on its application after the master's program". The majority of the professors think that SBP should be standard in the curriculum (ST25), a belief carried stronger by SBP+ (M=5.82, Min=4, Max=7, SD=.94) than by SBP-, the latter also showing less consensus (M=4.67, Min=1, Max=7, SD=2.35).

Professors were also asked about personal development. They described the term as development of academic skills, acquisition of knowledge, professional orientation, communication skills and reflection skills (ST26). Some answers also contained value judgments, ranging from important (by five professors) to side issue (by one professor). Some think there is not sufficient attention: "I think in my opinion it's too little, the personal development (participant 9)."

Career perspective and study choice

In terms of career preparation (ST27), professors thought that WBL contributes to both career preparation within academia (M=5.9, with SBP– more positive) and even more strongly outside academia (M=6.2, with SBP+ more positive). Still, all respondents generally recommended a WBL master's to students pursuing both academic and non-academic careers.

Zooming in on SBP and career preparation (also ST27), professors also saw a contribution to career preparation within academia and even much stronger outside academia. A professor stated: "Our program is really aimed at preparing students for PhD research, if that is not what you want, then Science, Business and Policy has a very high added value (participant 17)". On average, they would not recommend SBP for students pursuing an academic career. For students pursuing a career outside the university, they would strongly recommend SBP. Reflecting on this (ST28) professors state that they would recommend SBP if students doubt about their academic ambition, do not want to continue with research and/or when they have a clear ambition outside academia and/or do not want to continue in research. The reason for this advice is because SBP is seen as a good preparation for a career outside academia, better orientation to the professional field outside academia, development of other skills and internship opportunities. The reasons for not recommending SBP were less prominently mentioned and included: SBP comes at the expense of research skills, the research master is just as good or better, job opportunities are less or the program has little added value.

Discussion

For this study professors of the university of Groningen were interviewed about their vision on and attitudes towards Work-Based Learning, focusing on a specific example of WBL within their own university, the Science, Business and Policy (SBP) program.

It should be noted that we cannot rule out the possibility of social desirability bias to have occurred – the tendency to provide answers that provide a more favourable image of oneself or answers that diverge towards one's social norms or perceived social norms of the interviewer (van de Mortel, 2008). In addition, author bias risk is something we had to take into account, measurements to prevent this are described in the method section. These measures reduced the risk of social desirability and author bias. However when we zoom into findings, initially we expected to find at least some resistance and scepticism. This is expectation is based on a few different arguments.

Firstly, since SBP is a program that differs from the classical academic route one can expect to find a general aversion, as described in literature mentioning a pattern of resistance to change in academia in general (Tagg, 2012) and, more specifically, the field of science, which is described as conservative, change resistant and sceptical towards educational innovation (Lane, 2007). This is in line with the experience of the initiators of SBP in the start years of the program, who experienced resistance at the start of SBP, especially in disciplines of physics and chemistry.

The second reason to expect resistance is related to the nature of SBP. For successful implementation of problem-based learning in a classical curriculum, Neve et al. (2018) found that it is essential, but also difficult to align with existing attitudes and views of facilitators. SBP is maybe even more extreme because the entire curriculum is WBL-based, and does not contain just one problem-based learning element. Also the specific focus on (the impact on and integration with) society of this education could potentially form resistance. It is known as difficult to identify, conceptualize and measure higher education's contribution to society (Smolentseva, 2022).

The third reason is the extra attention to employment, which forms a new task, added to the already heavy workload of staff. This is also found in literature where for example Bennett (2019) concludes in a review of higher education that it is logical that there is a lack of commitment to incorporating employability in the curriculum because staff lacks time, resources and expertise. At the university of Groningen, we also found some hesitation. Interviewees were divided about how much time should be spent on career prospects, and also about the focus of this (academia vs non academia).

On the other hand, since SBP is already there for over fifteen years, and has a growing interest of students, change in attitude and vision may also have taken place. This is the main finding from the interviews with professors discussed in this paper: they all perceived SBP as a positive addition to the curriculum. They recommended SBP especially for students with career ambitions outside academia. Academics often find the student perspective important in innovation in education (Huang 2020). For SBP a positive attitude towards this alternative form of education was present based on the interviews, especially compared to the early experiences of the initiators of the program. However, the perception of a negative SBP image, not by the interviewees themselves but their thoughts on other colleagues' view on SBP is striking. Interviewees themselves experienced SBP as positive but fill in that colleagues think differently about this.

In addition, the results showed that research-focused programs are seen as academic, and SBP is perceived as "not traditionally academic" and different from the traditional research route on one hand but definitely as an academic program on the other hand. It

is noticeable that professors with experience in the SBP program are more positive than their colleagues that did not work in the SBP program. Unknown seems to make unloved.

When zooming in on "academic level", there was no real consensus what the term exactly entails and how it is developed, the unclarity of the term is also reported in literature. For example, Rosewell and Ashwin (2018) describe that the understanding of academic work and what it means to be an academic is already very complex, even from the perspective of the academics themselves. In this paper we tried to overcome this problem by letting professors give their own definition of academic level and academic skills. This does not tackle the problem completely since this still does not provide a univocal definition and different participants of the study might mean different things. But even while the definition might be unclear, remarkably professors see their own academic level as highest, compared to and followed by respectively their department, their institute and their faculty. The closer to themselves, the higher the academic level is estimated. This could be explained by the self-serving bias (cf: Coleman, 2011), in which people take more credits personally for things they do well and label these as internal attributions to protect self-esteem.

Academic skills are also seen a bit different by the SBP+ and SBP - participants, but seem to cover exactly the items/scales of the SSSI, an Australian academic skill list (Matthews & Hodgson, 2012). Differences were found in which academic skills were mentioned most frequently; SBP+ relatively valued higher targeted communication, independence, teamwork, objectivity and ethical responsibility and SBP– valued specifically critical and analytical thinking, research skills, written presentation and processing of literature. This might be explained by the fact that there are more SBP+ respondents with experience outside academia, which translates in assessing other skills relevant. Similar to the perceptions on their academic level, professors are most satisfied with their own academic skills followed by respectively their department, their institute and their faculty. When examining how to develop academic skills, SBP is considered to contribute to the development of academic skills in an equal to or better way than a traditional program. Summarized, a very positive attitude of professors towards WBL is seen in terms of skills.

Not only the case of SBP but also Work-Based Learning in general seems to evoke predominantly positive associations, and so does the multidisciplinary nature. On average professors believed that WBL contributes more to reaching a good academic level then the classical writing of a thesis. This is coherent with literature were a relation between academic performance and work placement (McCann & Hewitt 2023) is found. Besides academic level, professors also think academic skills can be developed by the use of WBL. WBL is perceived as useful for career preparation within academia and even stronger outside academia.

The conclusion is that WBL seems to be accepted in the organization as a suitable and valuable form of master education. SBP, here presented as a WBL case study, has gained an increased support over the past 15 years and it seems embedded in the academic culture.

When translating this development to change management in general, the final step of change management (Kotter, 1996), which is seen as crucial for making sustainable transitions - the incorporation in the organizational culture - seemed to actually have taken place in SBP. There is still room for even stronger incorporation in the organizational culture, since SBP does not have its own permanent professorship, which is usually seen as the ultimate recognition in academia. However, steps are made and the incorporation is finally becoming visible now in organisational structure, since SBP recently got a formal director. The embedding in program and exam committees is also formalised. Kotter's last step and thereby change in the academic landscape is stated in literature to be very difficult, for example Henderson et al. (2012) describe that even when innovation does take place, science faculties often discontinue educational innovation. Loughlin et al. (2020) describes a lack of commitment as an important barrier.

This paper is of interest to the rest of the world because it shows that even though resistance is experienced at the start-up of implementing an alternative education form, in this case Work-Based Learning, it takes time for high level academics to embrace educational change. The SBP case shows that even though there is resistance at the beginning, it can be done, and a new program can be accepted and valued in the long run. This can be seen as an example, for other universities worldwide, also outside the science discipline.

Another important lesson for those who are external practitioners, educational developers, course designers or planners, or in other ways involved in change in education, this paper shows that Work-Based Learning has a place in Higher Education, and it is possible to offer this in a sustainable way within the curriculum, as a valuable and innovative education form. We hope this forms an invitation to incorporate WBL in higher education, so it will be no longer an exception to gain job experience within the academic program, and the overall acceptance for WBL improves so it can be an obvious element in every curriculum. Looking at the results in Groningen WBL as a discipline should be much more confident.

The argument that WBL originated in vocational education and is thereby not suitable for higher education is proven wrong in this paper. In Groningen, WBL is perceived to generate a positive contribution to academic level. At this case study we see that higher

and experienced academic staff judges WBL as a suitable method to develop academic skills and can contribute to student development in a positive way.

Even though it might be difficult this study indicates it is not a mission impossible. The experiences with SBP from professors teaching at the university of Groningen, the Netherlands, would indeed indicate the possibility of a sustainable change and commitment for a step in the WBL revolution in higher education.

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Supplemental Tables (ST)

Supplemental table 1: Frequency (%) or respondents per discipline

Discipline	N (%
Biomedical Scienes	4 (20%)
Biology	4 (20%)
Pharmacy	3 (15%)
Neurobiology	2 (10%)
Chemistry	2 (10%
Physics	2 (10%
Marine biology	2 (10%)
Mathematics	1 (5%)

Supplemental table 2: Age of participants in years total and by gender

	M	SD	Min	Max
Age total	56.25	7.09	42	71
Age SBP + (N = 11)	57.73	7.36	42	71
Age SBP -	54.44	6.71	45	62
Age male (N = 15)	57.68	6.77	42	71
Age female	52.00	6.96	45	62

Supplemental table 3: Length of working at RUG in years

	M	SD	Min	Max
Years working on RUG	18.03	11.40	0	47
SBP + (N = 11)	19.82	13.54	4.5	47
SBP -	15.83	8.35	0	30

Supplemental table 4: Work experience outside academia of participants (Yes/No Question)

	SBP + (N=11)	SBP – (N=9)	Total
Yes	6	2	8
No	5	7	12
Total	11	9	20

Supplemental table 5: Length of work experience of participants outside academia in years

	M	SD	Min	Max
Years working outside academia	12.38	8.33	1	29
SBP + (N = 6)	11.00	5.06	1	15
SBP – (N = 2)	16.50	17.68	4	29

Supplemental table 6: Codebook example

Please describe in your own words what you think an academic level reflects.

Codes	Description
Scientific content knowledge	Mastering scientific knowledge in a particular field.
Oral communication skills	Being able to present/communicate orally at different levels with different stakeholders (e.g., colleagues, students)
Writing skills	Being able to write and report well (e.g., for scientific journals or funding)
Research skills	Being able to carry out all components of scientific research independently (e.g., formulate research questions, devise a research design, carry out research, carry out (statistical) analyses etc.)
Ethical/professional behavior	Understand the ethical and role as a professional scientist and from this role have the need for ethical/professional research.
Academic reasoning	Being able to look critically and analytically towards a variety of issues, including other (scientific) research.
etc.	etc.

Supplemental table 7: Questionnaire Topics open questions, items used and Cohen's Kappa

Open questions	Cohen's Kappa
Please describe in your own words what you think academic skills reflect.	0.849
Where do you think you have developed your academic skills?	0.877
When do you think you have developed your academic skills?	0.769
And which activities do you think have contributed to developing your academic skills?	0.872
Please describe in your own words what you think an academic level reflects.	0.867
Where do you think you have developed your academic level?	0.949
And which activities do you think have contributed to developing your academic level	0.748
Please describe in your own words what you think work-based learning is.	0.804
Please describe in your own words how you think about multidisciplinary master tracks.	0.864
Please describe in your own words how you think about education at the university that is practically oriented.	0.740
Please describe in your own words what you think the place of personal development for students within the curriculum of the FSE should be.	0.903
What comes to mind when you think about the master's variant Science, Business and Policy?	0.802
Why would you (not) recommend students to follow the SBP program if they want to pursue a career in academia?	0.878
When would you (not) recommend students to follow the SBP program if they want to pursue a career in academia?	1
Why would you (not) recommend students to follow the SBP program if they want to pursue a career outside academia?	0.936
When would you (not) recommend students to follow the SBP program if they want to pursue a career outside academia?	0.942
Why do you think the SBP program has a positive/negative impact on the quality of the FSE curriculum	1
Please describe in your own words how you think about a master track that combines one disciplinary year, that includes laboratory research, with one work-based learning oriented Science, Business and Policy year.	0.924
How do you think the Science, Business and Policy master track deviates from a traditional master track?	0.885
Mean Kappa	0.874

Supplemental table 8: closed-ended questions asked in the interviews

Closed-ended questions	7-point / 10-point
A program like SBP is academic	7
SBP is a positive addition to FSE master's programs	7
SBP is a negative addition to FSE master's programs	7
If you had to grade the average academic level of the FSE, which grade would you give? With one having no academic level at all, to ten having the best academic level possible.	10
If you had to grade the average academic level of your institute, which grade would you give? With one having no academic level at all, to ten having the best academic level possible	10
If you had to grade the average academic level of your department, which grade would you give? With one having no academic level at all, to ten having the best academic level possible.	10
If you had to grade your own academic level, which grade would you give yourself? With one having no academic level at all, to ten having the best academic level possible	10
I believe a master's program that is focused on research can be academic	7
I believe a master's program that is not focused on research can be academic.	7
I believe an academic level can be developed sufficiently through work-based learning	7
I believe an academic level can be achieved through writing a thesis.	7
I believe an academic level can be achieved through the SBP program	7
I believe academic skills can be developed through work-based learning	7
I believe academic skills can be developed through the SBP program	7
I believe academic skills can be developed just as much through the SBP program as through a traditional master's program	7
I believe the university should focus on preparing students for a career in academia	7
I believe the university should focus on preparing students for careers outside of academia	7
I believe the university spends enough time on career preparation for students focused on a career outside academia	7
I believe the university spends enough time on career preparation focused for students on a career in academia.	7
I believe the university spends enough time on career preparation for students	7
I believe the SBP program should have a standard place in the curriculum of FSE.	7
I believe work-based learning contributes to students' career preparation for working in academia.	7
I believe work-based learning contributes to students' career preparation for working outside of academia. (14)	7
I would recommend students to follow a work-based learning master's program if they want to pursue a career in academia	7
I would recommend students to follow a work-based learning master's program if they want to pursue a career outside academia.	7
I would recommend students to follow the SBP program if they want to pursue a career in academia.	7
I would recommend students to follow the SBP program if they want to pursue a career outside academia.	7
I believe the SBP program contributes to students' career preparation for working in academia.	7
I believe the SBP program contributes to students' career preparation for working outside academia.	7

Supplemental table 9: What comes to mind when you think about the master's variant Science, Business and Policy (open question)

Code	Total (*N*=13)	SBP + (*n*=5)	SBP- (*n*=8)
Not relevant to academic ambition	3	2	1
Less research (skills) at SBP	2	1	1
Relevant for ambition outside of academia	3	1	2
Internship	1	0	1
Bridging role between science and society	2	0	2
Orientation in work field	3	0	3
Policy making	2	0	2
Applying science	2	1	1
Positive image	2	0	2
Advising role	1	0	1
Development of general skills	2	2	0
Focus on business policy	2	1	1
Visitation via biology	1	0	1
Fit could be better for some previously followed BA/MSc	1	0	1
Not in-depth enough	1	1	0

Supplemental table 10: How do you think the Science, Business and Policy master track deviates from a traditional master track? (open question)

Code	Total (*N*=19)	SBP+ (*n*=11)	SBP- (*n*=8)
SBP focus on research/advising outside academia	6	5	1
SBP offers internships	2	0	2
Less research in SBP	5	3	2
Less career opportunities in research outside academia with SBP	1	0	1
SBP acts at the expense of specialization	3	2	1
Other courses in SBP	5	1	4
SBP focuses on societal/practical issues	3	2	1
SBP has a broadening role	2	1	1
Applying scientific knowledge in business/policy	4	4	0
SBP has bad image internally	2	2	0
SBP not/less academic	4	2	2
SBP multidisciplinary	1	0	1
SBP more skills	2	2	0
SBP develops professional network	1	1	0
SBP is more diverse	1	0	1
Career opportunities in academia less with SBP	1	1	0
Difference in focus	2	0	2
SBP focus on career outside academia	2	0	2
No difference in level	1	1	0
Don't know	2	1	1
SBP rigid	1	1	0
SBP working with people more	2	2	0
SBP learns how to deal with other stakeholders	1	0	1
SBP more focused on ethics	1	0	1
SBP integrates knowledge from inside and outside academia	1	1	0
SBP focusses on policy/industry	1	0	1

Supplemental table 11: General Perceptions of SBP (7-point scale: 1 totally disagree-7 totally agree)

Statement	Sample	M	SD	Min	Max
A program like SBP is academic	Total (*N*=20)	6.00	0.65	5	7
	SBP + (*n*=11)	5.82	0.60	5	7
	SBP - (*n*=9)	6.22	0.67	5	7
SBP is a positive addition to FSE master's programs	Total (*N*=20)	6.40	0.60	5	7
	SBP + (*n*=11)	6.45	0.52	6	7
	SBP - (*n*=9)	6.33	0.71	5	7
	Total (*N*=20)	1.40	0.60	1	3
SBP is a negative addition to FSE master's programs	SBP + (*n*=11)	1.36	0.51	1	2
	SBP - (*n*=9)	1.44	0.73	1	3

Supplemental table 12: Please describe in your own words what you think work-based learning is (open question)

Code	Total (*N*=20)	SBP+ (*n*=11)	SBP- (*n*=9)
Work placement/internship	1	0	1
Continued learning process	2	1	1
Oriented on practice	2	2	0
Step-by-step guidance	3	1	2
Development skills	2	0	2
Independence	3	2	1
Applying knowledge	2	1	1
Solving problems	3	2	1
Academic	1	0	1
Business	2	0	2
Motivation students	2	1	1
Research	3	1	2
Making mistakes	3	2	1
Project-based	1	1	0
Creativity	1	1	0
Not for everyone	2	1	1
Learn by doing	13	8	5
Unknown term	4	4	0
Working motivates	1	0	1
Fulfilling assignment	1	1	0

Supplemental table 13: Please describe in your own words how you think about multidisciplinary master tracks (open question)

Code	Total (*N*=20)	SBP+ (*n*=11)	SBP- (*n*=9)
Positive evaluation/judgment	16	9	7
Gave definition	3	1	2
Stress importance of specialization	5	3	2
At the expense of specialization	3	3	0
Societally oriented	2	1	1
Inferior to specialization	2	2	0
Generalistic = negative	3	1	2
Insufficient at this time in society	1	1	0
Modern	2	0	2
Room for improvement	1	0	1
Not conducive to scientific career	1	0	1
Necessary at this time in society	2	0	2
Gives examples of where it is	9	6	3
Emphasizes the importance of own field	4	2	2
Only important at the highest level	1	1	0
At the expense of academic level	1	1	0
Is for a certain type of person	1	1	0
Must be set up properly	3	2	1
Not as main track	2	2	0
Learning to deal with other fields	1	0	1

Supplemental table 14: Describe in your own words what you think an academic level reflects (open question)

Code	Total (*N*=20)	SBP+ (*n*=11)	SBP- (*n*=9)
Scientific content knowledge	5	3	2
Oral communication skills	5	4	1
Writing skills	3	3	0
Research skills	9	5	4
Ethical/professional behavior	3	2	1
Academic reasoning	10	6	4
Leadership skills	1	1	0
Independent thinking	7	5	2
Creativity	4	2	2
Knowledge transferring/Teaching others	4	2	2
Reading skills	2	2	0
Interdisciplinarity	1	1	0
High quality	1	0	1
Bridge Science & Society	2	2	0
Independently forming opinions	3	3	0
Flexibility	1	1	0
Open-minded	1	1	0
Carrying out relevant research	2	2	0

Supplemental table 15: Which activities do you think have contributed to developing your academic level? (open question)

Code	Total (*N*=20)	SBP+ (*n*=11)	SBP- (*n*=9)
Research	10	6	4
From others/environment	2	1	1
Writing	5	4	1
Teaching	5	4	1
Teamwork	7	4	3
Oral presentation	3	2	1
Leadership	2	1	1
Independence	2	0	2
Study/course	2	2	0
Reading literature	3	3	0
Put theory into practice	2	0	2
Scientific events	3	2	1
Character/attitude	3	3	0
Outside university	1	1	0
Creativity	1	0	1
Raising funds/scholarships	4	2	2
Advising/supervising	7	5	2
Receiving feedback	3	2	1
Learn from rules	1	0	1
Publish	4	4	0
Travel	1	1	0
Gain professional knowledge	1	1	0

Supplemental table 16: Average academic level of faculty, institute, department and self (10-point scale, 1 very bad-10 excellent)

Statement	Sample	M	SD	Min	Max
Average academic level of FSE	Total (*N*=18)	7.72	0.75	7	9
	SBP + (*n*=10)	7.60	0.84	7	9
	SBP - (*n*=8)	7.87	0.64	7	9
Average academic level of institute	Total (*N*=18)	7.94	1.00	6	10
	SBP + (*n*=10)	8.10	0.74	7	9
	SBP - (*n*=8)	7.75	1.28	6	10
Average academic level of department	Total (*N*=19)	8.26	0.56	7	9
	SBP + (*n*=11)	8.27	0.65	7	9
	SBP - (*n*=8)	8.25	0.46	8	9
Average academic level of self	Total (*N*=18)	8.44	0.71	7	10
	SBP + (*n*=11)	8.36	0.81	7	10
	SBP - (*n*=7)	8.57	0.54	8	9

Supplemental table 17: Rating statements on academic level (7-point scale: 1 totally disagree-7 totally agree)

Statement	Sample	M	SD	Min	Max
A master program focused on research can be academic	Total (*N*=20)	6.25	1.16	2	7
	SBP + (*n*=11)	5.91	1.45	2	7
	SBP - (*n*=9)	6.67	0.50	6	7
A non-research focused master program can be academic	Total (*N*=19)	4.47	2.01	1	7
	SBP + (*n*=11)	4.45	2.07	2	7
	SBP - (*n*=10)	4.50	2.07	1	7
Academic level can develop via WBL	Total (*N*=20)	4.75	2.15	2	7
	SBP + (*n*=11)	4.00	2.37	2	7
	SBP - (*n*=9)	5.67	1.50	2	7
Academic level can develop through writing a thesis	Total (*N*=20)	4.05	1.88	1	7
	SBP + (*n*=11)	3.37	2.01	1	7
	SBP - (*n*=9)	4.44	1.74	2	7
Academic level can be achieved via SBP	Total (*N*=20)	5.55	1.43	2	7
	SBP + (*n*=11)	5.00	1.67	2	7
	SBP - (*n*=9)	6.22	0.67	5	7

Supplemental table 18: Describe in your own words what you think academic skills reflect (open question)

Code	Total	SBP+	SBP-
Scientific content knowledge	5	4	1
Communication skills	13	7	6
Writing skills	7	3	4
Quantitative skills	9	4	5
Teamwork	3	1	2
Ethical thinking	4	3	1
Carry out research	4	1	3
Academic reasoning	12	6	6
Project-based working	2	1	1
Leadership skills	1	1	0
Working independently	7	3	4
Reading skills	3	1	2
Gathering information	8	6	2
Formulate opinion	2	2	0
Self-reflection	1	1	0
Flexible	1	1	0
Open-minded	1	1	0
Importance practice	3	2	1
Insight contexts of course	1	1	0
Creative	1	1	0
Competences for a job	1	0	1
Being able to teach	1	0	1
Networking	1	0	1

Supplemental table 19: Academic skills of self and students (10-point scale, 1 very bad-10 excellent)

	M	SD	Min	Max
Skills self (N=19)	8.58	.69	7	10
SBP + (N=11)	8.45	.82	7	10
SBP – (N=8)	8.75	.46	8	9
Skills student (N=18)	7.56	.78	7	9
SBP + (N=11)	7.45	.69	7	9
SBP – (N=7)	7.71	.95	7	9

Supplemental table 20: Where and when do you think you have developed your academic skills? (open question)

Code	Total	SBP+	SBP-
PhD	13	7	6
Continued process	8	3	5
Bachelor & Master	11	6	5
Post Doc	6	4	2
Career (after study)	7	4	3
Master	3	3	0
From highschool on	2	2	0
Outside academia	2	1	1
Congress/Conferences	1	0	1
During teamwork	2	0	2
Internships	1	0	1
From childhood on	1	1	0

Supplemental table 21: Which activities do you think have contributed to developing your academic skills? (open question)

Code	Total	SBP+	SBP-
Carrying out research	10	6	4
Learning from others	2	1	1
Oral presentation	6	3	3
Teaching courses	4	3	1
Attitude/character	2	2	0
Written presentation	7	4	3
Receiving feedback	4	1	3
Teamwork with colleagues	4	3	1
Leading a research group	1	0	1
Applying knowledge	1	1	0
Interaction with colleagues	7	3	4
Following courses	4	1	3
Going to conferences	2	2	0
Supervising others	4	2	2
Make the project your own	1	0	1
Giving feedback	2	1	1
Committee and council work	3	2	1
Reading work from others	2	1	1

Supplemental table 22: Ratings of statements regarding via which methods academic skills can develop (7-point scale: 1 totally disagree-7 totally agree)

Statement	Sample	M	SD	Min	Max
Academic skills can develop via WBL	Total (*N*=20)	6.40	0.82	4	7
	SBP+ (*n*=11)	6.36	0.92	4	7
	SBP- (*n*=9)	6.44	0.73	5	7
Academic skills can develop via SBP	Total (*N*=20)	6.15	0.49	5	7
	SBP+ (*n*=11)	6.00	0.45	5	7
	SBP- (*n*=9)	6.33	0.50	6	7
Academic skills can develop as much via SBP as traditional master's	Total (*N*=20)	4.70	1.78	2	7
	SBP+ (*n*=11)	4.64	1.86	2	7
	SBP- (*n*=9)	4.78	1.79	2	7

Supplemental table 23: Ratings of agreement with statements relating to the university's commitment to career preparation, and whether SBP should be part of the FSE curriculum (7-point scale: 1 totally disagree-7 totally agree)

Statement	Sample	M	SD	Min	Max
University should focus on academic career preparation	Total (*N*=19)	3.37	1.89	1	7
	SBP+ (*n*=11)	3.27	2.01	1	6
	SBP- (*n*=8)	3.50	1.85	2	7
University should focus on non-academic career preparation	Total (*N*=19)	3.47	1.68	2	6
	SBP+ (*n*=11)	3.27	1.79	2	6
	SBP - (*n*=8)	3.75	1.58	2	6
University spends enough time on career preparation	Total (*N*=18)	4.56	1.65	1	7
	SBP+ (*n*=11)	4.91	1.64	1	6
	SBP- (*n*=7)	4.00	1.63	2	7
University spends enough time on academic career preparation	Total (*N*=19)	5.63	0.90	3	7
	SBP+ (*n*=11)	5.73	0.47	5	6
	SBP- (*n*=8)	5.55	1.31	3	7
University spends enough time on non-academic career preparation	Total (*N*=18)	4.28	1.74	2	7
	SBP+ (*n*=11)	4.55	1.70	2	6
	SB - (*n*=7)	3.86	1.86	2	7

Supplemental table 24: Could you describe in your own words how you feel about practical-oriented academic education? (open question)

Code	Total (*N*=18)	SBP (*n*=10)	Non-SBP (*n*=8)
Full track is oriented to practice	7	4	3
Research is practice oriented education	3	1	2
Connection to society is important	3	3	0
Non-academic > vocational level	2	1	1
Positive evaluation/judgement	11	7	4
Preparation for career	1	0	1
OK for some master's	1	1	0
Soft skills	1	1	0
New issues arise	2	1	1
Apply knowledge	3	1	2
Ensuring academic education	3	0	3
Societal oriented	3	2	1
Room for improvement	3	1	2
Underestimated	1	1	0
Problem solving	1	1	0
Combination of theory and practice	2	1	1
Promotes academic level	3	2	1
There should not be a focus on practice	4	3	1
Teamwork with institutes and business	2	1	1
Gain practice experience	1	1	0
Always been there	1	1	0
Academic skills are good for practice	2	1	1

Supplemental table 25: SBP should be standard in FSE curriculum (7-point scale, 1 totally disagree-7 totally agree)

	M	SD	Min	Max
Total (N=20)	5.30	1.81	1	7
SBP + (N=11)	5.82	.94	4	7
SBP -	4.67	2.35	1	7

Supplemental table 26: Could you describe in your own words what should in your opinion be the place of student personal development in the FSE curriculum? (open question)

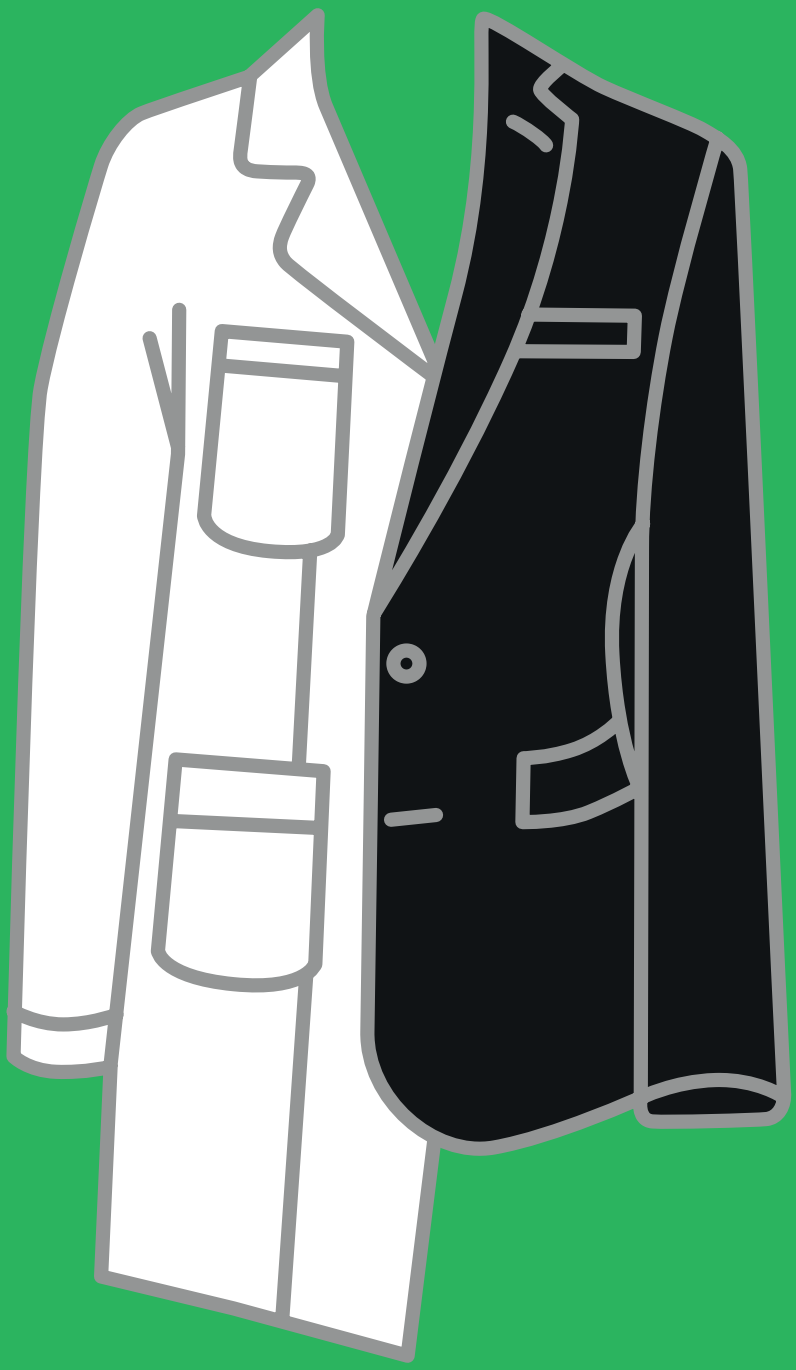
Code	Total (*N*=19)	SBP (*n*=11)	Non-SBP (*n*=8)
Important place	2	2	0
Side issues	1	1	0
During full education: BA & MSc	5	2	33
Master's	8	3	5
Bachelor's	5	4	1
Responsibility of student	4	3	1
During the research phase	3	1	2
Throughout the years	2	2	0
Internship	2	1	1
Currently room for improvement	4	3	1
Dependent of individual	2	1	1
Together with development of academic skills	4	2	2
Career orientation	2	0	2
Communication skills	1	1	0
Reflection	2	2	0
Working independently contributes	2	0	2
Learning to be critical	1	0	1
Personal development is more than academic skills	3	1	2
Cope with disappointment	1	0	1
Communication with supervisors	4	2	2
Learn from/with peers	3	1	2
Courses/education	3	2	1
Role university	3	2	1
Already integral part of education	6	3	3
Additional activities outside university	2	0	2
Students should get more room for it	2	2	0
Presentation skills	1	1	0
Giving/receiving feedback	1	1	0
Multidisciplinary activities	1	1	0

Supplemental table 27: Ratings of agreement with statements relating to WBL and SBP for career preparation (7-point scale: 1 totally disagree- 7 totally agree)

Statement	Sample	M	SD	Min	Max
WBL contributes to academic career preparation	Total (*N*=20)	5.85	1.09	2	7
	SBP+ (*n*=11)	5.64	1.29	2	7
	SBP- (*n*=9)	6.11	0.78	5	7
WBL contributes to non-academic career preparation	Total (*N*=19)	6.16	0.50	5	7
	SBP+ (*n*=10)	6.20	0.42	6	7
	SBP- (*n*=9)	6.11	0.60	5	7
Would recommend WBL master for academic career	Total (*N*=19)	5.21	1.78	2	7
	SBP+ (*n*=10)	5.20	1.75	2	7
	SBP- (*n*=9)	5.22	1.92	2	7
Would recommend WBL master for non-academic career	Total (*N*=19)	5.58	1.58	2	7
	SBP+ (*n*=11)	5.40	1.65	2	7
	SBP- (*n*=10)	5.78	1.56	2	7
SBP contributes to academic career preparation	Total (*N*=20)	4.80	1.80	2	7
	SBP+ (*n*=11)	4.45	1.86	2	7
	SBP- (*n*=9)	5.22	1.72	2	7
SBP contributes to non-academic career preparation	Total (*N*=20)	6.55	0.76	4	7
	SBP+ (*n*=11)	6.36	0.92	4	7
	SBP- (*n*=9)	6.78	0.44	6	7
Would recommend SBP program for academic career	Total (*N*=20)	2.80	1.61	1	6
	SBP+ (*n*=11)	3.36	1.50	2	6
	SBP - (*n*=9)	2.11	1.54	1	6
Would recommend SBP program for non-academic career	Total (*N*=20)	5.60	1.64	2	7
	SBP+ (*n*=11)	5.73	1.74	2	7
	SBP- (*n*=9)	5.44	1.59	2	7

Supplemental table 28: Why would you not recommend students follow the SBP program if they are pursuing a career within academia? (open question)

Code	Total (*N*=19)	SBP (*n*=11)	Non-SBP (*n*=8)
Less relevant experience	5	3	2
At the expense of research skills	3	2	1
At the expense of theoretical knowledge within specialization	3	1	2
Less career opportunities in academia	6	5	1
Not so much added value for academic career	2	1	1
Does not meet expectations of student	1	0	1
Stay in academia? Research track	6	4	2
Good preparation for career outside academia	2	2	0
Development of additional skills	2	2	0
Orientation work field outside academia	3	2	1
Teachers disadvantage you	1	1	0
Depends on student	2	2	0
Depends on research topic	1	1	0
Good students end up in business	1	1	0



7

Scientists in Society: Limitations of research master curricula and suggestions towards more effective science education

Science master education in Europe is traditionally focused on research. However only a part of science master students continue to work in research, as PhD or even beyond. Others will work in business or policy. The question can be raised whether they are prepared for such a career path, a topic surprisingly hardly studied. Here we show that an alternative master trajectory, as developed in the last 20 years at the University of Groningen and focused on the combination of science, business and policy has shown to be very effective in improving career progress. Students worked on real practise cases both in introductory courses but also in a work based learning approach outside university thus obtaining knowledge of and training in strategic aims and means in societal institutions as shown in extended alumni surveys. Also employers and faculty became positive in their judgement of this educational innovation. In contrast research master students had a delay in their societal career. It is suggested that even in pure research career pathways lessons in strategic decision making during the master education could advance scientific careers. Although some investment in developing a work based learning curriculum is needed we are confident that for most universities such a trajectory will be worthwhile, showing the societal responsibility of universities and at the same time being rewarding not only for students and faculty but also for societal partners that look for scientist who have knowledge of societal approaches.

In the Natural Sciences faculties of most Universities, research activities and student education are the two dominant, but sometimes competing tasks. In the European education policy known as the 'Bologna process' a system of quality assurance of Science education has been implemented, aiming "to strengthen the quality and relevance of learning and teaching" in Europe (1). However, traditionally many Science master (MSc) curricula place emphasis on research activities within an academic context only. This paper is based on our extensive experiences with both the classical 'research oriented' Science master and an alternative Master programme in Science Business and Policy (SBP), which we developed at the University of Groningen. The Netherlands is a pioneer in work based learning (2), which forms the base of the SBP program. Generalisation of the Dutch SBP approach may therefore be relevant in this rather unexplored, but upcoming area of education.

Both the development of critical academic attitudes and knowledge, as well as gaining some experience in research practice should be considered a minimum educational aim for the Science master curriculum. Indeed, one can ask what further professional qualities should be promoted by Science faculties, connected to the possible future career choices and employment of their students. The positive evaluation of the impact of our novel SBP program based on 20 years career history of SBP alumni, and the employers involved in the SBP program, give some observations that might be helpful in shaping the Science master programme going forward. Here we present five major considerations that have

risen from our 20-year experience with SBP and that may be of general interest for the development of science master curricula.

The career perspectives of Science students often lie outside academia. Therefore, preparing them primarily for a career within an academic research setting seems untenable, as the number of available positions for such a career are restricted, and transition into the job market is a bumpy ride (3). Perez *et al.* (4) state that a modern University should be training students to apply knowledge, especially given the complex transition of scientific knowledge to society at large, regularly leads to misappreciation of research efforts. Science should not only operate within the academic environment, but also outside in corporate and governmental contexts. This requires an educational shift away from generating questions, and towards generating solutions; thus moving focus from training fundamental researchers to training critical thinkers who also feel at home in society; and from acquiring knowledge to acquiring the skill set to apply this knowledge.

Based on work-based learning, we have been providing a master program at the University of Groningen that is specifically focused on making such a shift: the 'alternative' Science master program – Science, Business and Policy (SBP, (5)). This program forms the entire second year of a two-year science master (Fig 1).

SBP provides courses that are multidisciplinary at two levels, starting with students with different backgrounds in scientific discipline (for example chemistry, biomedical sciences and ecology) that work together. Secondly students integrate science with new domains, like law and economics, in the course projects. There is extra attention for Responsible research and innovation and ethics, needed for the final part of SBP, the external work placement, which is long, individual and completely within the curriculum.

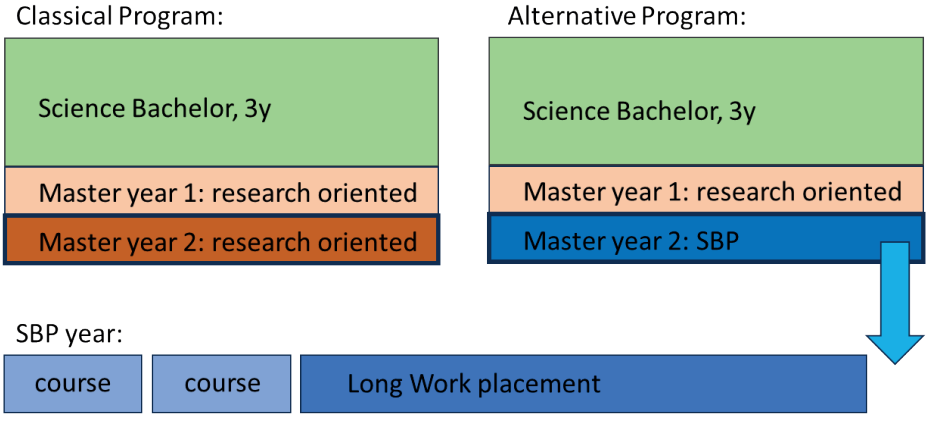


Figure 1: Science, Business and Policy curriculum build-up

Here we present five major considerations that have risen from our 20-year experience with SBP at the University of Groningen that might be important to the development of science master curricula for the next generations. These observations are largely based on findings from a detailed evaluation of the career development of two cohorts of science master students which were students focused either solely on academic research, or on a mix of fundamental research and research in the context of societal aspects of business and policy (5). Our findings highlight the complex interactions between Academia, Students and Society.

1) At least 70% of our research master students (6) do not stay in science after finishing a master or potentially a PhD. Students taught solely with a research focus fall behind in several aspects (like teamwork, leadership skills and communication skills) in comparison to SBP students, leading to a career progress delay of several years after degree completion. Remarkably, the value of their research skills and knowledge decreases rapidly, leading to a skill value that is comparable to, or worse, than students who did not aim for a career within science (7).
2) Aspects of entrepreneurship, communication skills and societal awareness are seemingly necessary for the careers of all science students (8). For SBP master students, the career effectiveness of their specific master program has been demonstrated (7,9). Also for students who initially engage in an academic career and later decide to leave, the just mentioned aspects of the SBP curriculum remain relevant, and these students would be able to profit from these during their master education (7). Analysing careers of prominent academic scientists, we conclude that, in addition to skills and knowledge related to conducting and understanding scientific research, talents in communication, teamwork and project management prevail. The careers of many more scientists could be advanced by spending more time and energy during their education on such topics, resulting in higher publication, educational and grant award rankings.
3) Academic education should have a strong foundation in advanced theoretical and practical research activities, for all students, either in depth in a specific scientific direction or in broadening and interconnecting different scientific areas (6,8). When the latter is chosen, the academic level of knowledge and skills should be maintained and monitored, and SBP demonstrates that this is possible by using work-based learning experiences (confirmed by all actors involved (6,7,8) and supported by grade comparison (5)). In educational design, quality control can be guaranteed when grading remains with the academic staff, although consultation with the workplace is desirable. So, without dropping academic standards (though academic staff marking), but focusing assessment on testing skills that are revenant to the real-world environment.

4) For students who already aim at a career outside academic, focused on the application of science, the master study should include elements of communication, teamwork, strategic considerations and project management; in addition, an element of true work experience, for example by work placements, is genuinely beneficial (4), as demonstrated by higher work satisfaction, more competitive salaries, and broader career perspectives, compared to research students (7,9,10).
5) For students who follow a pure research master, education should focus on research strengthening and research experience (6), together with at least some societal orientation. To align with career perspectives research should preferably be in various scientific environments. Furthermore permanent maintenance of research skills seems to require lifelong learning.

The career path of master students is rarely studied in research context, let alone in a comparative analysis of different curricula. This is remarkable, given the substantial amount effort that is invested in educational curricula of master students. Faculties deliver students who find a position somewhere in the professional landscape, these positions vary in the connection to science or society, and in the degree of entrepreneurship (fig 2).

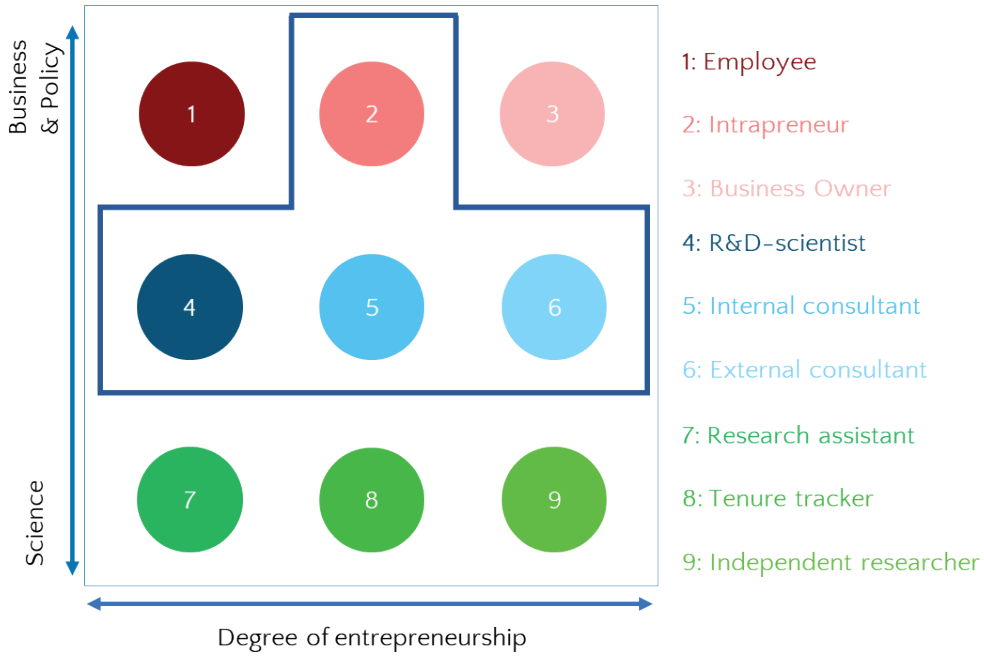
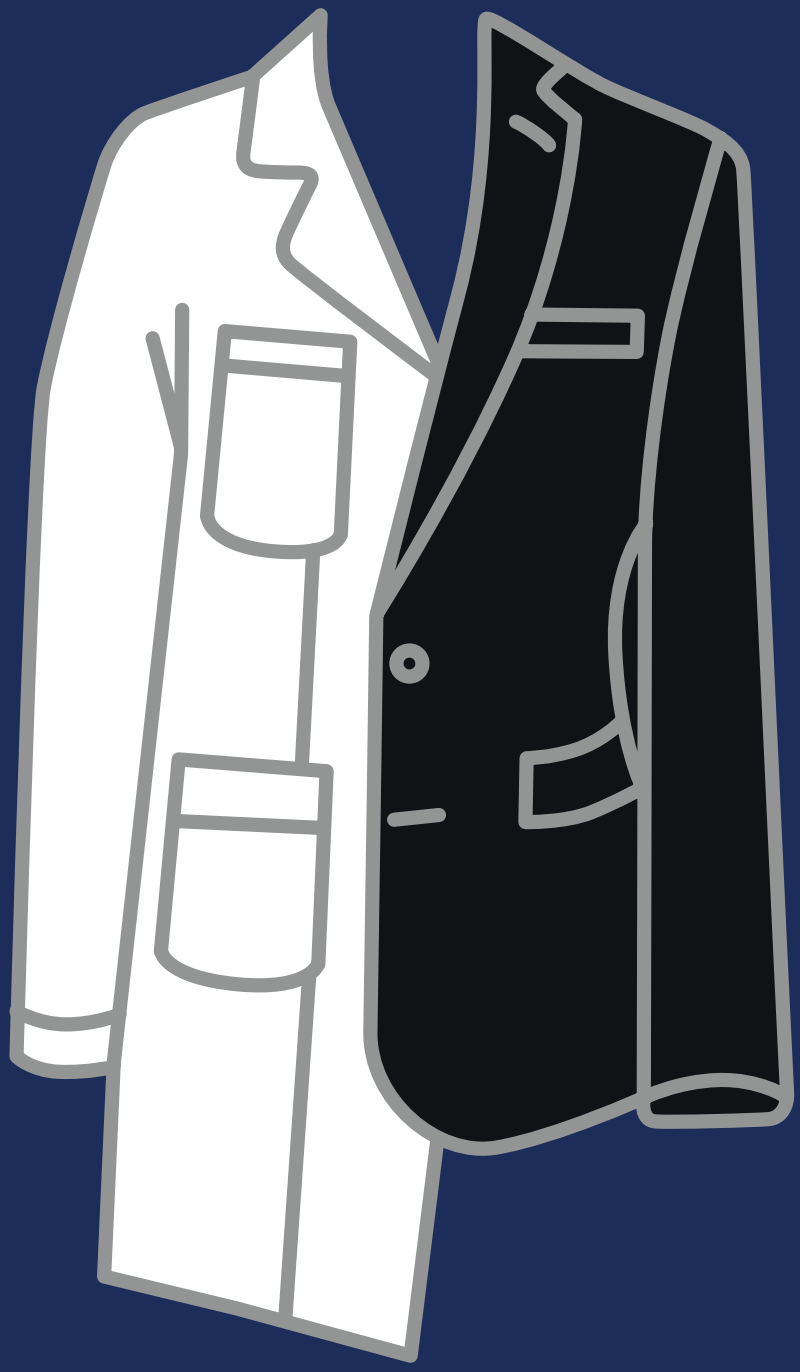


Figure 2: Plane of professions. A society oriented master program prepares for the professions framed in the figure. Modified after (9)

Not only alumni (9) of the SBP master program at the University of Groningen (indicated in fig 2) judge the curriculum and career development as positive, but also their employers (6). Also the appreciation of academic staff increased over the years (8). To improve education programs, it remains important to undertake further study of the professional outcomes of science students, in relation to their educational programs. Such insights will be critical to reshape master education at academic institutes that still do not invest in more tailored programmes built around the specific knowledge and skills students need for their future working lives, which we now know clearly extends beyond the narrow classical academic education they currently offer.

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8 Synthesis & Reflection

In this chapter the key findings of this thesis will be summarized. brought together. Then, I will explore the options for generalisation and further implementation of the concept of SBP. I will discuss what the limitations of the study are and the specific conditions of the program under study. Finally, I will suggest what is needed in terms of further research to make next steps for generalizations and usability of the experiences with SBP for other institutions of higher education.

Aim of the study

The theme of this dissertation is to determine the effects and impact of the SBP master program, as an example of work-based learning (WBL) within a master track of a Faculty of Science and Engineering at a Dutch research university. Impact is a broad term (explained in chapter 1), but what we mean by it is the perception of WBL by different actors. The actors we examined are described in figure 1.

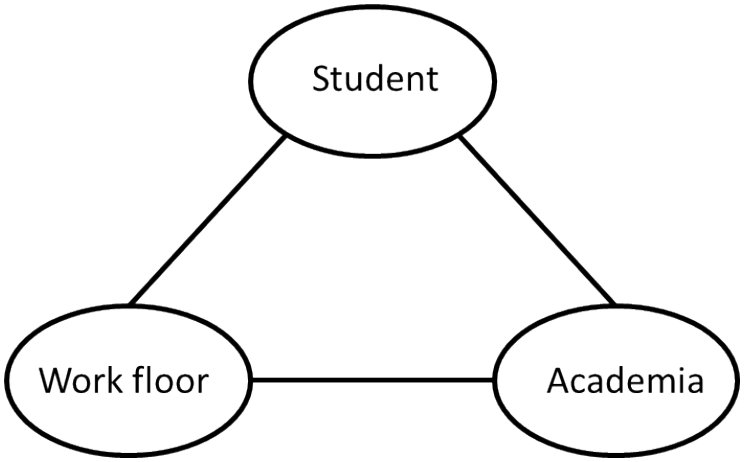


Figure 1 SBP's main actors, after Cardoso et al. (2014)

This thesis aims to contribute to closing a gap in literature by investigating the effect and perceptions of a WBL academic program on the different actors. The literature on WBL already contains concepts and theory, but the practical translation, especially at an academic level, is still underexposed. Studies that include cohort research in addition to single opinions are rare, as described in chapter 1. For science education, this is also a case example about multidisciplinary education that is focused on professionalisation outside academia.

Conclusions

Chapters 3-6 highlight different perspectives on the teaching program. Our representation of these perspectives is derived by using different qualitative and quantitative methods; these chapters cover the impact for the actors described in figure 1. To summarize the chapters and their main conclusions:

Chapter 2 is about the setup of SBP; it investigates the approach by doing a content analysis of the SBP student report archive and grade analysis. The most important conclusion is that the SBP program bridges science and society by using an integrative approach and a specifically developed model, the loop model, to integrate business and policy with science, thereby providing answer to societal problems within companies and (non)governmental organizations. It does so by choosing a work-based learning approach and thereby offering the needed skills and work experience for science advising. Grade correlation indicates that SBP is as distinguishing as a theoretical approach with classical examinations. The program's versatility and multidisciplinary is demonstrated by the range of internships projects; very diverse, on business as well as policy- related topics, encompassing various disciplines, sectors and regions.

In chapter 3 the perception of the SBP program by students was examined in alumni surveys. The main conclusions are that students choose this track based on content-driven motivation and the wish to prepare for a career outside academia. SBP alumni feel better prepared for their careers and they reported stronger development of skills on teamwork, multidisciplinary working, leadership, ethical thinking and project work in comparison to ROM alumni. Both cohorts of students were satisfied about the academic level of their program. Both programs seem to be a valid way to obtain a high- quality, science master level. They vary in focus and are suitable for different career paths.

Chapter 4 describes the career perspectives for SBP and ROM alumni. Both programs seem to lead to a good career perspective, fitting within the discipline of the followed study, but the career paths are different. SBP alumni often work in business and policy, consonant with their training. ROM alumni feel that they were trained for a career in science, but only a quarter actually continue in academia and many are employed in education. It seems that targeting a specific career path is more successful at SBP. Alumni of both groups indicate that their research skills generally decrease after their studies, while their soft skills increase. This illustrates that a targeted profile with a societal focus is more in line with the current labour market. Both alumni groups are generally satisfied with their first and current jobs, but SBP alumni score higher on satisfaction with income, status and career prospects. It can be concluded that diversification in educational profiles changes the societal career paths of science students.

The employer perspective is highlighted in chapter 5. Through content analysis of 20 interviews we see that there is a need for SBP trained professionals, and SBP students seem to be better prepared for non-academic careers from the perspective of the workplace. Work placements are positively assessed and described as attractive by employers. SBP students are seen as highly employable and their advice often has a direct impact on the workplace, such as improved work dynamics and new insights for the company. The SBP model, which emphasizes WBL and entrepreneurship, seems aligned with the needs of industry and policy organizations.

Perspectives from within the university on SBP are the topic of chapter 6. Again, content analysis of 20 interviews was done, this time interviewing professors. Initially, resistance against the program was experienced by the founders of SBP. However, in the current climate professors acknowledge SBP's added value and they recommend the track, especially for students who prefer a career outside academia. University professors think WBL is a good way to develop academic skills and are positive about the academic level achieved.

Chapter 7 briefly discusses the consequences of SBP as a case for master science education policy. The chapter underlines the importance of a solid theoretical background in a discipline combined with an option to either focus on a research career or do SBP and prepare for a non- academic career. Aspects of entrepreneurship, communication skills and societal awareness are necessary for the careers of all science students. WBL could be an interesting form to apply more generally within the science curricula.

Overall, based on the different chapters, it can be concluded that, as experienced by the main actors, there seems to be a need for a program like SBP. The quality, including the academic level, is perceived as good, and SBP is a useful and actionable addition to the curriculum in which science and society are integrated.

Concerning the research questions that examined SBP's impact on different main actors SBP provides benefits in practice for (a) students, SBP leads to options for study choice and gaining experience; for (b) alumni, SBP leads to skill development, job satisfaction and job opportunities; for (c) the university, SBP increases societal contribution, which is in line with university ambitions, learning objectives and educational offer and (d) for the work floor, SBP trains suitable employees and student advice reports are seen as useful for the companies, NGOs or governmental institutions.

Context

In this section different conditions and circumstances are discussed that one should take into account in implementing a program like SBP. Described conditions partly (coincidentally) played a beneficial role in the origin and development of SBP. Besides there are also conditions forming current trends that may be relevant and may influence the success or failure of introducing a WBL program into a curriculum.

Societal Conditions

SBP can be seen as a case study for work-based learning on academic level. To understand the meaning and value of the SBP program, it is necessary to start with societal conditions that form the complex context of this education program. Of the many social factors that play a role, a few will be named here, based on what seems to concern education design at research universities.

First of all, SBP is a Dutch program, designed in the Dutch political-cultural climate. In general Dutch society can be characterized as an open society, in which freedom of speech and an open climate for discussion are the norm. In literature the importance of student employability and communication in the application of scientific knowledge in industry is shown (De Wit-de Vries et al., 2019). Dutch companies have the reputation to be rather outspoken and direct in the communication of their demands in contact with universities. Also students and alumni are used to openly criticize their study programs; employers and staff of the university can generally disagree openly with colleagues and with faculty policy. In literature feeling save in mutual relations is described as an important requirement for university-industry relationships, the absence of this forms a hurdle, especially in developing countries (Kuchumova et al., 2023).

Secondly, besides a relatively open political-cultural climate, the economic conditions in the Netherlands have been favourable. Also during this study (2018-2020) the labour market was strong and the job perspectives were good. Probably, a program like SBP could be more challenging in a flooded labour market since the focus of alumni would then be on getting a job instead getting the best fit.

Finally, some general trends in higher education may affect programs such as SBP. The trends to digitize and work from home has increased significantly due to COVID. Understandably, the epidemy did bring changes in the educational and career landscape (Akkermans et al., 2020), especially in the vision on how one looks at working from home, which might change the idea of how to gain work experience. The pandemic could also form an opportunity to stretch the importance of entrepreneurship education for society (Ratten & Jones, 2021). How this relates to the specific experience-based preparation

for the work floor has not yet been fully examined. The first studies about offering WBL also digitally (approaching the new work floor situation) are currently conducted and seem to bring new challenges, specifically for the development of soft skills (Perusso & Wagenaar 2023). Another recent study (Gnecco et al., 2023) underlines the importance of the emergence of soft skills in the post-COVID era. Students with a well-paid jobs in the technical industry often attribute this to the development of soft skills during higher education. In addition, the project-based approach, also used in the SBP educational practice, is a method that has been proven effective in developing these soft skills (Dogara et al., 2020)

Another trend that may be relevant is internationalization and (re-)nationalization, exchange of students is very much supported within Europe by the European Commission (European Commission, 2022a). In addition, the European Commission aims to strengthen university's role in solving societal problems and improving economy (European Commission, 2022b), which may stimulate programs such as SBP. The creation of societal value is also described in literature as an increasingly important task of universities, which can be started by entrepreneurial education and educational design that focusses on preparing students for a future in which they can work with complex challenges (Van Rijnsoever et al., 2023). Finally a trend of long-life learning should be mentioned and the related tendency that the labor market attaches less value to diplomas of Higher Education Institutions, (see for instance Eimers, 2023). These trends affect the role and position of universities, which will be discussed below.

Vision on role of universities

The vision on what kind of institute a university should be is very relevant. In the Netherlands, the focus of research universities is on research and education but outreach is also seen as a main task (Universiteiten van Nederland 2023). The paradigm of the academy having a role and a responsibility in society is a starting point and a basic condition for a WBL program. Furthermore, it seems logical for universities to invest more in alternative programs since classical research training leads to high uncertainty in terms of employability of the student (Divan & McBurney, 2016).

Also the vision on how autonomous and independent universities and their staff should be influences the design of the program. Different tendencies can be seen here. For instance in Groningen, the university shows willingness to cooperate and listen to demands of the work floor (UG strategic plans 2015-2020 and 2021-2026), but at many universities, a strong urge for final decision making and quality control by the academy itself occurs (Powell & Walsh, 2018). The way these tendencies merge and mix, may have an impact on the design of the program.

The trend of increased intertwining of science and society (Bologna working group, 2005) was a reason to develop SBP. Future developments in this intertwining may be affected by an evolving paradigm shift towards a more inclusive vision on the identity of science in which science is for everybody (for instance Avraamidou, 2023). When this upcoming paradigm will continue to develop, one could imagine that science and science education are not strictly limited to a university anymore. The status of a university might change accordingly and perhaps companies decide to educate their own staff, and learn them exactly what a company itself requires. An example of this is the current Jaguar Land Rover degree apprenticeships at the university of Warwick (University of Warwick 2023). This would also influence work-based learning and potentially change the position of the SBP program.

Limitations

Definition problems

One of the problems during this study, in particular at the start of it, was confusion on definitions and terminology regarding key concepts. Noticeable is that the educational practise differs between countries. But so is the jargon used to describe education, which leads to papers apparently about the same topic, however discussing quite different items. Some of these points will be addressed here.

The first category of terms that showed ambivalence is about the form of learning: work-based learning (WBL), project-based learning, challenge-based learning and experience-based learning. In scientific and policy literature these terms are sometimes very clearly distinguished and sometimes used interchangeable. In view of the content of SBP, we use work-based learning to describe the SBP education program. In chapter 2 the WBL definition used in this thesis was introduced and justified as “an educational strategy or approach that provides students with real-life work experiences to apply academic knowledge and understanding as well as subject related and generic skills and competences to develop employability skills and competences”, as well as the way this term was interpreted .

In general the problem of concepts also persists in practise, for example the time students spent in a company or organisation to gain experience has have different names in different countries. Here the term work placement was chosen, but again, other terms such as internship, traineeship, apprenticeship and work experience are in use for similar, but sometimes for very different trajectories. The term entrepreneurship is used in many forms (explained in detail in chapter 5) as are related concepts like intrapreneurship and employability.

Regarding output of education, different definitions for the term skills are used, and sometimes mixed up with competences or even with knowledge and behaviour. Especially ambiguous is the term soft skills, which is sometimes replaced by 21th century skills, transferable skills, interpersonal skills, career skills or even live skills. Also more accomplished terms in universities are used in different ways. It is remarkably difficult to get a clear picture of what is meant precisely when people use the term academic level (see chapter 6) and the same goes for what is meant precisely with the words learning goals, curriculum and study program.

Summarized, although it was possible to define and use terms such as WBL, for understanding, interpreting and comparing literature the lack of definition of terms seems to be a permanent disability.

General Project remarks: Actors

In figure 1, the three major actors of WBL are shown. These actors are described as most important for WBL education (Mcewen et al., 2010). The impact of SBP on these actors, consisting of the students, the academy and the work floor, has been examined and written down in the different chapters, as summarized earlier. Obviously, this figure is a simplification of the reality. Other parties, like policy makers, university deans, WBL teachers, citizens and probably others are also involved. It is important to keep this in mind. Their opinion could perhaps shed another light on the here presented view on WBL.

General Project remarks: Project researchers and choice of methods

It could be seen as a weak point that we researched and investigated our own program, a program in which some of the authors played and continue to play key roles, as initiator, coordinator and lecturer. However, we tried to prevent a bias in the collection and interpretation of our data. In the first stage of our study, we collected data to evaluate and improve our own program. After becoming a best-case practise in an EU program (as described in chapter 1) and some direct requests from (international) colleagues, we decided to start a serious scientific practice-oriented empirical study, hoping that others in education could benefit from our findings. Using our data for research purposes stimulated us to actively search for ways to reduce any bias by different measurements. The tone of the second chapter is all about setting the agenda for WBL and includes a very elaborate description of the program to give transparency about the details of SBP education. In the following chapters the interviewing was all done by someone without direct involvement in SBP. We used (trained) research assistants for transcribing and coding the recordings and for the surveys. Creating and testing of the surveys was done in a training course about surveys at a different faculty.

During this research a mixed-method approach was used, but this had partly a practical and also opportunistic background. For the first part of this study it was aimed to give an elaborate description of the SBP program, based on an available archive of student advice reports. It was decided to do a content analysis, that was coded by research assistants. A more narrative approach might have led to different outcomes, but in this explorative stage of the study, the research assistants were not sufficiently experienced to carry out this type of research.

For the impact study on the work floor and within academia it was preferred to conduct semi-structured interviews. Doing open interviews was considered too risky because of the broadness of the term impact and the wide scale of opinions that could potentially be on a lot of different topics and levels and thereby resulting in a huge but totally unstructured and incomparable yield. To make this yield robust enough it was chosen to structure the format of the interviews and the analyses. The way of applying the format of the semi-structured interviews allowed focus on specific topics but also left room for refinement and the respondent's own input. In the analysis a conventional content analysis was combined with a directed content analysis. The coding process was carried out by research assistants - to prevent biased interpretation of data during the coding process (since these assistants had no knowledge of SBP). A weakness is that interesting points coming up during the interview could not be elaborated on in detail. Ultimately, a mixed-method of quantitative and qualitative data collection was applied in this study to accommodate this, by adding relevant quotes from the interviews.

For the impact study on students, an alumni survey was used, based on self-assessment. This survey was sent by mail. Self-reported data were added to course grades and demographics. This survey was designed in a cognitive interviewing training context. This led to a very well tested survey, but also to a method that is rigid in terms of answering. In hindsight it would have been also interesting to do open interviews with students or alumni to gather more specific comments.

Research Bias: Methodological Shortcomings

The specific methods and the shortcomings of the separate studies are discussed in the different chapters, but there are also overarching problems in the methodology that are more on the level of the entire project. Starting with the fact that SBP is used as a case, a very specific case in which only students who did and did not do the track are compared. We examined the differences but not the causation of this. So it is not known exactly what makes the SBP students score higher; the relationship with the type and amount of content and skills is hardly or not made. This would be very interesting for further research.

In most of the research set-ups self-assessments were used. This is not always easy and comes often with over estimation and blind spots. The Dunning-Kruger effect (1999) describes that on many domains people overestimate most when their abilities are low, and underestimate when abilities are high. Taken this into account the data on skills for example might differ less than reported by the respondents. On the other hand, probably all students have had some appropriate training.

Also social desirability is an issue, in literature (Paulhus, 2017) socially desirable responding is described as a tendency to answer on self-reports in such a way that respondents present themselves better, or closer to prevailing values. Furthermore the experience with SBP and whether it is successful also has to do with the attractiveness of the career perspective in relation to the research master and is therefore also very topic specific. It cannot be ruled out that this could have an weakening effect on the conclusions

A last issue is the excluding of non-responders. In the interview studies and in the survey studies non-responders got a reminder to join, followed by a replacement of another person. There was no follow up on this, due to time reasons. Perhaps people who are very negative have been missed (so negative they won't even join) or people who have a very busy agenda. To see whether this has any effect and perhaps these people could have made an interesting contribution, a follow-up study should be done.

Conditions

For setting up a program like SBP, the conditions are very determining of its success. Below some of these are described to create more understanding about the development of the program.

Political climate and University of Groningen

Historically, an important success factor was the policy climate when SBP was designed. The Bologna papers (2005) made a societal profile within natural sciences two years masters programs politically desirable and possible. Research universities could profit from a whole year in the curriculum which was an empty sheet to begin with this profile. This was a kick-start, since there was no competition for the time that SBP required; from the management layers of the university the track had green light and was even asked (and financed) to be developed. It made implementation relatively easy, compared to starting with a new curriculum that has to compete for time with other courses and has no policy push. One could also say that the founders of SBP at the University of Groningen

used the circumstances as window of opportunity since most science programs at other universities did not use the Bologna papers to set up a WBL curriculum.

In addition to the political, economic and cultural aspects mentioned earlier, it was important that multidisciplinary STEM education at an academic level has some tradition in the Netherlands, including at the University of Groningen. Thinking beyond the borders of the own discipline is thereby not entirely new to most educational programs. However, to be able to do this the discipline itself should already be developed. The SBP students all had a solid background in a natural science, which makes application and integration with other sciences possible. This disciplinary education was steadily in place and during the set-up of SBP there was no need to design this disciplinary basis. It provided sufficient basis to further develop an multidisciplinary practice-oriented master's program.

Although in this study only natural sciences program was taken into account, one could imagine that large parts of the SBP track may also work in, for example, social or medical sciences. Every discipline will have its specific own opportunities and challenges, however, for example in the field of the design of multidisciplinary education at different stages of the study, the relationship between education and research and the types of labor markets.

General conditions at the faculty level

One of the most important conditions in broad terms is, firstly, that there is enough time available to develop a full academic year program like this. Time is needed to deliberately develop a program, to let it mature and to try out the WBL vision in practice. Roughly estimated, this will take at least 5 years. Secondly, serious investment in time and money is required to ensure resources for the execution of the program and to adapt the curriculum. There need to be for example time(slots) reserved in the curriculum and enough staff hours available for teaching and supporting staff.

Furthermore, all involved parties must be interested in the intertwining of science and society, which is one of the key elements of tracks such as SBP. A sufficient number of students should have interest in an alternative and more applied education option, and they must have opportunities to follow this program easily. Staff is needed who has societal knowledge and experience (or is open to learn this) and societal partners (like companies and governmental organisations) that are interested in being part of a training science program.

Detailed conditions

In addition to the above mentioned general conditions, more factors play a role, at various levels, for the sustainability and prospects of SBP. Based on the previous chapters, several Strengths and Weaknesses as well as various Opportunities and Threats of SBP can be identified, which are shown in the SWOT diagram in figure 2.

Strengths	Weaknesses
· SBP is integrated in faculty curriculum · SBP is a strong point in visitations and audits · Academic level of SBP is established · Alumni reinforce and form network · Excellent career perspectives · Development of relevant soft skills · Multidisciplinary practice-oriented experiences, including knowledge from non-natural sciences	· Program is (still) relatively unknown · Outreach and exposure is weak · Maintaining network takes much time · More demand than supply for employees · No direct influence on inflow students
Opportunities	**Threats**
· Translation to other regions and disciplines · Fits in modern university vision · There is a support base from management · Fills a full niche when there is no MBA · Societal profit earned by SBP: science solves problems · Changes in societal demands can be met	· Dependent on teaching staff of other faculties (Law, Economics) · Difficulties to find suitable SBP staff (connectors) · Research culture, university and faculty are rewarded for PhDs · Applied science institutes create competitive programs · Science supervisors with broad view are rare

Figure 2. SWOT analysis of SBP conditions

Looking at the strengths in the SWOT diagram (figure 2) program level anchorage in the curriculum can be seen. In terms of learning outcomes high academic level combined with soft skills and multidisciplinary work form a combination that leads to high employability. Integration of science and society, high student satisfaction and employable alumni are appreciated in visitation and education audits of the university and faculty, but also create another strength, which is a continual growth in networks, formed by every year of graduating students.

The SBP team currently does not have a focus on outreach and publicity, this makes that the program is relatively unknown to students, staff and future employers. Because of the growing network this slowly starts to change, but the maintenance of the network also needs time and attention and is thereby very labour-intensive. Since SBP is the second year of a science master program, there is dependence on the inflow of students in the program of the first master year. Comparing the student inflow to the demand of the job market, a much bigger student population for SBP is desirable.

For SBP, the current educational climate forms an opportunity since it fits well in the modern vision of a university were the integration of science and society is emphasized.

In Groningen there is no separate master of business administration, which could be another way to fill this niche, at least partly. Both of the above-described opportunities lead to general management support. From society SBP also receives support, since SBP generates not only welcomed employees, but also forms direct benefit in solving societal issues by the student work placements, where science advice is used to solve problems in industry, governmental organizations or in society in general. When there is a change in need for solutions, for example in times of a pandemic or an energy crisis, there is even more need for SBP alumni. This is not only true for science integration, but also for integration of other disciplines. SBP is currently only given at the Faculty of Science and Engineering in Groningen. Because the WBL projects are proven to function also (inter) nationally, it's concept is probably translatable to other regions and universities.

Possible threats, as described in figure 2 start with staff issues. The typical SBP teacher is somebody who is a connector and a true generalist, who has knowledge of at least natural science but is also familiar with not natural sciences and with applied science: these people are rare and hard to find. Besides the SBP staff, one also needs specialists in science and in business or policy. This means there is dependency on a lot of people – and faculties - and their willingness and suitability to cooperate in a multidisciplinary program. Another threat for the SBP program is competition. Universities are still rewarded financially for their PhD's, which makes it attractive to keep investing maximally in education that prepares for this career route. The competition with the research programs of the applied sciences universities (which are developing masters and professional doctorate programs on top of bachelors education, called HBO is Dutch) are shifting towards doing more research, but the academic level is still an important difference.

Perspectives

The various chapters in this dissertation discuss the impact on different actors; students, professional field and academia. The general conclusion is that WBL can be a suitable form for academic science education and the perception is positive according to these main actors concerning this form of education.

Generalization

There remains a lot of uncertainty about generalizing the findings of this study to other universities or educational institutes and conditions needed for successful implementation elsewhere. To see whether WBL is more applicable in different settings, also internationally, further research in initiatives, also in other countries would be useful. In general, WBL is an upcoming form of education and more countries start to use this in

their education. At this moment the Netherlands is one of the leading countries in this (Perusso & Wagenaar, 2021). It would be valuable to examine different needs in different countries and the implications for the design of an academic WBL program. On national level, the historically grown situation within the Dutch Universities varies a lot. Analysis of the consequences of this variation for WBL programs may also be interesting for refinement and further implementation.

Studying WBL cases.

Studies on WBL in academic science education are scarce. This thesis is a contribution to close the literature gap and to stimulate more programs to share findings on cohort base; thus data and not concepts can be the base of education development. WBL cases are published, but again, not frequently analysed on academic level. Mores studies and publications might help to understand and improve various WBL approaches. It might also be a way to communicate what questions students are actually studying and how; which solutions came up; and what the practical tasks are of teachers and those who offer work placements. Although this study may be a solid basis for further research, some shortcomings were mentioned. In a follow up study one may focus on other types of impact and systemize the research design further. A study in which SBP is compared to other society-oriented tracks at other natural science faculties of research universities could shed light on what specific elements of the SBP program, in terms of contents and skills, made it a better preparation for a non-academic career than the traditional natural science research track. Further study should also include the context of development of these types of education programs, at the university as well as the wider societal level.

Implementation of WBL

As said before, we see WBL as a valuable and fitting form of education at the academic master level. WBL may form an important part of future academic education. However, successful development of WBL requires the right conditions, such as sufficient funding for education innovation, appropriate competences of teachers and of the composition of staff, suitable organisation and adequate support from the management teams to overcome resistance.

Furthermore, for good implementation one needs to keep up with the societal work field, which also asks for further research. The strength of WBL is that students really experience function in a complex environment (Lester & Costley, 2010). Research about ongoing change in this environment is essential, the trends and needs on the work floor have to be acknowledged. Earlier in this chapter, some general trends were mentioned such as internationalisation and (re-)nationalisation, life-long learning, economic fluctuations and digitalisation, which should be taken into account. Currently the use of general-purpose AI language models is an upcoming trend. Universities try to figure out on how

to include this in their programs. It would be interesting to see what a student needs in terms of AI skills in a job and then include these in educational programs accordingly.

To further examine in detail individual elements and to try to determine their contribution to the impact on different actors could be an interesting exercise. However, a causal analysis for all suspected individual contributing elements would take multiple in-depth studies as perhaps different elements might influence each other .

Altogether, I hope that this dissertation will stimulate a further reflection on (science) master programs and the use of work-based learning within curricula. This may result in good starting positions for a larger group of alumni in their further careers. And finally it would be great if this thesis would contribute to initiating international discussions within (science) faculties on the development of more differentiated master profiles, to encourage better integration of science and society.

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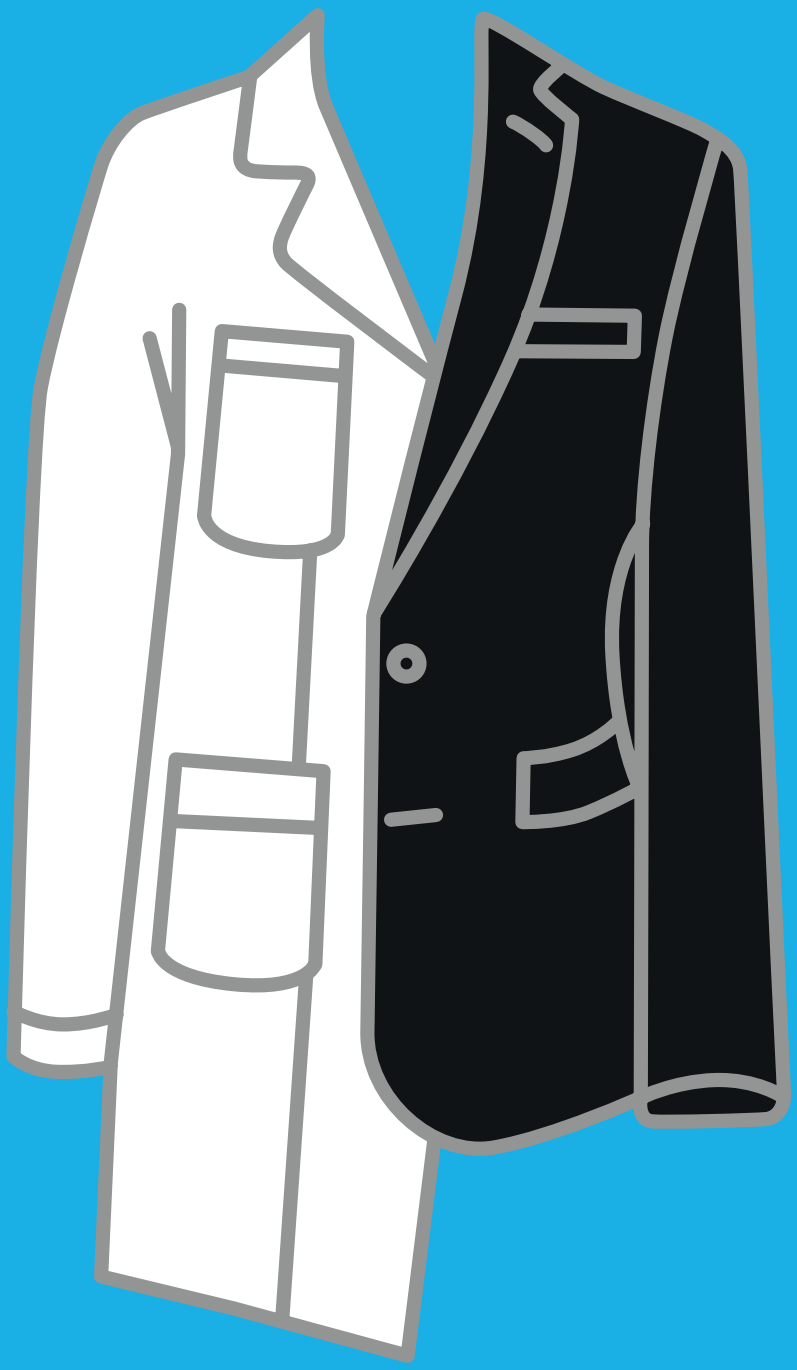
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A Appendix

Dankwoord
About the author

Dankwoord

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