ecoom
EXPERTISECENTRUM O&O MONITORING

Vlaams Indicatorenboek 2021

WETENSCHAP – TECHNOLOGIE – INNOVATIE

DEPARTEMENT
ECONOMIE
WETENSCHAP &
INNOVATIE

Vlaamse
overheid

Overzicht van de gemaakte selectie

Het Vlaams Indicatorenboek bevat een portfolio aan beleidsindicatoren die de ontwikkeling van het Vlaams potentieel inzake wetenschap, technologie en innovatie in kaart brengen.

Sinds 1999 wordt het boek om de twee jaar uitgegeven en vanaf 2017 wordt het Indicatorenboek een virtueel boek met een eigen website: http://vlaamsindicatorenboek.be. Het boek dat u nu in handen hebt is een selectie van hoofdstukken uit dit boek. Voor de volledige versie verwijzen we u graag naar de website.

Onderstaande delen werden geselecteerd:

De website van het Indicatorenboek biedt u ook de mogelijkheid om een eigen selectie samen te stellen van hoofdstukken die voor u relevant zijn. Surf hiervoor naar: http://vlaamsindicatorenboek.be/selectie.

Wij wensen u alvast een informatieve zoektocht door het Vlaamse innovatielandschap!

Dankwoord

Wetenschap, technologie en innovatie zijn onmiskenbaar essentiële hefbomen tot welvaart en welzijn in onze maatschappij. De Vlaamse overheid heeft daarom veelvuldig en veelzijdig aandacht besteed aan de ontwikkeling van de kwaliteit en de slagkracht van het Vlaamse Wetenschaps-, Technologie- en Innovatiesysteem. Het brede spectrum van wetenschappelijk en technologisch onderzoek aan de Vlaamse kennisinstellingen is daarbij vervolledigd met maatregelen en instrumenten om het innovatievermogen van de in Vlaanderen opererende ondernemingen te verhogen, en daarbij ook de kleine en middelgrote ondernemingen steeds meer, gerichte innovatiekansen te bieden.

Het is dan ook nuttig en wenselijk om het geheel aan acties, en hun meetbare resultaten, in een coherent, regelmatig te verschijnen Indicatorenboek te bundelen. Het vernieuwde Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie, dat de tijdsreeksen uit de vorige Indicatorenboeken actualiseert en uitbreidt, draagt daartoe bij. Zo is het mogelijk een robuust en internationaal vergelijkbaar overzicht te geven van de situatie in Vlaanderen op het vlak van de bestedingen voor en de resultaten van onderzoek, ontwikkeling en innovatie.

Het Indicatorenboek 2021 wordt net als de vorige editie uitsluitend in een interactieve bevragingsmode elektronisch aangeboden.

Uiteraard bouwt dergelijk Indicatorenboek op de inspanningen van veel enthousiaste medewerkers. De redactie en het schrijven van dit boek kwamen dan ook tot stand onder impuls van een redactiegroep van experts behorend tot de verschillende beleidsactoren uit het Vlaams Innovatiesysteem, die de staf van het Expertisecentrum O&O-monitoring (ECOOM) van de Vlaamse overheid bijstonden in de opdracht dit Indicatorenboek te ontwikkelen. Elk van hen droeg bij tot de conceptie van dit werk. We willen hen dan ook van harte danken voor de constructieve samenwerking om onder de gebruikelijke tijdsdruk dit document af te werken:

De Heer Paul De Hondt van het Kabinet van de Vlaamse Minister voor Economie, Wetenschap en Innovatie en tevens voorzitter van het Beheersorgaan van het Expertisecentrum O&O-Monitoring,

Mevrouw Linda De Kock van de Administratie Hoger Onderwijs,

De Heer Peter Viaene en Mevrouw Monica Van Langehove van het Departement Economie, Wetenschap en Innovatie (EWI),

De Heren Eric Sleeckx en Maarten Sileghem van het Vlaams Agentschap Innoveren en Ondernemen (VLAIO),

Mevrouw Danielle Gilliot van de Vlaamse Interuniversitaire Raad (VLIR),

Mevrouw Daniëlle Raspoet en Mevrouw Kristien Vercoutere en Mevrouw Annelies Wastyn van de Vlaamse Raad voor Innoveren en Ondernemen (VARIO),

De Heer Hans Willems van het FWO,

De collega's Tim Engels, Raf Guns, (ECOOM-Antwerpen), Katia Levecque en Noëmi Debacker (ECOOM-Gent), en Wolfgang Glänzel, Bart Thijs, Machteld Hoskens, Wytse Joosten, Laura Verheyden, Julie Callaert, Sarah Heeffer, Veronique Adriaenssens en Mariëtte Du Plessis (ECOOM-Leuven), en het ganse ECOOM-Leuven team dat de realisatie van deze digitale versie in goede banen heeft geleid,

die samen de nodige expert-inzichten en inbreng geleverd hebben bij het tot stand komen van de Vlaamse O&O gegevens.

Daarnaast danken we tevens van harte alle auteurs die op basis van de inbreng van de redactiegroep, de verschillende hoofdstukken en dossiers hebben uitgewerkt, geschreven en gedocumenteerd met relevant en betrouwbaar cijfermateriaal.

Zonder hun gezamenlijke inspanning was dit tiende Vlaams Indicatorenboek WTI nooit tot stand kunnen komen!

Van harte dank!

Prof. Koenraad Debackere en Prof. Reinhilde Veugelers
Redacteurs Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie
Leuven, september 2021

Woord van de ministers

Na een moeilijke periode die getekend werd door de coronacrisis toont Vlaanderen veel veerkracht.

De pandemie heeft ons dynamische wetenschapslandschap niet kunnen temmen. Anders dan aanvankelijk werd gevreesd, is de innovatie in het bedrijfsleven niet teruggevallen, en ook de kmo's worden steeds meer betrokken bij de noodzakelijke innovatie. De samenwerking tussen bedrijfsleven en kennisinstellingen, onder meer via de speerpuntclusters, verloopt nog steeds uitstekend en ook het fundamenteel onderzoek ondersteund door het FWO bleef productief.

De relance na de coronacrisis kan steunen op een heel stevige basis. Voor het eerst heeft Vlaanderen de norm van 3% van het bbp aan onderzoek en ontwikkeling doorbroken. In 2019 hebben alle bedrijven, overheden en kennisinstellingen in Vlaanderen samen 3,35% van het bbp geïnvesteerd in onderzoek en ontwikkeling, zo bleek uit de 3% nota 2021 van ECOOM. Dat is een belangrijke mijlpaal. Uit andere internationale rapporten komende nog positieve elementen naar voor. Zowel België als land, als Vlaanderen als regio, komen voor het eerst in de kopgroep van 'innovatieleiders' in Europa op een respectievelijke 4de (European Innovation Scoreboard) en 27e plaats (Regional Innovation Scoreboard).

Zoals blijkt uit de tiende editie van het indicatorenboek zet Vlaanderen met succes in op de ontwikkeling van haar talentbasis via hoger onderwijs en toenemende mobiliteit van studenten en onderzoekers binnen Vlaanderen maar ook internationaal, op de sterke aanwezigheid in Europese onderzoeks- en innovatieprogramma's, en op de ontwikkeling van significante posities inzake intellectuele eigendom zowel bij het bedrijfsleven als bij de kennisinstellingen. Ook de institutionele versterking van het innovatieweefsel met een portfolio van complementaire kennisinstellingen trekt investeringen in het Vlaamse WTI-weefsel aan.

Ook de toekomst ziet er goed uit. De Vlaamse Regering maakte 4,3 miljard vrij voor haar relanceplan , het plan dat de Vlaamse welvaart en het welzijn van de Vlamingen moet helpen versterken na corona.

In ons onderwijs wordt steeds meer de nadruk gelegd op STEM-richtingen. We zetten met de Digisprong ook een ambitieuze digitaliseringsoperatie van het hele onderwijs op de rails. Specifiek voor het hoger onderwijs is er in de nasleep van de coronacrisis een Voorsprongfonds van 60 miljoen euro gelanceerd, dat onze hogescholen en universiteiten nog toekomstgerichter en digitaler zal maken.

Het beleidsdomein EWI kan vanuit het Relanceplan Vlaamse Veerkracht 631 miljoen euro investeren. Hiervan wordt 87% uitgetrokken voorn onderzoek en innovatie (waterstofonderzoek, bio-economie, digitalisering en duurzaamheid, O&O bedrijven, O&O onderzoeksinfrastructuur, ...) en 13% voor productieve, economische investeringen.

De komende jaren zal innovatie nog belangrijker worden, zeker in het kader van de uitdagingen rond duurzaamheid en zorg. We plannen deze legislatuur 250 miljoen euro voor onderzoek & ontwikkeling en daarbovenop nog eens 195 miljoen euro extra voor onderzoeksinfrastructuur.

Door innovatie als prioriteit van het beleid te blijven zien, willen we ook de komende jaren boven die 3% blijven en de plaats van Vlaanderen in de groep van innovatieleiders verder versterken. Kortom we willen Vlaanderen op het vlak van technologie, wetenschap en innovatie in de Europese cockpit plaatsen.

Het blijft essentieel voor het beleid om alles internationaal nauwgezet op te volgen en hierin speelt het Vlaams Indicatorenboek Wetenschap, Technologie en Innovatie (de tiende editie ondertussen!) een belangrijke rol. Dit geldt zowel op het vlak van de bestedingen voor O&O en innovatie als voor de resultaten van het onderzoek uit het hoger onderwijs, onderzoek, ontwikkeling en innovatie.

Het Vlaams Indicatorenboek is dan ook uitgegroeid tot een belangrijk evaluatie-instrument voor het beleid.

Wij willen in naam van de Vlaamse regering ECOOM en iedereen die eraan meewerkte dan ook uitdrukkelijk bedanken.

Hilde Crevits
Viceminister-president van de Vlaamse Regering en Vlaams minister van Economie, Innovatie, Werk, Sociale economie en

Ben Weyts
Viceminister-president bevoegd voor Onderwijs, Sport, Dierenwelzijn en Vlaamse Rand

Volledige inhoudsopgave

7 Dossiers

In addition to the recurrent chapters, each edition of the Flemish Indicator Book also offers a number of specific dossiers that provide a summary of relevant figures and recent research into relevant themes. In this edition there are six different files that deal with very different topics.

7.5 Situating and assessing interdisciplinarity involving the social sciences and humanities

By Joshua Eykens, Raf Guns and Hongyu Zhou (University of Antwerp).

Interdisciplinary research or IDR is gaining a lot of attention both in science studies and higher education policy. Research policy makers, in particular, attach a lot of importance to IDR, because it is commonly believed that interdisciplinarity is a necessary condition to solve some of the most complex societal problems, such as the UN's Sustainable Development Goals. Large research funding organizations, like the European Commission and the European Research Council, the National Science Foundation (NSF) in the USA and the National Natural Science Foundation of China (NSFC), all share this idea and give high priority to interdisciplinarity, for example by developing specific financing opportunities for IDR. As Bonnie Wolff-Boenisch, head of research affairs at Science Europe, stated, "interdisciplinarity is not new, but [in Europe] it has gained increasing traction in the context of the global transformation of societies, the SDG's, and the 'Mission-oriented research' concept of the European Commission" (Europe, 2019). The growing importance of IDR has led to changes to research assessment. New assessment procedures are being developed to better account for the interdisciplinarity of research projects, teams, and output. Among other things, new indicators have been developed to measure different facets of IDR (Wang & Schneider, 2020).

For all the attention directed towards IDR, relatively little is known about interdisciplinarity in the social sciences and humanities (SSH). As a result, the potential contribution of SSH to IDR may be neglected or overlooked, or IDR projects involving the SSH may be evaluated without taking the specificity of SSH into consideration. In the current dossier, we, therefore, discuss what is specific about SSH research and IDR involving SSH.

The dossier is structured as follows.

- Part 1 introduces the concept of disciplines: we discuss how disciplines can be operationalized, what sets SSH apart, and the internal heterogeneity of SSH.
- Part 2 considers how these aspects affect interdisciplinarity involving the SSH.
- This leads us to formulate seven principles for research assessment of IDR in the SSH, in part 3.
- The final part 4 contains some conclusions.

Parts of this dossier are based on a forthcoming chapter (Eykens, 2022).

7.5.1 Disciplines and their differences

The concept of disciplines

To understand inter-disciplinarity, one must first consider the concept of disciplines. What is a scientific discipline? In a broad overview of the literature, Sugimoto and Weingart (2015) find that disciplines have been characterized as more or less coherent "units of intellectual content", with clear social, communicative, and institutional features. That is, a body of research on a specific problem, approached using certain methods, can only be recognized as a discipline if it is studied by a community of researchers, with their own discourse and some form of institutionalization (journals, conferences, education...). In addition, a discipline needs to be recognizable as a separate entity from other, related disciplines.

Since disciplines are multi-faceted entities, it's no surprise that they have been studied and operationalized in different ways. Daraio and Glänzel (2016) mention four types of disciplinary classifications:

- *Administrative:* as seen by government or policy makers;
- *Cognitive or epistemic:* based on contents, either on the disciplinary profile of the publication channel (e.g., journal) or on the contents of the individual publication;
- *Organizational:* based on organizational structure;
- *Qualification-based:* based on education and competencies.

Through a comparison of a cognitive and organizational classification, Guns et al. (2018) find that "all organizational disciplines are to some extent prone to publishing 'outside' one's own discipline but there are great differences between disciplines". Cognitive classifications at the journal level have been shown to carry traces from the context in which they originate (Sīle et al., 2021). Such classifications have two main disadvantages: (1) research in multidisciplinary journals cannot adequately be represented and (2) even disciplinary journals may publish publications that contribute to other disciplines. On the other hand, while cognitive classifications at the publication level may solve these issues, they can be labour-intensive or require computationally demanding procedures to cluster publications based on, e.g., citations (Waltman & Eck, 2012) or textual data (Eykens et al., 2020).

Diversity of disciplines

In one of the first major bibliometric texts published, Derek de Solla Price (1963) pointed towards the differences in publication and citation/referencing practices between different disciplines. Since then, numerous other studies have appeared which all make important nuances about particular cases, but basically argue along similar lines: each field or discipline has its own knowledge objects or subjects, conceptual frameworks, sets of relevant research questions and preferred methodologies. Due to this epistemological identity, among other factors, every discipline follows a particular way of communicating research. These differences range from the ways in which research from predecessors is acknowledged to publication formats and writing styles – the so-called practice of communicating research.

Although there are other important factors at play, the epistemological identity of a discipline to a large extent influences its communication practices. This heterogeneity is important because it complicates the design of discipline-invariant indicators for interdisciplinarity. Let us first look at a broad division, the split between the science, technology, engineering, and medical sciences (STEM disciplines) on the one hand, and the SSH on the other.

Differences between STEM and SSH. The fluidity and dynamicity of knowledge subjects in SSH disciplines makes these disciplines stand out in terms of their communication practices. A first important difference is that an endless number of variables can be taken into account in explanations for social phenomena. These social phenomena themselves are also constantly changing. Hence, problem-solving is more complex. In fact, some SSH research takes the form of contributing additional perspectives to

phenomena of interest, rather than attempting to answer a question or solve a particular problem. The complexity of some puzzles in the SSH sometimes demands a lengthy argument, and when many factors are taken into account, a plea needs to build on an extensive list of previous references supporting researchers' decisions.

It follows that the form of the publications in the SSH in general differs from those in STEM disciplines. SSH publications are, for example, more lengthy on average. Scholars from SSH disciplines communicate their findings in books or monographs more often (Engels et al., 2012; Nederhof, 2006). Reference lists are often more lengthy and the average cited reference in a document tends to be much older than those in STEM disciplines (Glänzel & Schoepflin, 1999). In addition, depending on the research questions at hand, references may include a broad array of document types (such as grey literature, literary and historic texts, or archival materials), and publications are often written in languages other than English, generally considered the *lingua franca* of the sciences.

Disciplines in the SSH are multi-paradigmatic. Different theoretical or methodological schools might be trying to address different issues. This leads to the fact that many disciplines in the SSH are also multi-methodological. In contrast, STEM disciplines tackle more aligned research problems with a more or less clear set of rules and tools to study these research problems. The turn-over in 'solved problems' for STEM disciplines is quick and the time-horizon for noteworthy scientific revolutions which fundamentally change the ways of doing research lies far ahead. Consequently, publications are mostly written in the format of an English language journal article, citing a bolstered set of recent publications. Knowledge building is often quoted as being cumulative in these disciplines.

Diversity within the SSH. It is generally accepted that the social sciences are closer in epistemics and research and communication practice to STEM than the humanities. This overlooks, however, that there are many differences between disciplines both in social sciences and in humanities. In addition, even *within* disciplines, one may encounter quite some heterogeneity.

Disciplines within the SSH have been shown to differ from each other as well. Studies demonstrate that psychology and economics, for example, show many similarities with STEM disciplines, whereas others, like social work and educational sciences or law and criminology are very different. Within the humanities, similar distinctions between disciplines can be noted. Computational linguistics and the digital humanities, for instance, share cognitive and methodological aspects with computer sciences, whereas history, arts and ethics exhibit a more standard 'humanities' practice. Some disciplines are more locally oriented, publishing more research in Dutch or French, often through publication channels that are largely invisible in international databases and indexes. Some disciplines are more oriented towards policy or practice instead of being methodological or empirical-theoretical in nature.

The further we zoom in on these fractal divisions, we again face differences between sub-disciplines, or groups of scholars specialized in a certain topic. As noted by Becher and Trowler (2001), if we zoom in on particular departments of different universities which represent the same discipline, we may encounter very different practices. For instance, while one department might be specialized in sociological theorizing, another might be more policy-oriented. The former department might exhibit more impact in terms of publications covered in Web of Science, while the latter shows greater societal impact as measured by references in policy documents and contributions to the public debate.

In addition, disciplines are in constant flux. They grow and shrink, they differentiate into new specialties, or dissolve completely. The differentiation into new specialties can lead to the emergence of new disciplines with their own research and communication practices. These dynamic aspects of disciplines pose additional challenges for the measurement of interdisciplinarity.

7.5.2 Interdisciplinarity involving the SSH

The concept of interdisciplinarity

Interdisciplinary research also allows the boundaries of the various disciplines to be crossed. These assumptions are reflected in the definition of interdisciplinary research put forward by the US National Academies of Sciences (2005), which is commonly referenced in policy documents, bibliometrics and research evaluation:

> "*Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice*."

In other words, *knowledge integration* is central to interdisciplinary research.

Is SSH research becoming more interdisciplinary?

Although many disciplines in SSH have interdisciplinary origins since the early establishment, only few quantitative assessments and monitoring of interdisciplinarity in SSH can be found in the literature, compared to that of STEM. Research that investigated the status and evolution of interdisciplinarity in SSH often adopts the generic operationalization of interdisciplinarity instead of devising some new indicators addressing the special needs of SSH. Nonetheless, an interdisciplinary evolution in the social sciences is observed by some researchers. Levitt et al. (2011) found that IDR in the social sciences and its disciplines experienced a declining trend in the 1980s and a sharp rise in the 1990s. Zhou et al. (2021) examine the disciplinary diversity in the references of 300 thousand publications between 1960 and 2009 from five SSH disciplines to infer the evolution of interdisciplinarity. They find that research in the SSH are adopting a broader yet more specialized knowledge base in recent years.

Challenges for estimating interdisciplinarity of SSH research

In part 2 we have shown that communication practices in SSH are different from STEM, and there are many differences between and even within SSH disciplines. Additionally, we have argued that disciplinary structure itself is prone to change. These two findings have important implications for the measurement of interdisciplinarity.

Science dynamics and its consequences. The science dynamics perspective attests that interdisciplinarity is one of the evolutionary dynamics in science. On the level of disciplines, the knowledge of two or more disciplines is coupled and integrated to face a complex research problem. If successful, such an integrative event might lead to the emergence of a new research specialty and, later on, a discipline. Existing indicators of interdisciplinarity may not fully capture this subtlety: "The diversity and coherence indicators depend on boundaries between fields, and [...]generally deploys the top-down fixed (WoS) subject categories. This implies that the dynamics of the disciplinary landscape is not taken into account, when calculating diversity and coherence" (Vugteveen et al., 2014, p. 75). An alternative might be to step away from pre-specified classification schemes, and start from the data (bottom-up instead of top-down by mapping relations between documents). For instance, the classification system of Microsoft Academic Graph (MAG) used by Zhou et al. (2021) is based on such bottom-up relations.

Current indicators of interdisciplinary do not always account for disciplinary change. The scientific landscape is constantly evolving and our proxies for disciplines are trying to keep up with this fast paced world. The results of interdisciplinary endeavors might for example be absorbed by an existing field rather quickly (Besselaar, 2019) and may not clearly manifest in disciplinary classifications.

Differences in communication practices among disciplines. Many indicators that are currently in use rely on citation data. Since citation practices are not uniform across all fields of science, specific care should be taken to ensure that the SSH are adequately represented. Professionally oriented research in the social sciences, concerned with solving local societal issues, for example, might often be published in professional journals that are not indexed in international commercial citation databases. Some newer citation databases, like MAG or Dimensions, try to capture a broader range of publications and publication channels, although the problem is not yet fully solved. On the other hand, institutional or national databases tend to have better coverage, but usually lack citation data.

7.5.3 Suggestions for research assessment and evaluation of interdisciplinarity in the context of the SSH

Klein's principles

To tackle the difficulties which arise in an interdisciplinary research assessment context, seven evaluation principles are proposed by Klein (2008) in her review on the subject. These principles bundle many years of experience with inter- and transdisciplinary research studies and policy-making on the part of Klein, but also on the part of research management and policy systems currently in place. Here we recapitulate these seven principles and briefly discuss each one in the context of IDR in the SSH. While every project proposal or research outcome is unique, these seven generic principles can serve an important function when designing evaluation or research assessment procedures for the social sciences.

1. Variability of goals. To begin with, not all disciplines in the SSH harness the same goals. It follows that the individual researchers from these different disciplines will behave differently. Whereas scholars active in more traditional disciplines might have the ambition to create new knowledge about a topic central to their disciplines, researchers from sub-disciplines like feminist studies or area studies might have the ambition to empower certain groups of people. The same holds true for interdisciplinary research projects. For some, "the production of new and broad knowledge of a particular phenomenon" is important, and for others "the development of technical equipment or products" is the main goal (Klein, 2008).
2. Variability of criteria and indicators. The previous principle "drives the variability of criteria and indicators" (Klein, 2008). More traditional indicators, such as the number of publications or citations, for example, are not equally applicable to all disciplines in the same style. When it comes to communicating research, some social science disciplines or specialties value publications in journals more, while others value books more as outputs. The same goes for interdisciplinary research. While some projects might be concerned with societal changes, others will be directed towards the development of new scientific methods or techniques to approach a research problem. It goes without saying that these sociostructural differences as well as the differences in perceived goals should be taken seriously by panel members when assessing project proposals and their submitters. Societal impact, for example, should not be assessed with bibliometric indicators only.
3. Leveraging integration. Knowledge integration is considered to be central to interdisciplinarity. It is therefore crucial to take into account the degree to which initiatives are taken to accomplish or 'leverage' this goal. Klein cites the organization of structural support to allow for integration, like opportunities for communication (meetings among researchers), the development of a common vocabulary, etc. A set of guiding questions has been developed by Klein to take stock off this aspect.
4. Interactions of social and cognitive factors in collaboration. Interdisciplinary research, like all research, is a social process. Leveraging 'intellectual integration' (the previous principle) is a social endeavour and, according to Klein and others, communication and negotiation form the core of this endeavour.
5. Management, leadership, and coaching. This principle underscores principle (3), the importance of "how well the organizational structure fosters communication". Leadership is an important aspect in this regard, and should thus be taken into consideration when an interdisciplinary research project entails complex collaborations among researchers from different (and disparate) disciplines.
6. Iteration and transparency in a comprehensive system. According to Klein, a strictly linear evaluation model is not appropriate for the assessment of interdisciplinary research. IDR in many cases develops in different phases and reiterates over these phases. In an early phase, principles 4 and 5 might be very important and thus deserve more attention when

intermittent assessments are carried out. In a later stage, when an IDR project comes to an end, indicators for research output or impact might become more important. Transparency ensures that evaluators and those being evaluated are aware of the criteria being used at what stage. Ideally, Klein suggests, both evaluators and those who are evaluated get involved when defining appropriate indicators for their goals.

7. **Effectiveness and impact.** The principle of effectiveness and impact returns to the first two principles. The impact of IDR is often "diffused, delayed in time, and dispersed across different areas of study and patterns of citation practice" (Boix Mansilla, 2006). Thus, the assessment of IDR requires thorough consideration and ideally takes into account potential but unpredictable long-term impacts.

Most of these principles require an active conversation among those who conduct IDR and those who evaluate it. Appropriate evaluation, Klein states, is not given but made: "It evolves through a dialogue of conventional and expanded indicators of quality". As we discussed earlier, this is because 'peers' in the traditional sense are largely lacking in the case of interdisciplinarity. As such, "there is no consensus on the legitimate sources and types of control over [IDR]" (Huutoniemi & Rafols, 2016). A co-creation model of evaluation procedures guided by these principles might lead to more appropriate research assessment practices for IDR.

Quantitative assessments

We have pointed out that we should first approach the scientific system in terms of dynamics of change. With regard to quantitative approaches discussed above, a first step consists of adequately mapping the scientific system. While citation-based approaches are immensely useful, they can be problematic if applied unthinkingly to the SSH, because the most commonly used data sources have serious coverage problems for (parts of) the SSH.

Science maps open up the possibility to study changes in the disciplinary system as a whole and will allow us to come up with more adequate and dynamic approaches to IDR. The increase in data availability (e.g., more textual data) will allow researchers to not only take into account journal articles, but also other research outputs in the form of text when drawing these maps. Sidestepping the need for predefined science classifications, a bottom-up text-based approach which makes use of document similarity methods and clustering, for instance, could yield important insights into the SSH landscape. In an evaluation context, these methods allow research administrators or policy advisors to locate research or researchers on the boundaries of established fields and disciplines – the cognitive areas where knowledge integration takes place.

7.5.4 Concluding remarks

Interdisciplinary research is lauded for its transformative qualities. Innovative IDR has the potential to change the scientific landscape and reconfigure disciplines, or even lead to the emergence of entirely new research domains. However, the statement that IDR leads to more qualitative problem-solving than disciplinary research merits further research. Specialized disciplinary research has also led to ground-breaking research, and is not necessarily inferior to IDR (Jacobs, 2017).

IDR has been around since the early establishment of the modern disciplinary system. Disciplines should not be taken for static and natural, they are social and dynamic entities which can be studied and approached as such. The disciplinary dynamics perspective, which was introduced by van den Besselaar, can be seen as an important first step in the bibliometric identification and approach of IDR and disciplinary change. For qualitative research assessment and peer review on the other hand, we propose the guiding principles introduced by Klein as important cornerstones.

On a final note, the creation of distinct criteria and practices for evaluation of IDR may introduce new difficulties (Huutoniemi et al., 2010), since it requires "an operational definition of such research, plus a set of viable parameters to empirically distinguish it from disciplinary research – a problem that is not yet fully solved [...] The participation of researchers in the definition of criteria and the selection of reviewers ensures that more aspects of the work can be more comprehensively assessed. Such a dialogue and feedback loops between researchers and reviewers also supports a mutual commitment to long term goals" (Huutoniemi, 2010, p. 313).

7.5.5 Bibliography

Becher, T., & Trowler, P. (2001). *Academic tribes and territories: Intellectual enquiry and the cultures of disciplines*. Open University Press.

Besselaar, P. van den. (2019). Interdisciplinary and disciplinary identities: Towards a theory of forms of knowledge change1. *BioRxiv*, 603449. https://doi.org/10.1101/603449

Boix Mansilla, V. (2006). Assessing expert interdisciplinary work at the frontier: An empirical exploration. *Research Evaluation*, *15*(1), 17–29. https://doi.org/10.3152/147154406781776075

Daraio, C., & Glänzel, W. (2016). Grand challenges in data integration—state of the art and future perspectives: An introduction. *Scientometrics*, *108*(1), 391–400. https://doi.org/10.1007/s11192-016-1914-5

Engels, T. C. E., Ossenblok, T. L. B., & Spruyt, E. H. J. (2012). Changing publication patterns in the Social Sciences and Humanities, 2000–2009. *Scientometrics*, *93*(2), 373–390. https://doi.org/10.1007/s11192-012-0680-2

Europe, S. (2019). *Science Europe Symposium on Interdisciplinarity*. Zenodo. https://doi.org/10.5281/zenodo.4925712

Eykens, J. (2022). Assessing interdisciplinary research in the social sciences: Are we on the right track? In T. C. E. Engels & E. Kulczycki (Eds.), *Handbook of Research Assessment in the Social Sciences*. Edward Elgar.

Eykens, J., Guns, R., & Engels, T. C. E. (2020). Fine-grained classification of social science journal articles using textual data: A comparison of supervised machine learning approaches. *Quantitative Science Studies*, 1–26. https://doi.org/10.1162/qss_a_00106

Glänzel, W., & Schoepflin, U. A. (1999). A bibliometric study of reference literature in the sciences and social sciences. *Information Processing and Management*, *35*, 31–44.

Guns, R., Sīle, L., Eykens, J., Verleysen, F. T., & Engels, T. C. E. (2018). A comparison of cognitive and organizational classification of publications in the social sciences and humanities. *Scientometrics*, *116*(2), 1093–1111. https://doi.org/10.1007/s11192-018-2775-x

Huutoniemi, K. (2010). Interdisciplinarity in research evaluation. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), The Oxford Handbook of Interdisciplinarity (pp. 309–320). Oxford University Press.

Huutoniemi, K., Klein, J. T., Bruun, H., & Hukkinen, J. (2010). Analyzing interdisciplinarity: Typology and indicators. *Research Policy*, *39*(1), 79–88. https://doi.org/10.1016/j.respol.2009.09.011

Huutoniemi, K., & Rafols, I. (2016). *Interdisciplinarity in Research Evaluation* (SSRN Scholarly Paper ID 2818321). Social Science Research Network. https://papers.ssrn.com/abstract=2818321

Jacobs, J. A. (2017). The need for disciplines in the modern research university. In R. Frodeman, J. T. Klein, & R. C. S. Pacheco (Eds.), *The Oxford handbook of interdisciplinarity* (2nd edition, pp. 35–39). Oxford University Press.

Klein, J. T. (2008). Evaluation of Interdisciplinary and Transdisciplinary Research. *American Journal of Preventive Medicine*, *35*(2), S116–S123. https://doi.org/10.1016/j.amepre.2008.05.010

Levitt, J. M., Thelwall, M., & Oppenheim, C. (2011). Variations between subjects in the extent to which the social sciences have become more interdisciplinary. *Journal of the American Society for Information Science and Technology*, *62*(6), 1118–1129. https://doi.org/10.1002/asi.21539

National Academies. (2005). *Facilitating Interdisciplinary Research*. National Academies Press.

Nederhof, A. J. (2006). Bibliometric monitoring of research performance in the Social Sciences and the Humanities: A Review. *Scientometrics*, *66*(1), 81–100. https://doi.org/10.1007/s11192-006-0007-2

Price, D. J. D. S. (1963). Little Science, Big Science. In *Little Science, Big Science*. Columbia University Press. https://www.degruyter.com/document/doi/10.7312/pric91844/html

Sīle, L., Guns, R., Vandermoere, F., Sivertsen, G., & Engels, T. C. E. (2021). Tracing the context in disciplinary classifications: A bibliometric pairwise comparison of five classifications of journals in the social sciences and humanities. *Quantitative Science Studies*, 1–29. https://doi.org/10.1162/qss_a_00110

Sugimoto, C. R., & Weingart, S. (2015). The kaleidoscope of disciplinarity. *Journal of Documentation*, *71*(4), 775–794. https://doi.org/10.1108/JD-06-2014-0082

Vugteveen, P., Lenders, R., & Van den Besselaar, P. (2014). The dynamics of interdisciplinary research fields: The case of river research. *Scientometrics*, *100*(1), 73–96. https://doi.org/10.1007/s11192-014-1286-7

Waltman, L., & Eck, N. J. van. (2012). A new methodology for constructing a publication-level classification system of science. *Journal of the American Society for Information Science and Technology*, *63*(12), 2378–2392. https://doi.org/10.1002/asi.22748

Wang, Q., & Schneider, J. W. (2020). Consistency and validity of interdisciplinarity measures. *Quantitative Science Studies*, *1*(1), 239–263. https://doi.org/10.1162/qss_a_00011

Zhou, H., Guns, R., & Engels, T. C. E. (2021). The evolution of interdisciplinarity in five social sciences and humanities disciplines: Relations to impact and disruptiveness. *Proceedings of ISSI 2021*, 1381–1392.