Operationalisation of Higher Education Teaching Performance (HETP) recognising and rewarding teaching as a part of science is enabled by Open Scholarship

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Abstract (English)

Higher Education Teaching Performance (HETP) defines the performance of academics in university teaching. This performance includes the development of tailored teaching concepts and methods as well as the planning and implementation of lectures, seminars, tutorials and internships. It also includes the preparation of exams and the assessment of students. These activities can be a very significant part of everyday academic life. Not only do many academics at universities have teaching obligations, and those activities form a central part of academic life. Moreover, in the Humboldt understanding of academic life, teaching is an integral part of academic research. Research achievements are honoured in the academic Recognition & Reward System (RRS). The RRS encompasses mechanisms for acknowledging and incentivizing scientific achievements, considering both qualitative and quantitative approaches, though RRS predominantly relies on quantitative metrics. Academics who perform outstandingly in research enjoy a high reputation in the community and are rewarded by research funding or job positions. The achievements of academics in university teaching are often less visible than research achievements. High-quality teaching is less beneficial for academics than research for which they receive less recognition and career advantages. This imbalance is problematic: first, good teaching is not sufficiently valued and teachers who invest commitment and effort in their teaching are not recognised adequately in terms of prestige and rewards. Second, this imbalance can lead to a loss of quality in higher education. Students may receive a poorer education if teachers invest little time and energy in didactic concepts. Knowledge transfer could take a back seat, even though universities have a central educational mission. Third, a greater emphasis on research than on teaching may create disincentives for academics. A research-focused RRS may encourage academics to concentrate on publishing research findings and attracting external funding rather than focusing on teaching.

This thesis examines this imbalance, and I pursue the goal of making HETP tangible so that these achievements can become visible in the academic RRS. For this purpose, teaching performance is operationalised, i.e. translated into measurable indicators or concrete terms, so that it is accessible for the RRS. To comprehensively investigate the operationalisation of HETP, the topic is examined from an educational science perspective. This approach places education at the centre of teaching performance, emphasizing teaching itself as the primary focus. A key challenge in operationalising HETP is the limited availability and accessibility of information on teaching performance in higher education. The open scholarship movement has opened a door of opportunity in this respect. Open scholarship makes academic practices and products accessible and visible to the public. The movement enables open products of university teaching (Open Educational Resources - OER) to be considered on an equal footing with open products in research. This accessibility is particularly relevant for the quantification of scientific output (scientometrics). To generate an overview of this field of scientometric recording of open scholarship, the following thesis presents a mapping review of open scholarship indicators. This sets out how the landscape of open scholarship indicators is structured and to what extent it takes greater account of research output than teaching output. This is followed by a discussion of concrete quantitative operationalisation in the form of OER Statistics. It explains how these were developed, and which applications and limitations are conceivable. The thesis concludes with a synthesis of the individual studies and offers an outlook on potential avenues for future research.

Abstract (Dutch)

Titel doctoraat: Operationalisering van Hoger Onderwijs Onderwijsprestatie (HETP) - Het erkennen en belonen van onderwijs als onderdeel van de wetenschap wordt mogelijk gemaakt door Open Scholarship

Abstract:

Hoger Onderwijs Onderwijsprestaties (HETP) definieert de prestaties van academici in het universitair onderwijs. Deze prestaties omvatten de ontwikkeling van op maat gemaakte onderwijsconcepten en -methoden, evenals de planning en uitvoering van colleges, seminars, werkcolleges en stages. Het omvat ook de voorbereiding van examens en de beoordeling van studenten. Deze activiteiten kunnen een zeer belangrijk onderdeel vormen van het dagelijkse academische leven. Niet alleen hebben veel academici aan universiteiten onderwijsverplichtingen, maar deze activiteiten vormen ook een centraal onderdeel van het academische leven. Bovendien is onderwijs volgens het Humboldt-begrip van het academische leven een integraal onderdeel van academisch onderzoek. Onderzoeksprestaties worden beloond in het academische Recognition & Reward System (RRS). Het RRS omvat mechanismen voor het erkennen en stimuleren van wetenschappelijke prestaties, waarbij zowel kwalitatieve als kwantitatieve benaderingen in aanmerking worden genomen, hoewel het RRS voornamelijk op kwantitatieve maatstaven is gebaseerd. Academici die uitblinken in onderzoek genieten een hoge reputatie in de gemeenschap en worden beloond met onderzoeksfinanciering of banen. De prestaties van academici in het universitair onderwijs zijn vaak minder zichtbaar dan hun onderzoeksprestaties. Hoogwaardig onderwijs levert academici minder voordelen op dan onderzoek, waarvoor ze minder erkenning en carrièrevoordelen krijgen. Deze onevenwichtigheid is problematisch: ten eerste wordt goed onderwijs onvoldoende gewaardeerd en krijgen docenten die zich inzetten en inspannen voor hun onderwijs onvoldoende erkenning in termen van prestige en beloningen. Ten tweede kan deze onevenwichtigheid leiden tot een kwaliteitsverlies in het hoger onderwijs. Studenten kunnen een slechter onderwijs krijgen als docenten weinig tijd en energie steken in didactische concepten. Kennisoverdracht zou op de achtergrond kunnen raken, ook al hebben universiteiten een centrale onderwijsmissie. Ten derde kan een grotere nadruk op onderzoek dan op onderwijs ontmoedigend werken voor academici. Een op onderzoek gericht RRS kan academici ertoe aanzetten zich te concentreren op het publiceren van onderzoeksresultaten en het aantrekken van externe financiering in plaats van zich te richten op onderwijs.

Deze thesis onderzoekt deze onevenwichtigheid en ik streef ernaar om HETP tastbaar te maken, zodat deze prestaties zichtbaar worden in het academische RRS. Hiertoe wordt onderwijsprestatie geoperationaliseerd, d.w.z. vertaald in meetbare indicatoren of concrete termen, zodat deze toegankelijk wordt voor het RRS. Om de operationalisering van HETP uitgebreid te onderzoeken, wordt het onderwerp bekeken vanuit een onderwijskundig perspectief. Deze benadering plaatst onderwijs centraal in de onderwijsprestaties en benadrukt het onderwijs zelf als primaire focus. Een belangrijke uitdaging bij het operationaliseren van HETP is de beperkte beschikbaarheid en toegankelijkheid van informatie over onderwijsprestaties in het hoger onderwijs. De open scholarship-beweging heeft in dit opzicht nieuwe mogelijkheden gecreëerd. Open scholarship maakt academische praktijken en producten toegankelijk en zichtbaar voor het publiek. Dankzij deze

beweging kunnen open producten van universitair onderwijs (Open Educational Resources - OER) op gelijke voet worden beschouwd met open producten in onderzoek. Deze toegankelijkheid is met name relevant voor de kwantificering van wetenschappelijke output (scientometrie). Om een overzicht te geven van dit gebied van scientometrische registratie van open wetenschap, presenteert het volgende proefschrift een mapping review van indicatoren voor open wetenschap. Hierin wordt uiteengezet hoe het landschap van indicatoren voor open wetenschap is gestructureerd en in hoeverre het meer rekening houdt met onderzoeksoutput dan met onderwijsoutput. Dit wordt gevolgd door een bespreking van concrete kwantitatieve operationalisering in de vorm van OER-statistieken. Hierin wordt uitgelegd hoe deze zijn ontwikkeld en welke toepassingen en beperkingen denkbaar zijn. De scriptie sluit af met een synthese van de afzonderlijke studies en biedt een vooruitblik op mogelijke wegen voor toekomstig onderzoek.

Content

List of abbreviations

DIZ..... Didactic Implication Context (German: Didaktischer Implikationszusammenhang)
GIZ ..... Social Implication Context (German: Gesellschaftlicher Implikationszusammenhang)
HETP ..... Higher Education Teaching Performance
OER ..... Open Educational Resources
PIZ.... Psychodynamic Implication Context (German: Psychodynamischer Implikationszusammenhang)
RRS..... Recognition and Reward System

1. Introduction

The Recognition and Reward System (RRS) in the university context describes structures and processes according to which academics achieve visibility, are valued and/or promoted for certain efforts, activities and results. These processes vary in detail according to the national and disciplinary context. They can also differ depending on the university. Consequently, it is not possible to speak of a single system, but rather of many different systems, depending on the context and environment. Nevertheless, there are overarching structures. These include the high reputation of research publications (like articles in prestigious journals, books or conference proceedings) and research impact (i.e. the visibility of the publication in the research community in the form of citations). In addition, the acquisition of external research funding is welcomed and highly valued. In some areas, innovations and patents are also among the most appropriate scientific results. National or international collaborations and activities in academic committees and involvement in academic self-administration are also valued in science (Hornbostel 2010; Hicks et al. 2015).

It is striking that until recently, the RRS was primarily based on research. Research publications, research impact, research funding acquisition, but also patents and research collaborations are based on research activities and tasks. Higher education teaching, on the other hand, is viewed in a less comprehensive and diverse way, especially when it comes to rewards or decisions based on quantitative indicators. This circumstance is surprising as universities are understood as a place of unity of research and teaching. It is also problematic when higher education policy decisions are made, for example when job appointments, promotions or the allocation of academic funding are based exclusively on research activities.

In my thesis, I focus on universities and academics who are committed to both research and teaching. I argue for greater recognition and reward of Higher Education Teaching Performance (HETP) and highlight the often undervalued contribution that academics make to teaching. HETP encompasses a wide range of activities directed at educating, mentoring, and supporting students throughout their academic journey. These activities go beyond the basic delivery of lectures; they include comprehensive course preparation, designing and updating syllabi, creating innovative and accessible teaching materials, and employing effective assessment methods to foster student learning and engagement.

I situate my work in the broad discourse surrounding the academic RRS, which has been the subject of heated debate for some time. For example, there are repeated calls for a more cautious and prudent use of quantitative indicators, such as in the Leiden Manifesto (Hicks et al. 2015), the *San Francisco Declaration on Research Assessment* (DORA) (2012) or the report *The Metric Tide* (Wilsdon et al. 2015). The current discourse also addresses the diversity of academic activities and calls for this to be reflected in the RRS. For example, the *German Research Foundation* (DFG) has demanded that types of publication considered should not be viewed so narrowly but that output should be considered alongside traditional articles and books (DFG 2022). The Dutch public knowledge institutions and funders (VSNU, NFU, KNAW, NWO & ZonMw) have also issued a statement in the position paper *Room for everyone's talent* (2019), in which they explain that they are striving for the Dutch RRS to achieve a better balance between education, research, impact and leadership. The University of Leiden's strategy paper *Academia in Motion* explains how the diversification of academic careers at the university will be implemented in concrete terms (University of Leiden 2024). One international endeavour worth mentioning is the declaration of the *Coalition for Advancing Research Assessment* (CoARA), which aims to reform assessment practices, value the

diversity of academic contributions more strongly and strengthen qualitative assessments (CoARA 2022). The present work can be located within this discourse. By addressing university teaching as an integral part of the RRS, a broader consideration of academic activities is promoted, and the discourse on what counts is expanded.

One way of situating teaching activities in the RSS is by acknowledging and measuring open scholarship practices. Openness in science means the promotion and implementation of practices that allow science to become more transparent, meaning that it is accessible to all, that the processes and results are comprehensible and can be reused. It includes free access to scientific publications (open access), but also to research data (open and FAIR data), methodological procedures (open methodology), published research software (open research software), freely accessible infrastructures such as repositories (open infrastructure) and freely accessible teaching/learning material (open educational resources) (Leibniz Association 2022). Regarding academic recognition and reward, many position papers have discussed and called for the inclusion of openness indicators to create incentive structures for these practices and reward corresponding activities. The following two European Commission strategy papers can be referred to in this context: *Next-generation metrics: Responsible metrics and evaluation for open science* (European Commission 2017(a) and *Evaluation of research careers fully acknowledging open science practices* (European Commission 2017(b)). The GraspOS (Open Research Assessment Dataspace) (OSAF 2023) and OPUS project (Open and Universal Science Project) (O´Neill (date unknown)), which address the aspect of openness in academic recognition and reward, should also be mentioned to emphasize how strongly openness indicators are currently being addressed. Open scholarship practices aim at the inclusion of university teaching performance in academic recognition and reward processes. The emergence and dissemination of Open Educational Resources (OER) opens opportunities for data collection that would not be possible without free access to teaching material. Data-supported inclusion of teaching in the academic RRS thus becomes conceivable for the first time. OER ”are learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others.” (UNESCO 2024). OER as a movement offers an opportunity for the inclusion of HETP in the RRS, as openness enables access to data. This offers the prospect of a more differentiated view of academic activities and results.

I aim to operationalise HETP in such a way that it can be made accessible for recognition and reward in the university context. Operationalisation in this case means the “translation of a rather abstract variable or a fine theoretical construct into a concrete measurable characteristic” (Bortz 2005, 794; free translation by the author). Translation/ operationalisation into concrete characteristics is essential if higher education teaching is to be considered in the RRS of academic performance. While questions are addressed in each of the sub-chapters, the entire thesis is devoted to the following overarching question:

> *How can Higher Education Teaching Performance (HETP) be operationalised for the academic Recognition and Reward System (RRS)?*

The operationalisation of academic performance is common using both qualitative and quantitative approaches. The qualitative operationalisation of HETP is the subject of the following chapter and is similar to the peer review process known from research. This is an academic evaluation process in which experts in a particular field review and assess research papers or, as in the context of my thesis, teaching material. The process usually takes place before the work is published or used for certain purposes. I examine the question of the quality of HETP from three different educational

science perspectives and then discuss the resulting implications regarding qualitative operationalisation (chapter 2) (Weimer, Alt & Hiebl 2024).

I then consider quantitative (i.e. scientometric) approaches to operationalising HETP for the academic RRS. Scientometrics is the quantitative analysis and measurement of academic output. In the field of research, for example, the quantification of articles, books or research data is common. In my thesis, I discuss the transfer of these approaches to the field of university teaching and the quantification of teaching/learning materials as a method to make teaching performance accessible for the RRS. I do not consider HETP in its totality in chapters 3 and 4 but focus on the quantification of freely accessible teaching/learning materials. I argue that published output of higher education teaching is the scientometric equivalent of published research output. Where scientometric indicators of published research material are fundamental to science policy discussions and decisions, scientometric indicators of published teaching material can be the basis for science policy discussions and decisions. To capture the state of the art on research and teaching-related open scholarship indicators, I present the method and results of a mapping review in chapter 3 (Weimer, Heck, van Leeuwen & Rittberger 2023). The review uncovers that open scholarship indicators are insufficiently discussed and applied when it comes to teaching. In the following I address the development and evaluation of a concept which discusses the quantification of freely accessible teaching/learning material (chapter 4) (Weimer & Kullmann 2023; Weimer & Kullmann 2024; Weimer & Kullmann 2025).

2. Higher Education Teaching Performance (HETP)

The second chapter looks at HETP from an educational science perspective and explores the question of good university teaching. To obtain a differentiated view of the issue, I approach the topic from three different angles. I examine HETP against the background of Humboldt's educational ideal (chapter 2.1), from a subject-education perspective according to Huisinga & Lisop (chapter 2.2), and from a systems theory perspective according to Luhmann (chapter 2.3). The following summary focuses on the results and discusses implementations for the qualitative operationalisation of HETP (chapter 2.4). The subsequent texts are extracts from a contribution to an edited volume. The extracts are taken verbatim. Changes have only been made to ensure readability in this context (Weimer, Alt & Hiebl 2024).

2.1. HETP according to the humboldtian educational ideal

Criticism that the RRS is limited exclusively to research is particularly evident in the light of Wilhelm von Humboldt's (1767 - 1835) understanding of universities and education. Humboldt is often accredited for demanding a so-called *unity of research and teaching*. Although this phrase is not found verbatim in Humboldt's literature, his work can nevertheless be interpreted in this way:

> *"The concept of higher scientific institutions, as the pinnacle in which everything that happens directly for the moral culture of the nation comes together, is based on the fact that they are intended to process science in the deepest and broadest sense of the word, and to provide it for use as a material of intellectual and moral education that is not intentionally but purposefully prepared by itself" (Humboldt 2022, original around 1810(a), 152)*[1]

Humboldt argues for the simultaneous location of "science" (or: research) and "intellectual and moral education" in the same "higher scientific institution" (or: university). The unity of research and teaching therefore does not mean that the two are identical but that both practices are carried out in the same place, in the same institution. Humboldt argues for an interplay between the two practices so that they mutually enrich and stimulate each other. Research should enter into teaching, refer to it. Likewise, teaching should refer to research and influence it. This argument can be justified by Humboldt's understanding of education.

At a time of progressive social differentiation and harsh cultural criticism (for example by Schiller) (Rieger-Ladich 2019, 48 - 49), Humboldt argued for a return to the individual as the central starting point for education and social transformation. He places the individual at the centre of his educational theory:

> *"At the centre of all special types of activity is the human being, who, without any intention directed towards anything in particular, only wants to strengthen and increase the forces of his nature, to give his being value and duration." (Humboldt 2022, original around 1810(b), 6)*

[1] All quotes in chapter 2 were originally in German. They have been translated into English by the author for this publication.

Education therefore is an inner process (Humboldt 2022, original around 1810(b), 8). People are not educated but they educate themselves. This inner process is based on the mind, which has "manifold" (or multifaceted; differentiated) powers (Humboldt 2022, original around 1810(b), 8). However, the mind does not suffice so according to Humboldt's theory of education, a counterpart is needed against which the human being can educate themselves:

> *"But since mere force needs an object on which it can exercise itself, and mere form, pure thought, needs a substance in which it can continue to develop, man also needs a world outside himself." (Humboldt 2022, original around 1810(b), 6)*

In educational processes, people interact and people "impress their spirit's shape on the world and make both more similar" (Humboldt 2022, original around 1810(b), 8). According to Humboldt, education is therefore a resonance process in which the human being has an impact on the world and the world has an impact on the human being (Rieger-Ladich 2019, 51-52). According to Humboldt, this "linking of our ego with the world" (Humboldt 2022, original around 1810(b), 7) is at the core of the educational process.

If both university teaching and research are seen as educational processes for academics, then the demand for the unity of research and teaching can be explained by the principle of Humboldt's educational ideal. It seems sensible that students benefit from an external environment where research happens. They can interact with research and deal with the latest scientific findings. It is also logical that researchers and teachers enrich their research and educational processes when they present and discuss their content with young scientists. They are confronted with communicating complex content in an understandable and comprehensible way and this potentially resonates with critical questions or interesting thoughts.

Higher education in the sense of the Humboldtian educational ideal aims to develop the personality and (in the tradition of the Enlightenment) is geared towards the formation of self-determined individuals (Rieger-Ladich 2019, 50). In this individuality, people should become aware of themselves and of being "whole":

> *"In order to escape the scattering and confusing multiplicity, one seeks allness; in order not to lose oneself in an empty and unfruitful way towards infinity, one forms a circle that can be easily overlooked at every point; in order to attach the idea of the ultimate purpose to every step that one advances, one seeks to transform scattered knowledge and action into a unified one, mere erudition into learned education, mere restless striving into wise activity" (Humboldt 2022, original around 1810(b), 9)*

Regarding the question of what "wise activities" are in the humboldtian sense, reference should be made to Eduard Spranger. He closes his habilitation thesis "Wilhelm von Humboldt und die Humanitätsidee" by stating:

> *"Of course, no teaching can create individuality and a sense of form (totality). But it can stifle them if it works against them. That is why the demands on every form of school today are: "Strengthening and protecting individuality. Contact with and training in reality." Inner form and unity of the educational ideal: humanity!" (Spranger 1936, 500)*

The concept of individuality means the centralization of the human being and the sense of form/totality means going beyond oneself. According to Spranger, these two aspects are essential in the Humboldtian sense of education but not sufficient. Only the idea of humanity completes the understanding of education and is therefore also part of higher education. This idea of humanity means supplementing self-improvement with "social ethics" or "practical love of humanity" (Spranger 1936, 16).

If the idea of humanity is to be incorporated into university teaching, then the question arises as to what circumstances are needed for this to succeed. In this regard, Humboldt primarily emphasized the freedom of those being educated: "Freedom is the first and indispensable condition for this education" (Humboldt 2022, original around 1810(c), 76). Only when people are free from external constraints can they develop in a self-determined way, can their intellectual powers contribute to the development of their personality and develop humanity. Humanity is therefore inherent in human beings. What the development of this looks like in concrete terms is up to the individual: "One person would ponder and collect for himself, another would associate with men of the same age, a third would gather a circle of disciples." (Humboldt 2022, original around 1810(a), 153). This argument therefore refers to the students' personal circumstances. Anyone who worries about their income, for example, or is burdened by caring for relatives or loved ones, will not be mentally free to educate themselves according to the Humboldtian ideal. However, the idea of freedom also applies to the university. Humboldt makes it very clear that the state must keep out of the organization of a university that represents the Humboldtian ideal of education: "Public education therefore seems [...] to lie entirely outside the bounds within which the state maintains its effectiveness." (Humboldt 2022, original around 1810(d), 104). This, too, addresses a form of freedom when the space of higher education is not politically directed, but can work exclusively as an interplay of research and teaching. Political influence can also appear in external funding or the subsidization of special research projects. If universities are required to be completely independent of the state, then funding can only be provided via institutional funds and project-supported research funds are unavailable. The state's only controlling task is to ensure that schools prepare young adults for universities. Humboldt therefore did not deny the state any influence on schooling. Humboldt sees the state as being responsible for curricula and organizational issues (Humboldt 2022, original around 1810(a), 158).

Finally, regarding Humboldtian university teaching, the relationship between teacher and learner should be addressed. Humboldt emphasizes that science should be treated as "a problem that has not yet been fully resolved" (Humboldt 2022, original around 1810(a), 153) and must be taught as such. As a result, a different teacher-learner relationship is appropriate in a university context compared to a school context. At school, the teacher imparts knowledge to students and creates a space for education. At university, teaching is not offered as a service. Rather, teachers and students collaborate to create a space for educational processes. In addition to the option of personal development, it should also be said: "Both are there for science" (Humboldt 2022, original around 1810(a), 153).

2.2. HETP from a subject-education perspective

Some of Humboldt's educational ideas are shared and further developed by emancipatory educational science (German: Emanzipatorische Erziehungswissenschaft) and the associated theory of subject formation (German: Subjektbildungstheorie). In particular, the interaction of the educated person with the world is similar in both educational theories. In this regard, Humboldt mentions the individual's mind as being linked to the other person (Humboldt 2022, original around 1810(d), 8). Emancipatory educational science argues that the subject (the learner) is in a reciprocal relationship with the world (subject-object dialectic) (Lisop & Huisinga 2004, 103).

Both schools of thought should be seen in their different cultural and historical contexts. The end of the 18th and beginning of the 19th century was characterized by progressive social differentiation, the constant demand for increased performance and the associated disintegration of the individual (Rieger-Ladich 2019, 48 - 49), prompting Humboldt to call for a return to the human being as the

starting point for all activities (Humboldt 2022, original around 1810(d), 6). Emancipatory educational science, which emerged in the 1970s, reacted to the pedagogical "Wesensschau" (Roth 1963, 112) pursued in the humanities, which had done nothing to counter German fascism and the Holocaust and allowed them to continue. It is based on a social critique of ideology, appeals to individual and collective potential for maturity in pursuit of democratic and humanist goals and thus adds an emancipatory dimension to Humboldt's educational ideal. Education should not be functional but should liberate from political and economic appropriation (Mollenhauer 1977, 27).

Lisop & Huisinga (2004) develop a theory of subject formation with "Arbeitsorientierte Exemplarik", which is meant to meet this requirement. They argue that people encounter their environment through work, change it and are changed by it. Lisop & Huisinga draw on a broad anthropological concept of work with a trinary character (gainful employment, reproductive work and public work) and thus include all conscious activity in all areas of life in the concept of work (Lisop & Huisinga 2004, 20). The individual, who is thus constituted as a subject, is accordingly part of society and is also shaped by it (Lisop & Huisinga 2004, 138-139). Through the subject-object dialectic and the objectification of the individual lifeworld, one's own individuality is developed by means of the ability to work and cognize (Lisop & Huisinga 2004, 138). Accordingly, the subject is constituted through "knowledge and ability, reflexivity and work, with which people can transcend the status of being an object, of merely functioning" (Lisop & Huisinga 2004, 103). The authors thus differentiate the concept of the individual from the subject. The former is seen as a transgression, based on the anthropological developmental capacity of humans, in accordance with their species. Consequently, development is aimed at unfolding as a social, creative human being. This higher value within the development process is characterized by autonomy, activity, and reflexivity of one's own history and environment, as well as the related conscious shaping and autonomous unfolding. The development of the subject is also always individual as well as shaped by the lifeworld. Ultimately, the subject's consciousness relates both to the development of self and to its inner conceptions of society and genus (Lisop & Huisinga 2004, 138). The subject can establish connections of meaning between sub-areas and the social whole in order to generate autonomous and discursive solutions to problems and conflicts. In this context, the subject faces certain ambiguities and polarities which, due to the environment and psychological experience, cannot always be overcome by means of the ability to act, decide and evaluate. In this respect, the subject tends to be enlightened, tends to have scientific awareness and also tends to have a moral world view (Lisop & Huisinga 2004, 102-103).

Based on the described process of subject formation, the authors view their emancipatory understanding of education as conveying value patterns for shaping life and society as well as for the development of the personality (Lisop & Huisinga 2004, 106) by means of self-competence, professional competence and social competence according to Heinrich Roth:

- *Self-competence* (German: Selbstkompetenz), also described by Roth as value insight and ego-competence (Roth 1971, 448), is aimed at self-determination and moral maturity. This refers to the ability to act responsibly for oneself (Roth 1971, 17, 180). It is therefore crucial to develop values and norms in the individual and in society in order to enable the individual to solve moral tasks. Moral maturity as the ability to act is only possible if the individual has factual and social competence (Roth 1971, 389, 405, 589).
- *Professional competence* (German: Sachkompetenz) encompasses intellectual curiosity (Roth 1971, 456) as the ability to set goals, to use them to build knowledge about the world through thoughtful inner action, anticipation of the action plan and linguistic articulation as experiences of reality (Roth 1971, 459-460). In factual areas, critical thinking requires that the reference to reality is not lost but is nevertheless creatively transcended. Critical thinking is therefore linked to creative thinking, going beyond existing conditions (creative thinking:

creativity, imagination, ideas, intuition, invention and discovery) (Roth 1971, 465-467, 470). The factual insight also leads to the learning of distanced behavior towards the world (Roth 1971, 432).

- *Social competence* (German: Sozialkompetenz) equates social maturity. This means being able to judge and act in socially and politically relevant areas (Roth 1971, 17, 180).

Lisop & Huisinga see this subject formation as enabling the "holistic development and unfolding" of human potential with reference to the following threefold principles of education (Lisop & Huisinga 2004, 107):

- Historical education: cause and effect relationships as well as causal relationships and the ability to think in terms of consequences
- Technical education: Knowledge and skills for manufacturing efficiency and functionality in all areas of life
- Aesthetic education: evaluative shaping of work, both product-related and in relation to events

In summary, the challenge in educational processes is to access critical analysis of social existence from the conditions of subject constitution, with a particular focus on the resources of autonomous self-realization. This adheres to the subject's reflexivity on the understanding of a possibly linear or intermediate level of reflection insofar as one's own thinking must become clear about preconditions and their historical and cultural roots. Such self-reflection on one's own presuppositions does not per se provide insight into the history of the genre. Rather, the concrete determinations of one's own thinking, acting and evaluating require the above-mentioned understanding of education to open and clarify certain experiences in which socio-cultural implication contexts are incorporated. Such an implication-theoretical view cannot therefore stop at a mere collection of knowledge. The educational effort aims to penetrate the surface of the factual material, to break down the immediacy of current social problem contexts in a subject-oriented way in order to unfold imminent context. The authors pursue this intention when they understand education as an implication (Lisop & Huisinga 2004, 98) as a structure of mutual inclusion; by placing a subject matter in an overall context, by finding all thematic interrelationships (Lisop & Huisinga 2004, 97). In this way, teaching is not aimed at the learning material or the learning process itself but at subject formation (Lisop & Huisinga 2004, 74). Using exemplarity as a guiding didactic principle, they provide guidance on how learning objects can be selected and prepared given complexity and high psycho-social and cognitive integration requirements (Lisop & Huisinga 2004, 17, 19). The starting point for exemplary education is a concise point (object, complex, concept or law) from which meaning structures, manifestations, parts and whole, individual and social, general and can be developed in a knowledge-oriented way. Learning objectives develop their formative effect when they belong to the whole in a meaning-oriented way (Lisop & Huisinga 2004, 433-434). The wholeness of the social constitutional logic (Lisop & Huisinga 2004, 93-96) results from the structuring of individual parts in relation to each other so that learners can develop the pattern of the whole from the parts (Lisop & Huisinga 2004, 433). To this end, Lisop & Huisinga develop three implication contexts:

According to Blankertz, the **Didactic Implication Context** (German: Didaktischer Implikationszusammenhang (DIZ)) clarifies the central question of the meaning of the acquisition of knowledge, skills and attitudes for life and the social utilization context (interdependence between goal, content and method) (Lisop & Huisinga 2004, 163). This decision in terms of content and method is important:

> *"The methodological structuring of teaching always has to unite the individual-subjective (anthropogenic) prerequisites of the pupils with the objective factual claim (which in turn*

has socio-cultural conditions), regardless of all other differences in procedures. For our purposes, we will call this the methodological guiding question" (Blankertz 1977, 99)

The guiding question cannot then be imposed in the form of a recipe (Lisop & Huisinga 2004, 9), rather it requires the frame of reference of the individual implication contexts (see DIZ, PIZ, GIZ below) as perception, interpretation and decision-making (Lisop & Huisinga 2004, 73-74). In this respect, imparting does not mean ""teaching" but rather linking, connecting and integrating" (Lisop & Huisinga 2004, 79) by the teaching staff. The medium is the tool through which the teaching takes place methodically (Lisop & Huisinga 2004, 52), without the modulation of the material in the context of the learners' goals and level of development being ignored. The contexts of implication thus prevent a reduction to methodological arrangements" (Lisop & Huisinga 2004, 55, 254-255). In short, no distinction is made between methodological and media issues:

"We regard didactics [...] as the professional core of pedagogical activity, which has to relate objectives, objects of learning or knowledge, methods and framework conditions, developmental stage and interests of the learners as well as social concerns to each other" (Lisop & Huisinga 2004, 431).

The **Psychodynamic Implication Context** (German: Psychdynamischer Implikationszusammenhang (PIZ)) centers the constitution of the subject from the somato-psychic-social mediation of the individual and the social. This means that on the subject side, life forces and needs are at work, which are differentiated according to two movements - the somato-psychic and the psycho-social side - to create meaning and identity through the satisfaction of these life needs and the expression of the life forces. The PIZ is a model of basic human orientation in the socialization process in order to counteract motivational problems, attachment issues and learning resistance (Lisop & Huisinga 2004, 178-182).

The **Social Implication Context** (German: Gesellschaftlicher Implikationszusammenhang (GIZ)) solves the question of the subjectively effective experiences, norms and values of the contextualized social pre-understanding. In this respect, learning content must be prepared with reference to society and milieu. The GIZ provides an analytical and decision-making framework for structuring the material:

1. orientation in the subject or in the field of forms of production (categories such as understanding, moving and coping with the world)
2. the objectives in terms of the skills and competences to be developed
3. socialization and psychodynamics - subject reference (prior knowledge, experience)
4. correlation and condensation (is there something that explains and characterizes the social constitution in an exemplary sense?) (Lisop & Huisinga 2004, 208-215).

In summary, the authors present a competence-oriented relevance framework for deciding on and differentiating objectives, content and methods to address human behavior, relationships, values and the need for action in society from a socio-psychological, individual-psychological and economic perspective in educational processes. Lisop & Huisinga consider that learning is not exclusively a cognitive process, and that emotional and affective processes need to be dealt with in an educationally oriented manner, precisely because of the social conflicts and resulting contradictions. In this respect from an emancipatory perspective, this is a subject-oriented contribution to pedagogical professionalism which addresses higher education (Lisop & Huisinga 2004, 15), to make the social context of action at the intersection of science and practice the subject of critical (self-) reflection. This is a contribution to individual and social development, qualification and professionalization.

2.3. HETP from a systems theory perspective

By taking a systemic approach, a more descriptive and less normatively charged perspective on higher education teaching is presented. Niklas Luhmann (1927 - 1998) saw science as a functional system with education as a part. To make this (and other functional systems) describable, Luhmann uses codes in his systems theory, i.e. binary schemes that are used in functionally differentiated systems to process and organize information. They serve to orient and structure communication within a system. The scientific system uses the true/untrue code to evaluate information and make decisions. Programs are complex sets of rules or criteria used in systems to determine how codes are applied. They provide more detailed guidance for decision-making within a system, often being customised to its specific conditions and goals. In the scientific system, theories and methods are examples of programs that make information assessable according to the code true/false (Luhmann 1998).

In addition to the academic system, higher education can also be seen as part of the education function system. The functional system of education contributes to the stabilization of social structures by conveying and maintaining norms and values. Socialization is the fundamental process through which people learn and adapt to the norms, values, behaviours and culture of their society. "While socialization is always self-socialization on the occasion of social communication, education is the communicative event itself because this is the only way to understand its unity." (Luhmann 2009(a), 188).

When describing university teaching as part of the social functional system of education, it is necessary to ask about the medium through which the system operates, which forms this medium can take, within which codes and with which programs the system operates.

In Luhmann's theory, a medium enables malleability. It is a loose but stabilizing structure that facilitates the formation of forms. A medium consists of a multitude of elements that exist in a kind of potential state and can be structured by forms. For example, language is a medium that enables various forms of communication. In the economic system, the medium is money, which also enables communication in terms of payments. A form is a specific structure that arises within a medium. It is shaped by selection from possibilities of the medium. Forms are the concretized states within a medium that carry a certain information or meaning. In the example of language, a specific word or sentence would be a form.

In the educational system, the medium is the child who, according to modern educational theory, is "equipped" with knowledge and skills for life in society (Luhmann 2008, 195). The child is an observer’s construct (Luhmann 2008, 199). Just as media are malleable, the child as a medium of education is also malleable. "Knowledge, seen in this way, is the contraction of the medium to certain firmly coupled forms, and the children to be educated can (or at least should learn to) deal with it " (Luhmann 2008, 206). The medium/form scheme for this is therefore child/knowledge.

In order not to "consume" the medium of the child through its formal education, the concept of education is replaced by the formula of learning ability. "The learning ability formula postulates a principle of the selection of forms of knowledge that is oriented towards the learning opportunities they convey. And learning possibilities means that new yet undetermined coupling possibilities are generated. [...] The medium remains bound to the distinction between children and adults, but it can supplement the term 'child' with others (pupils, students or finally: learners)." (Luhmann 2008, 210)

The "imposition of forms in a medium" is always selective. It takes up specific possibilities and by favouring them leads to other possibilities being ignored. In view of the openness of the medium

(child), all learning simultaneously implies corresponding learning restrictions (Luhmann 2008, 208). True knowledge is taught and learned in the classroom. This results in a relevance of truth that corresponds to the code of truth of the scientific system (Luhmann 2008, 207).

Luhmann (2008, 211; 2009(a), 197) finds it somewhat difficult to code the medium of the child in binary terms, as the coding into good/bad children, passed/failed exams etc. is carried out for reasons of selection and not for reasons of education. To carry out this coding, the educational system must educate non-trivial systems (children) as trivial systems (Luhmann 2009(b), 204). Non-trivial and trivial systems differ in that trivial systems qua programming produce an expected (always the same) output for a given input: 2+2=4. Children as non-trivial systems "form" a "self", which in turn influences the programming.

If we now understand students as the medium of university teaching, we must realize that the trivialization of students has reached a new quality since the Bologna reform latest. In the Humboldtian sense, the university is caught between organization and freedom. Everything that cannot be regulated by organization can remain in a sphere of freedom. Luhmann understands freedom as a medium and organization as a form. However, Luhmann (2009(c), 214) argued in the 1980s that this distinction had become obsolete, distinguishing three trends in particular that are undermining the traditional self-image of universities:

(1) Function of prestige multiplication: "Education participates in the prestige of scientific research, while this research owes its social prestige not least to the fact that it is conducted by academics." (Luhmann 2009(d), 218)
(2) Deinstitutionalization of life courses: "This means that individual prospects are no longer based on predetermined conditions of normalcy and can no longer even deviate from them. The relatively rigid order of proper time in relation to education, contact with the opposite sex, marriage, having children, career choice, professional career and age has been significantly loosened." (Luhmann 2009(d), 218)
(3) Decreasing usability of education in interactions: "To put it more concretely, education is about presenting the fruits of reading in interactions among those present." (Luhmann 2009(d), 219)

Luhmann's systems theory gives us a new perspective on the topic of university teaching compared to what we have experienced from Humboldt and subject formation theory. If university teaching is viewed systemically and students are understood as the medium of university processes, then this opens a different perspective on the RRS of academia.

2.4. Summary and qualitative operationalisation

We can approach a critique of a research-focused RRS at universities in the context of Wilhelm von Humboldt's understanding of education. Humboldt emphasizes the importance of integrating science and intellectual and moral education in an educational institution. He argues for an interplay between research and teaching, whereby both should enrich each other. He places the individual at the center of his educational theory and sees education as an internal process in which people educate themselves. Education occurs in interaction with the world, whereby people and their environment influence each other. He sees university teaching and research as educational processes that enrich students and researchers alike, whereby both serve science, and the teachers are not exclusively imparting knowledge (chapter 2.1).

The theory of subject education adopts a critical perspective in pedagogy, emphasizing the need for a systematic testing of socio-historical conditions and striving to promote individual and collective maturity as well as democratic and humanist objectives. Education should not happen in a pre-social and apolitical space but include political, economic and ideological factors. Regarding university teaching, Humboldt emphasizes the importance of personality development and the formation of self-determined individuals, arguing for an education aimed at humanity and supplemented by social ethics. Critical educational theory goes beyond the ideal of the education of individuality as a process of self-education and integrates the idea that the individual is absorbed into the generic being. Education is a process that is embedded in historical contradictions and contributes to the memory of a liberated humanity. In the context of higher education, this perspective focuses on linking education, science and social practice and emphasizes science´s critical function. Higher education should not only serve current purposes but should also be able to reflect on these purposes. In summary, subject education theory aims to liberate education and training from political and economic appropriation and instead use them as a means of changing society and developing maturity, emancipation and autonomy. Central to this is the idea that good higher education and professionalism arise from a twofold problem: On the one hand, the (historically) truthful recording of social reality and on the other, the preservation of reference to normative value systems, particularly the emancipation of the subject (chapter 2.2).

Regarding a qualitative operationalisation of HETP, a good argument can be made based on the humboldtian educational ideal and the subject education perspective. If the humboldtian educational ideal or the education of emancipated subjects is set as the goal of higher education processes, then quantitative indicators can only reflect the fulfilment of this achievement to a very limited extent. In this logic, more substantive aspects should be examined. For example, the application process should establish whether empirical knowledge and scientific knowledge are interlinked in the teaching material (in the sense of theory-practice coupling). The learning content should ideally have a connection to the students' world so that they can reflect on themselves in the learning processes. There should be the opportunity to promote personality development within the framework of university seminars and to critically question one's own values and norms in relation to society. For this purpose, there should be discourse among students but also with the teacher.

If university teaching is to be considered qualitatively in the RRS, then the following questions can be addressed:

- Are personal, technical and social skills developed during teaching?
- Is the teaching well prepared didactically? (see *Didactic Implication Context*; chapter 2.2)
- Does the teaching serve to promote personality development?
- Do the learners have the opportunity to develop and reflect on values and norms?
- Is the holistic context of the learning objective and the learning material clear?
- Is the teaching geared to the learners' needs and environment? (see *Psychodynamic Implication Context*; chapter 2.2)
- Is the teaching socially relevant? (see *Social Implication Context*; chapter 2.2)

Questions like these can be answered qualitatively. Colleagues from the same discipline could review teaching performance and thus provide a more comprehensive insight into the teaching performance of a person or institution (equivalent to peer review in the research area).

Building on Luhmann's systems theory, it can further be argued why quantitative approaches are useful to operationalise HETP. Systems theory, which tends to abandon the individual level in favour of the societal level, shows how this contradiction between individual-normative educational demands must give way to a system logic of complexity reduction to maintain the structural coupling

between the individual functional systems as well as the communication within a functional system. If we imagine that in an application process two people had to be assessed with all their facets from birth to the present day, a decision could not be made. Moreover, key figures relieve us morally so that we do not have to justify the choice with an assessment of a personality, of their self, but can refer to this "objective" measure. This makes decisions justifiable and attributable (chapter 2.3). Following Luhmann's systems-theoretical argument, the academic RRS could be described as a trivial system. A binary coding of this system follows the pattern service provided/service not provided (or: teaching material published/teaching material not published). Based on this argument, quantitative operationalisation's of HETP make a lot of sense. I will discuss these in the following.

3. Openness as a possibility for quantitative operationalisation

In the context of the quantitative operationalisation of HETP, I focus on a data-based approach of the RRS. The basis here (in chapters 3 and 4) is data on higher education teaching. As already mentioned in the introduction to this thesis, I will focus on freely accessible teaching material (material without access restrictions). I see the openness of academic practices as a great opportunity for quantifying HETP, as open practices provide insights into teaching activities that were not previously possible. Scientometric indicators can quantify open material (open scholarship indicators). Practices and products that are not openly shared and accessible cannot be analysed by scientometricians and are therefore not included in this study.

To present the state of the art of research on these open scholarship indicators, I will present and discuss a mapping review of such indicators in the following chapter 3. The research questions are as follows: (1) Which open scholarship indicators are currently applied and discussed? (2) Which subjects address and which disciplines and journals shed light on open scholarship indicators? This review summarizes the current discussions surrounding scientometric indicators relating to open scholarship, exploring the relationship between the indicators employed in research and those used in university teaching. It was published in the Quantitative Science Studies (QSS) journal (Weimer, Heck, van Leeuwen & Rittberger 2023). In the following, text has been taken verbatim from the journal article. Only omissions and individual sentences have been changed to ensure readability for this thesis. No substantive changes have been made.

3.1. Method: mapping review

Data Sources: The present study was designed as a mapping review/systematic map and serves to categorize literature about open scholarship indicators. My co-authors and I decided against conducting a qualitative systematic review because we are interested in mapping and categorizing the literature rather than analyzing the literature thematically. The mapping review explicitly serves to provide an overview and to identify research gaps. Methodologically, the literature search, screening and coding are as structured and comprehensive as they would be in a systematic review. Yet, we do not assess the content of the literature in the mapping review in detail, which would be the methodology of a systematic review (Grant & Booth 2009, 94). The data basis for the literature search consists of two international literature databases, one German literature database with a focus on educational research, and one pre-print server that seems to contain relevant pre-prints on the review´s topic. No manual search was carried out because the selected literature databases broadly cover the topic of the mapping review in terms of content.

The Web of Science (abbreviation: WoS; publisher: Clarivate Analytics; https://webofknowledge.com) is an international bibliographic database containing cross-disciplinary publication and citation metadata with a bias towards the Anglo-American language area (van Leeuwen et al. 2001). For this review, we accessed Web of Science (WoS) via the licence of the Competence Centre for Bibliometrics (https://www.bibliometrie.info/index.php?id=home). The licence includes all indexes of Web of Science (WoS).

The database *Bielefeld Academic Search Engine* (abbreviation: BASE; publisher: Bielefeld University Library; https://www.base-search.net/) is a meta search engine containing a variety of scientific publications from different sources. Publications include scientific articles and books as well as

information on research data, doctoral theses and postdoctoral theses, teaching material, and other types of documents. BASE accesses 9,104 data providers. Relevant providers are e.g.:

- ArXiv.org (Cornell University Library) – Coverage in BASE: 100%
- SSOAR - Social Science Open Access Repository – Coverage in BASE: 99%
- Zenodo – Coverage in BASE: 98%

The *Fachportal Pädagogik* (German Education Portal, abbreviation: FP; publisher: DIPF; https://www.fachportal-paedagogik.de/en/literatur/index.html) is highly interesting here because of its broad coverage in the field of educational research in German-speaking countries. Beyond its national collection of literature references (FIS Bildung as part of FP), FP also contains information from other data sources (e.g. ERIC). For this search, all data sources except BASE, which was searched at its own search site, were included. We considered FP due to its educational focus, including literature on open and educational science assessment and infrastructures.

We also consider the pre-print server of the *Open Science Framework* (abbreviation: OSF; publisher: Center for Open Science; https://osf.io/preprints/) because we expect to find relevant pre-prints on the review's topics. Similar to BASE and FP, OSF uses different data providers. In this case, the search was limited to OSF's own preprint server.

Search terms and search queries: A first literature search was conducted in October 2021. It served to validate the search terms. The search queries consist of two blocks (Table 1). For block A, the two umbrella terms "open scholarship" and "open science" were chosen, as well as openness terms that primarily refer to quantifiable entities ("open access"; "open data"; "open educational resources" and the corresponding abbreviation "oer"). Softer openness terms were excluded from the search syntax, such as "open scholarly communication", "open collaboration" or "open method", as the mapping review focuses on countable entities. Part B of the search syntax includes terms that capture scientometric indicators. For the search term validation, 18 terms were tested (Table 1, search terms 1 - 18). The test search results were subjected to a keyword analysis to validate the search terms (dataset: research data (1)). In the keyword analysis, all keywords assigned to documents returned in the test search were examined for their relevance. As a result, search terms 19 to 22 were added to the final search. The search terms 1 - 18 as well as the division into part A and B of the search query were retained.

search terms in block A		("open scholarship" OR "open science" OR "open access" OR "open data" OR "open educational resources" OR "oer")	
AND (a search term from block B)			
search terms in block B		English (for all databases)	German (only for FP)
	1	indicator*	indikator*
	2	metric*	metrik*
	3	scientometric*	szientometri*
	4	bibliometric*	bibliometri*
	5	webometric*	webometri*
	6	altmetric*	altmetri*
	7	sociometric*	soziometri*
	8	"research assessment"	(forschungsbewertung* ODER forschungsbilanz*)
	9	Reward	belohnung
	10	recognition	anerkennung
	11	Ranking	rangliste
	12	monitor*	

	13	“evidence-based policy“	(“ evidenzbasierte politik“ ODER “ faktenbasierte politik“ ODER “faktengestützte politik“)
	14	“impact analysis“	(wirkungsanalyse ODER folgenanalyse)
	15	“academic impact“	("wissenschaftliche bedeutung" ODER "wissenschaftliche auswirkung" ODER "akademische bedeutung" ODER "akademische auswirkung")
	16	“research impact“	forschungswirkung*
	17	“performance measurement“	leistungsmessung*
	18	Incentive	anreiz*
	19	“statistical analysis“	“statistische Analyse“
	20	“research evaluation“	“Forschungsevaluation“ ODER “Wissenschaftsevaluation“
	21	informetric*	informetri*
	22	“data-driven policy*“	“datenbasierte politik“

Table 1. mapping review: search terms.

The final search was conducted between February 20th and March 18th 2022. The German translations were only used in the FP database. For each data source, the search queries were adapted according to the database field options (Table 2). For Web of Science (WoS) we chose the fields title and keywords (author keywords & keywords plus). In BASE, we did two separate searches in the fields title (=tit) and keywords (=subj). In FP and OSF, the free text search was chosen, because the test searches showed that hit rates were not much higher than for searches in specified fields like title. Table 2 shows the concrete search queries for each database. The wild card […] marks the location for each term from the search block B.

database	search query
WoS	(ti=(“open scholarship” OR “open science” OR “open access” OR “open data” OR “open educational resources” OR “oer”) OR ak=(“open scholarship” OR “open science” OR “open access” OR “open data” OR “open educational resources” OR “oer”) OR kp=(“open scholarship” OR “open science” OR “open access” OR “open data” OR “open educational resources” OR “oer”)) AND (ti=[…] OR ak=[…] OR kp=[…])
BASE	tit:("open scholarship" "open science" "open access" "open data" "open educational resources" "oer") tit:[…]
	subj:("open scholarship" "open science" "open access" "open data" "open educational resources" "oer") subj:[…]
FP	(Freitext: "OPEN SCHOLARSHIP" oder "OPEN SCIENCE" oder "OPEN ACCESS" oder "OPEN DATA" oder "OPEN EDUCATIONAL RESOURCES" oder OER) und (Freitext: […])
OSF	("open scholarship" "open science" "open access" "open data" "open educational resources" "oer") AND […]

Table 2. mapping review: search queries per data source.

Search results and screening: Table 3 presents the search results of the individual queries per search term and database.

	SEARCH QUERY	**WOS**	**BASE**		**FP**		**OSF**
		title & keyword search (author keywords and keyword plus)	title search	keyword search	free-text search		free-text search (OSF own data provider; subject: Library & Information science
		English query	English query	English query	German query	English query	English query
	("open scholarship" OR "open science" OR "open access" OR "open data" OR "open educational resources" OR "oer") … **AND**						
1	indicator*	149	35	44	6	58	0
2	metric*	143	20	7	1	26	0
3	scientometric*	45	15	16	1	34	0

4	bibliometric*	173	124	117	27	20	0
5	webometric*	14	12	0	2	2	0
6	altmetric*	79	31	24	3	3	1
7	sociometric*	1	0	0	1	0	0
8	“research assessment“	18	28	132	1	0	13
9	reward	47	19	21	5	6	0
10	recognition	109	69	175	27	54	1
11	Ranking	97	49	106	0	18	0
12	monitor*	143	104	13		42	1
13	“evidence-based policy“	5	10	12	0	0	2
14	“impact analysis“	3	2	9	1	0	2
15	“academic impact“	2	1	3	0	0	3
16	“research impact“	32	81	118	0	0	13
17	“performance measurement“	4	10	11	7	0	0
18	Incentive	104	14	28	22	12	0
19	“statistical analysis“	19	11	25	87	0	0
20	“research evaluation“	25	24	110	1	0	12
21	informetric*	4	1	4	2	2	0
22	“data-driven policy*“	1	0	0	0	0	14
					194	*277*	
	Subtotal		*660*	*975*			
	Total	**1217**	**1635**		**471**		**62**

Table 3. mapping review: search results (including all duplicates).

Following the extraction of the search results, the data set was cleaned of duplicates. The first step was performed internally in the individual database results. In Web of Science (WoS), duplicates were identified and removed via the WoS-internal database ID (=UT). In OSF, duplicates were identified via the DOI, in BASE via DOI and title, and in the FP via the database-internal ID and title. The second step of the duplicate cleaning process involved the cross-database cleaning of duplicates. This was also done using the DOI and the titles. The number of duplicates identified and removed can be seen in the PRISMA diagram (based on: Page et al. 2021) (Figure 1).

The PRISMA diagram also shows the two screening steps conducted after the duplicate cleaning. Both screening steps were carried out by me. 2262 documents were included in Screening 1. The title and abstract were checked for relevance. First, we excluded documents that lack data completeness, i.e. all hits with no data about title and author were excluded. Second, all hits not available in German or English were excluded as the authors are only familiar with these two languages. Documents were also excluded in Screening 1 if their content did not cover the topics of performance measurement, openness and/or indicators (content exclusion criteria). Documents were dismissed if the inappropriateness of the documents was obvious, otherwise the document was kept for Screening 2. One example of an excluded document addressed fishing performance in open waters.

After the first screening, we kept 424 documents for Screening 2, then we analysed the full texts for relevance. Formal exclusion criteria related to inappropriate document types, for example short sketches or conference abstracts with no available full text. The content exclusion criteria are identical to Screening 1, but with a detailed assessment of the exclusion criteria to record on which criterion the documents were excluded. In Screening 2, 158 documents were excluded for content reasons. The PRISMA diagram shows which of the three exclusion criteria were applied and how often, exclusion based on more than one criterion is possible. The final data set used for coding includes 248 documents (dataset: research data (1)). The 248 documents were published between 2004 and 2022, with more than 50% published in 2018, 2019 and 2021.

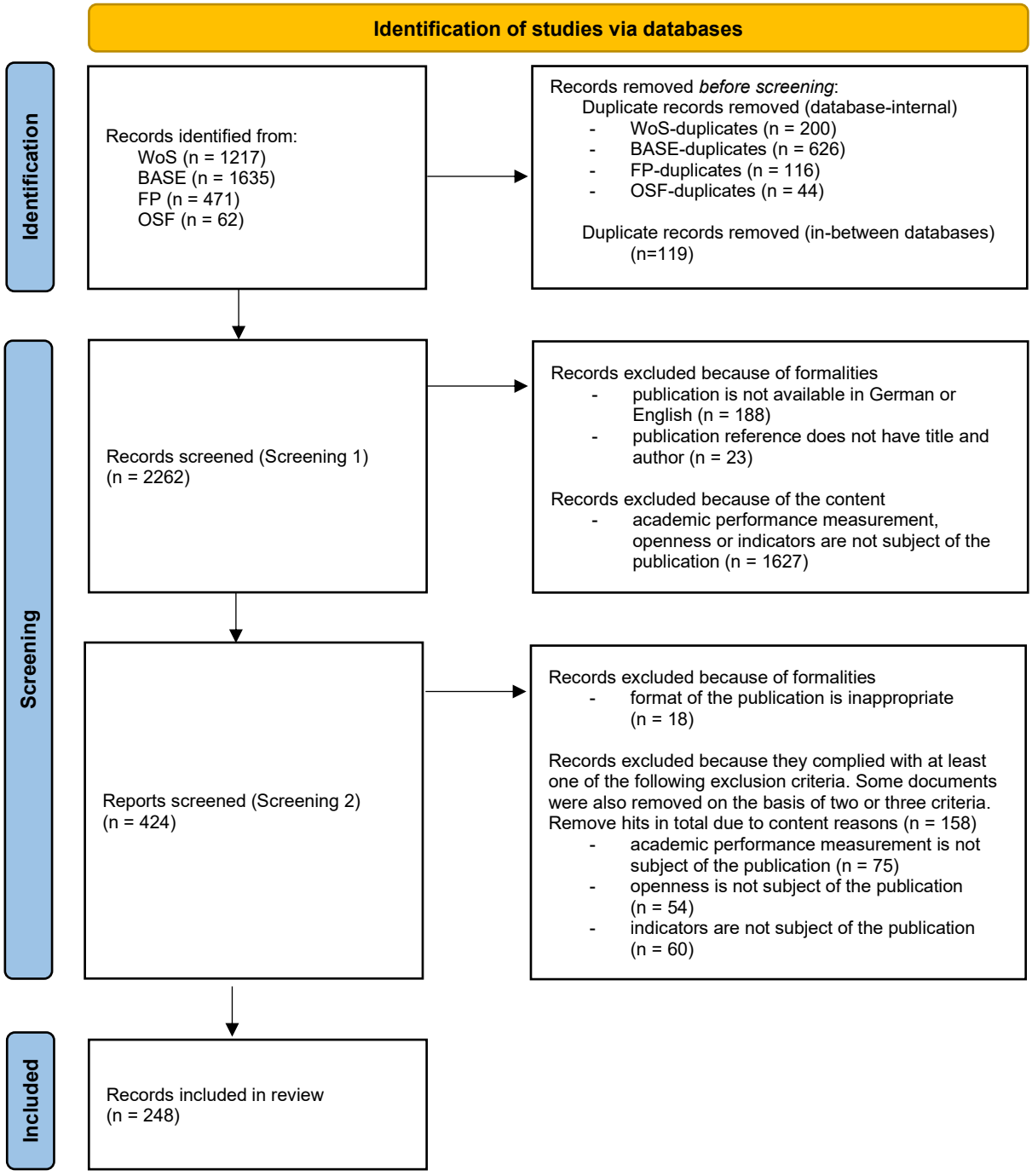

Figure 1. mapping review: PRISMA Diagram.

The inductive coding was divided into three parts carried out by me. In the first step, I distinguished empirical applications of the indicators and discussion papers regarding the indicators. In the following step, the applied or discussed indicators were identified. I distinguished between a) known bibliometric and altmetric indicators (e.g. journal impact factor) applied to open scholarship objects (e.g. open access journals), and b) open scholarship indicators explicitly designed to measure open scholarship objects. The last coding aspect refers to the documents the open scholarship indicators were applied to (e.g. open access publications, open data, open code, etc.). The result of the coding can be taken from the research data (research data (1)).

To address the second research question, the topics, disciplines and journals of the dataset are analysed. The data provided by the databases (keywords, subject categories and source) are

processed. A descriptive analysis is performed for an overview of all disciplines the publications relate to (Table 6 and Table 7). Furthermore, the data is visualized with VOSviewer (https://www.vosviewer.com/). For this purpose, the program extracts noun phrases from the titles and abstracts. These are represented by nodes and links. The connection between two nodes indicates that both terms occur together in a document.

Limitations: The first limitation of this study is that the subject categories are not available for all documents but only for those from the Web of Science (WoS) (171 out of 248 documents). Furthermore, it must be noted that search queries must always be restricted regarding terminology. It is conceivable that the quantification of open teaching material is not discussed within scientometric terminology but within educational science terminology. We have approached the subject matter here from a scientometric perspective and thus disregarded potentially interesting search terms. Follow-up studies could broaden this perspective and in addition to scientometric approaches also consider student evaluations for example. Accordingly, the search queries would have to be adapted and expanded.

3.2. Results: open scholarship indicators

The coding of the mapping review revealed that 203 documents specifically apply the indicators in empirical studies and 45 documents present, discuss or issue recommendations regarding the indicators. Concerning the first research question of this paper, chapter 3.2.1. presents the indicators of the empirical studies and chapter 3.2.2. the discussion/strategy papers. Following these findings, the keywords and disciplines of the documents are analysed in chapter 3.2.3.

3.2.1. Application of the indicators

In total, I identified 82 indicators in the empirical studies of the mapping review. 37 of these are bibliometric indicators (e.g., the h-index), 37 are altmetric indicators (e.g., the altmetrics attention score (AAS)), and 8 indicators relate specifically to the openness of the materials (e.g., the openness status). Due to the search queries of the review, all indicators are related to openness in some way. For example, surveys are among the studies that examine data sets for "open access citation advantage". For this purpose, the indicator "times cited score" (tcs) was applied to open access and non-open access documents (Langham-Putrow, Bakker & Riegelman 2021). At the material level, there is a link to openness, but the tcs indicator is a classic bibliometric indicator. Therefore, the umbrella category of openness indicators was not chosen in this case. I have categorized the indicators into the three categories myself. Table 4 shows the ten most frequently used bibliometric and altmetric indicators as well as all openness indicators, as this is the main focus of this paper (for the complete list see dataset: research data (1); for the description of the indicators: van Leeuwen & Tatum 2018; Waris et al. 2021; Moed 2017).

	INDICATOR	DESCRIPTION	FREQ.
BIBLIOMETRIC INDICATORS	times cited score (tcs)	number of citations recorded to all papers involved (citation count)	79
	journal impact factor (JIF)	calculates how often the articles of a particular journal are cited in other scientific publications on average per year	34
	number of papers (p)	(normal articles, letter, and reviews) published in journals	31
	Hirsch Index (h-index)	number of publications (h) by a scientist, that have been cited at least h times	23
	annual growth of publications (AGR)	year-on-year growth rate (%)/ increasing trend	10
	Eigenfactor Score (ES)	journals are rated according to the number of incoming citations, with citations from highly ranked journals weighted	9
	CiteScore (CS)	"average citations per document that a title receives over three years"	8
	highly cited papers (10%) (pp_top10%/ HCP10%	the share of the number of papers that are among the 10% most frequently cited of all similar papers in the period x - y	7
	Source normalized impact per paper (SNIP)	ratio of the journal´s citation count per paper and the citation potential in its specific subject fields and calculated as the number of citations received in the current year to publications in the past three years, by the total number of publications during the last three years	5
	journal mean citation score (jmcs)	average citation rate of all articles published in the journals in which an institute/ group has published (excluding self-citations)	5
	[…]	[…]	[…]
ALTMETRIC INDICATORS	twitter mentions/tweets	twitter mentions/ tweets are counted	22
	mendeley readers/ bookmarks/ mentions	mendeley readers, bookmarks and mentions are counted	15
	facebook mentions	facebook mentions are counted	12
	download count	number of downloads are counted	11
	altmetrics attention score (AAS)	amount of attention that one document has received on various webpages (these are weighted differently) are counted	9
	blogpost count	blogposts are counted	8
	total readers count/ view count	total readers/ views are counted	8
	Wikipedia (all languages) mentions	wikipedia mentions are counted	6
	usage count	usage can be defined in different ways; in the case of WoS, for example, as digital access to a document	5
	google+ mentions	google+ mentions are counted	4
	[…]	[…]	[…]
OPENNESS INDICATORS	OA status (green, gold, hybrid)/used license	different typologies are used for counting (e.g. golden/green path or green/ golden/ bronze/ hybrid path)	25
	article publishing charge (APC)	economic factor is included by comparing articles/journals with high APCs with those with low APCs	10
	number of open code	number of open code is recorded	2
	number of open data	number of open data is recorded	1
	number of open data (re)use	number of (re)uses of open data according to the binary principle (reused or not reused)	1
	Normalized Open Access Indicator (NOAI)	first, the share of OA publications is calculated by institution (or country) and by discipline (or subject area) and then normalized to the global share; secondly, an average weighted according to the number of publications per discipline is calculated	1
	OA citation advantage (OACA)	proportion of average citations of OA articles relative to non-OA articles	1
	transparency of the peer review process	14-item tool to assess the transparency of the peer review process based on the journal website	1

Table 4. mapping review: indicators used in the empirical studies.

Objects	*Freq.*
OA articles	100
OA journals	61
mixed document types	9
open data	8
OA books	7
OA repositories	7
OER/ MOOCs	4
preprints	4
OA citation data	1
open bibliometrics	1
open code	1
SUM	**203**

Table 5. mapping review: open scholarship objects to which the indicators were applied.

Furthermore, we identified the open access objects to which the indicators were applied. Only one label was assigned per document and the label “mixed document types” was assigned as soon as no clear distinction could be made between OA articles, OA books and other types of publication. For example, this label was assigned to the document that gives the following information about the data basis: “All document types for the 2000-2019 period were retrieved.” (De Filippo & Mañana-Rodríguez 2020). 49.26% of the documents (n=100) refer to open access articles (Table 5). It is interesting to note that the indicators are applied to OER or MOOCs four times. The following documents are the ones dealing with teaching materials:

- Wang, Xiaochen; Liu, Mengrong; Li, Qianhui; Gao, Yuan (2017): A Bibliometric Analysis of 15 Years of Research on Open Educational Resources
- Zancanaro, Airton; Amiel, Tel (2017): The academic production on open educational resources in Portuguese
- Zancanaro, Airton; Todesco, Jose Leomar; Ramos, Fernando (2015): A Bibliometric Mapping of Open Educational Resources
- Wahid, Ratnaria; Ahmi, Aidi; Alam, A. S. A. Ferdous (2020): Growth and Collaboration in Massive Open Online Courses: A Bibliometric Analysis

On the one hand, the four represent a small number, and on the other hand, it should be noted that OER are not mentioned in the specific labels of the indicators (Table 4). In contrast to studies which, for example, specifically state in the methods section that they use the indicator "number of open data", this is not explicitly addressed in the studies on OER. There, reference is made to the use of general bibliometric or altmetric indicators. These are then applied to the object of the OER without addressing this methodologically.

3.2.2. Discussion and policy papers

Some indicators do not appear in the empirical studies but are presented in the discussion and policy papers. Nichols & Twidale (2017) introduce and discuss various open scholarship indicators. The *Practical Openness Index (POI)* is a simple indicator at the author level that divides the number of open articles and conference papers by the number of all articles and conference papers. The *OI-Broad* follows the same approach but also includes book chapters as a third type of publication in the formula. The *Effective Openness Index* divides the number of open publications by the number of all publications minus the number of publications with copyright restrictions. The *Preservation-Friendly*

Openness Index (PFOI) considers the repositories of deposited open documents. Only documents deposited in environments that are considered "long-term locations" (e.g. institutional/disciplinary repositories or library archives) are counted. Publication locations such as personal websites are not counted. The *Acce$$ Index* records the sum of the prices of all non-open items. The calculation can be done by simply adding up the costs, or in a more complex way by weighting costs differently. The *Actual Individual Purchase Index* represents actual costs paid by readers to access work (cost of consumption). The *Openness Cost Index*, on the other hand, calculates the costs incurred in publishing open access documents (costs of publication). Finally, the *Open Reference Index (ORI)* is the proportion of all the cited works of a paper that are themselves open access.

Like the indicators discussed by Nichols & Twidale (2017), three other open scholarship indicators are also discussed in the discussion papers but do not appear as use cases in the empirical studies and therefore do not appear in chapter 3.2.1. The *data-index* considers both the number of datasets and the dataset citations. The calculation procedure is based on the calculation of the h-index (Hood & Sutherland 2021). *Metric for the evaluation of open data (Meloda 5)* is an indicator that records the reuse of open data. The metric has 8 dimensions. They include the legal licensing of the data, the mechanisms for accessing the data, the technical standards of the datasets, the data model, geographical content of the data, the frequency of updating, the dissemination, and the reputation (Abella, Ortiz-de-Urbina-Criado & Blos-Heredero 2019). Finally, the *Danish open access indicator* is discussed which captures the publication output of Danish universities and thus monitors the national open access strategy. Publications are categorized according to whether they (1) are open access, (2) have untapped open access potential (publications that are not open access but have been published in journals that allow green open access with an embargo period of up to one year), or (3) have unclear open access potential (Elbæk 2016).

Some discussion papers have concrete policy dimensions and issue recommendations. In each case, the introduction of open scholarship indicators is accompanied by a call for development of new indicators as well as a caution against the misapplication of these indicators.

Three policy papers of the mapping review dataset operate at the European level. The European Commission published a framework dedicated to the development and use of metrics for open science (Next-Generation Metrics: European Commission 2017(a)). Listing 12 recommendations, the framework aims to achieve four overarching goals: 1) fostering open science 2) removing barriers to open science 3) developing research infrastructures for open science 4) embedding open science in society. The aim is to shift the paradigm from "publish as early as possible" to "share your knowledge as early as possible". For example, the recommendations include a call for recognizing and rewarding open science principles and practices (recommendation 4) and encourage the development of new openness indicators and the further development of existing indicators (recommendation 2). (European Commission 2017(a)).

Another strategy paper of the European Commission, also from 2017, is dedicated to concrete implementation strategies. The "Open Science Career Assessment Matrix" (OS-CAM) represents the range of assessment criteria for the evaluation of open science activities. The framework can be applied to both early career scientists and experienced senior researchers and is intended to drive a change in culture towards open practices. OS-CAM presents possible evaluation criteria regarding openness. Depending on the application, criteria can be taken from the framework. The entire framework does not always have to be considered but it must be applied to the use cases. The indicators can be used on an individual level as well as on a group level. For example, for the "purpose of recruitment and promotion" or for monitoring purposes. Classically, research output can be mapped with the indicators but also the aspect "service and leadership" (e.g. peer review or

networking) or the aspect "teaching and supervision" (e.g. mentoring or supervision) (European Commission 2017(b)).

The European Commission's third policy paper (OpenEdu) is about openness in teaching. "Open Education" in this case goes beyond OER and research output to include policy decisions, teaching methods, collaboration, open learning, and publicising all content. The OpenEdu framework is aimed at higher education institutions and presents 10 dimensions for opening education. It mentions 6 core dimensions (access, content, pedagogy, recognition, collaboration and research) and 4 transversal dimensions (strategy, technology, quality and leadership). The core dimensions focus on what should be implemented and the transversal dimensions deal with the question of how it can be implemented. All dimensions are interconnected and overlap (Inamorato dos Santos, Punie & Castaño-Muñoz 2016).

Knowledge Exchange (KE) is a science policy organization that serves to support and promote higher education and research, in particular open scholarship. It is a consortium of six national research funding organizations (from Germany, the UK, Denmark, the Netherlands, Finland and France). Part of the open scholarship promotion also lies in changes of the RRS and discusses the implementation of an "Openness Profile". This could be included into the ORCID website, increasing the visibility of open scholarship practices. Part of the position paper is also a synthesis of different open scholarship taxonomies. In this context, it is interesting to note that teaching and OER are mentioned more frequently. For example, collaborative authoring of OER is mentioned as an activity, as is sharing OER in open development environments and platforms (Jones & Murphy 2021).

Finally, the Stifterverband in Germany should be mentioned which is a non-profit association that advises science. The Stifterverband in Germany calls for the development of new indicators that reflect open research and innovation processes, supports the development of new data sources and calls for reflective indicator impact assessments to cushion unintended consequences (Blümel 2019).

3.2.3. Presentation of the keywords, disciplines and journals

We took a closer look at the keywords, disciplines and journals represented in the documents. For this purpose, the co-occurrence of the keywords of all coded literature data was evaluated and displayed by a topic modelling procedure of VOSviewer. VOSviewer's topic modelling extracted 154 noun phrases from the 248 titles and abstracts and identified four clusters (Figure 2; also available here: https://app.vosviewer.com/?json=https://drive.google.com/uc?id=12SpWTi_nPlrh4jLkebLPqhTzblEmea54). Each keyword corresponds to a node in the network, where the size of the node represents the frequency of occurrence for the keyword. The links between nodes (n=4068) indicate that associated keywords were shared at least once for a publication. The total link strength (n=5910) indicates that some links have multiple assignments and are weighted accordingly. All nodes are very close to each other, only the green cluster has a slight tendency to separate. The many connections between the clusters show that they are not to be considered as separate from one another but rather merge.

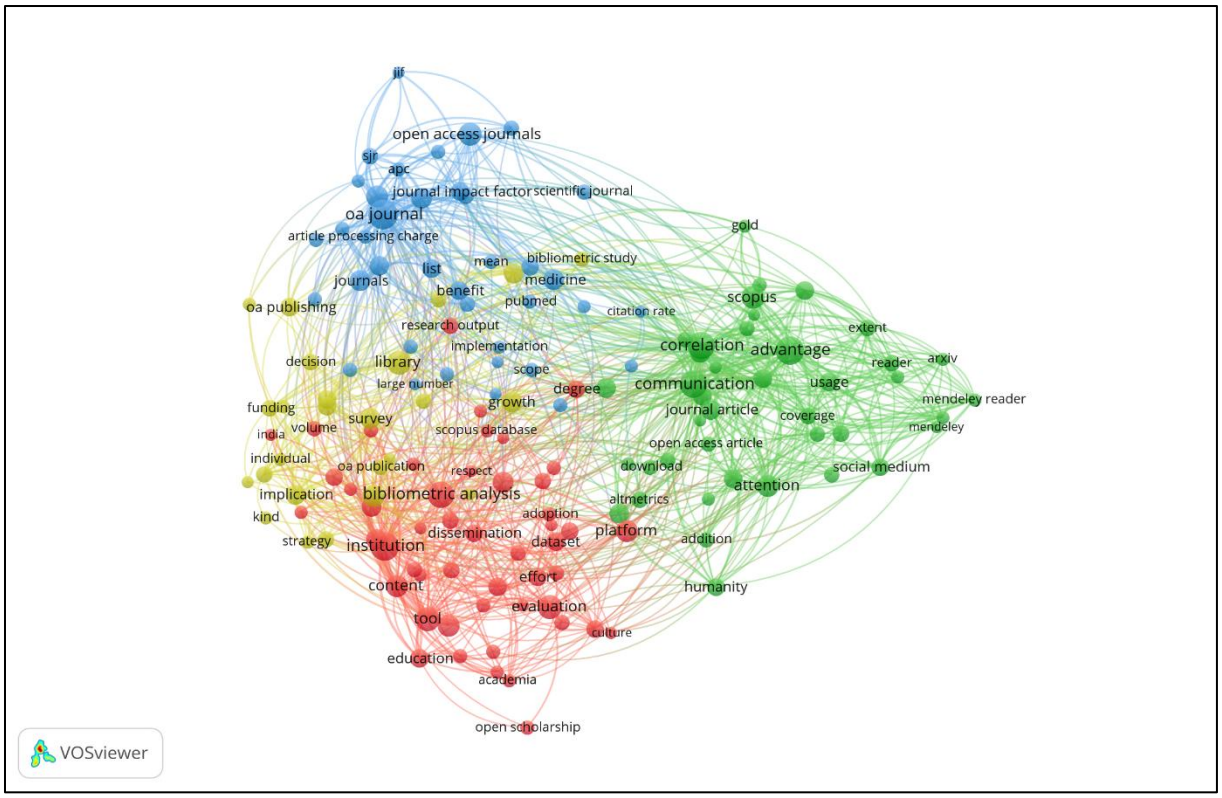

Figure 2. mapping review: visual representation of the clusters.

CLUSTER 1			
item	occur-rence	links	total link strength
institution	26	106	210
bibliometric analysis	23	79	126
evaluation	19	66	92
tool	19	87	148
content	15	81	132
open science	15	44	63
platform	15	76	108
movement	14	73	105
repository	14	67	93
change	13	66	103
initiative	12	71	103
dataset	11	53	72
education	11	52	78
aspect	10	54	76
degree	10	67	88
dissemination	10	68	90
effort	10	61	79
open data	10	55	67
world	10	59	78
collaboration	9	54	74
institutional repositor	9	55	79
interest	9	65	82
research output	9	48	63
academic	8	43	48
account	8	46	56
limitation	8	45	51
regard	8	43	54
volume	8	56	70
adoption	7	37	40
china	7	35	46
open access publicatio	7	37	43
open scholarship	7	21	27
research community	7	42	49
scientific community	7	43	52
transparency	7	46	56
academia	6	40	59
concern	6	41	47
future	6	44	47
scientific publication	6	38	50
scientific research	6	46	53
scopus database	6	32	37
subject category	6	32	36
usa	6	39	51
citation analysis	5	31	33
culture	5	37	43
idea	5	32	39
india	5	20	24
internet	5	31	34
item	5	31	36
respect	5	38	39

CLUSTER 2			
item	occur-rence	links	total link strength
advantage	27	89	213
communication	24	104	216
correlation	24	97	210
scopus	18	84	151
attention	15	84	158
case	14	74	129
journal article	13	72	96
relationship	13	70	102
social science	13	82	111
google scholar	12	69	121
usage	12	56	108
view	12	71	105
altmetric	11	61	83
information science	11	48	93
humanity	10	55	82
social medium	10	50	98
altmetrics	9	43	54
coverage	9	56	79
extent	9	53	85
reader	9	52	87
user	9	55	86
addition	8	54	70
bibliometric indicato	8	49	57
book	8	34	41
citation data	8	42	62
download	8	41	45
non oa articles	8	52	76
open access article	8	42	49
subject	8	49	63
oa status	7	51	72
arxiv	6	36	63
gold	6	37	53
mendeley reader	6	34	70
open access advanta	6	33	39
research question	6	33	38
tweet	6	40	74
wos	6	39	62
fact	5	34	37
lis	5	44	57
mendeley	5	37	59
unpaywall	5	29	32

CLUSTER 3			
item	occur-rence	links	total link strength
oa journal	28	105	266
open access journals	17	64	115
directory	15	70	125
h index	14	69	113
journals	14	63	100
medicine	14	67	104
subscription	13	74	116
benefit	12	71	100
journal impact factor	12	57	91
list	12	62	88
percentage	10	63	88
doaj	9	38	51
sjr	9	51	83
quartile	8	42	69
research article	8	54	70
scientific journal	8	42	44
apc	7	48	71
article processing char	7	44	61
cost	7	40	51
form	7	56	63
gold open access	7	33	45
jcr	7	45	57
mean	7	53	59
opportunity	7	45	53
pubmed	7	50	61
scope	7	35	40
subscription journal	7	45	65
support	7	51	60
variable	7	47	53
bibliometric data	6	37	52
implementation	6	43	48
open access status	6	43	47
prevalence	6	48	56
citation rate	5	41	45
full text	5	36	41
google	5	47	54
jif	5	27	43
large number	5	33	35

CLUSTER 4			
item	occur-rence	links	total link strength
library	19	78	142
context	16	79	119
growth	14	78	118
survey	14	59	75
implication	13	65	109
oa article	13	88	143
design methodology appro	12	74	122
oa publishing	12	66	102
originality value	12	74	122
decision	9	57	73
funding	9	62	84
incentive	9	54	81
peer review	9	66	81
bibliometric study	8	37	47
health science	8	62	76
oa publication	8	59	76
present study	8	54	74
individual	6	37	45
kind	6	31	34
oa model	6	47	58
possibility	6	38	40
strategy	6	49	66
constrast	5	28	31
response	5	40	46
transition	5	47	58

Figure 3. mapping review: tabular representation of the clusters.

A closer look at the nodes and connections supports the impression that the network is very closely interwoven thematically. Figure 3 shows which items were assigned to which cluster, how often they were assigned in the data set, and how many links they have to other items (both the weighted (=total link strength) and the unweighted number (=links)). The presentation reveals that two umbrella categories stand out. These are bibliometrics-related terminology and openness-related terminology. Bibliometrics-related terms include for example "citation analysis" in cluster 1, "bibliometric indicator" in cluster 2, "h-index" in cluster 3, or "bibliometric study" in cluster 4. Thematically related to openness are, for example, "open data" in cluster 1, "oa status" in cluster 2, "oa journal" in cluster 3, or "oa article" in cluster 4. The predominance of these topics is not a coincidence but a logical consequence due to the search query of the mapping review (chapter 3.1). The topics are distributed across four clusters and no umbrella terms can be found for the individual clusters.

In the context of open scholarship, some research-relevant terms are apparent (e.g. "research community" (cluster 1) or "survey" (cluster 4) and many more), but only one term that is directly related to university teaching, which is "education" in cluster 1. In our view, this is a bias that cannot be explained by the search query but rather it indicates a skew in the appreciation of research and teaching achievements in the context of open scholarship. It seems that the quantification of open scholarship addresses research and neglects university teaching.

The keyword analysis was followed by an analysis of the disciplines. In total, the documents with available subject categories (n=171) were classified into 36 different categories - the largest share being from the categories "Information and Library Science" and "Computer Science" (together 69%) (Table 6).

Subject Category	*Freq. (total)*	*Freq. (%)*
Information and Library Science	108	41.38
Computer Science	72	27.59
Science & Technology	14	5.36
Communication	6	2.3
Social Sciences	6	2.3
Education & Educational Research	6	2.3
Business & Economics	5	1.92
Health Care Sciences & Services	5	1.92
General & Internal Medicine	4	1.53
Medical Informatics	4	1.53
Environmental Sciences & Ecology	2	0.77
Psychology	2	0.77
Radiology, Nuclear Medicine & Medical Imaging	2	0.77
Arts & Humanities	2	0.77
Dentistry, Oral Surgery & Medicine	2	0.77
Automation & Control Systems	1	0.38
Biochemistry & Molecular Biology	1	0.38
Rheumatology	1	0.38
Engineering	1	0.38
Pathology	1	0.38
Linguistics	1	0.38
Orthopedics	1	0.38
Evolutionary Biology	1	0.38
Geography	1	0.38
Government & Law	1	0.38
History & Philosophy of Science	1	0.38
Life Sciences & Biomedicine	1	0.38
Mathematical Methods In Social Sciences	1	0.38
Mathematics	1	0.38
Neurosciences & Neurology	1	0.38
Sociology	1	0.38
Surgery	1	0.38
Physiology	1	0.38
Cell Biology	1	0.38
Public Administration	1	0.38
Urban Studies	1	0.38

Table 6. mapping review: subject categories.

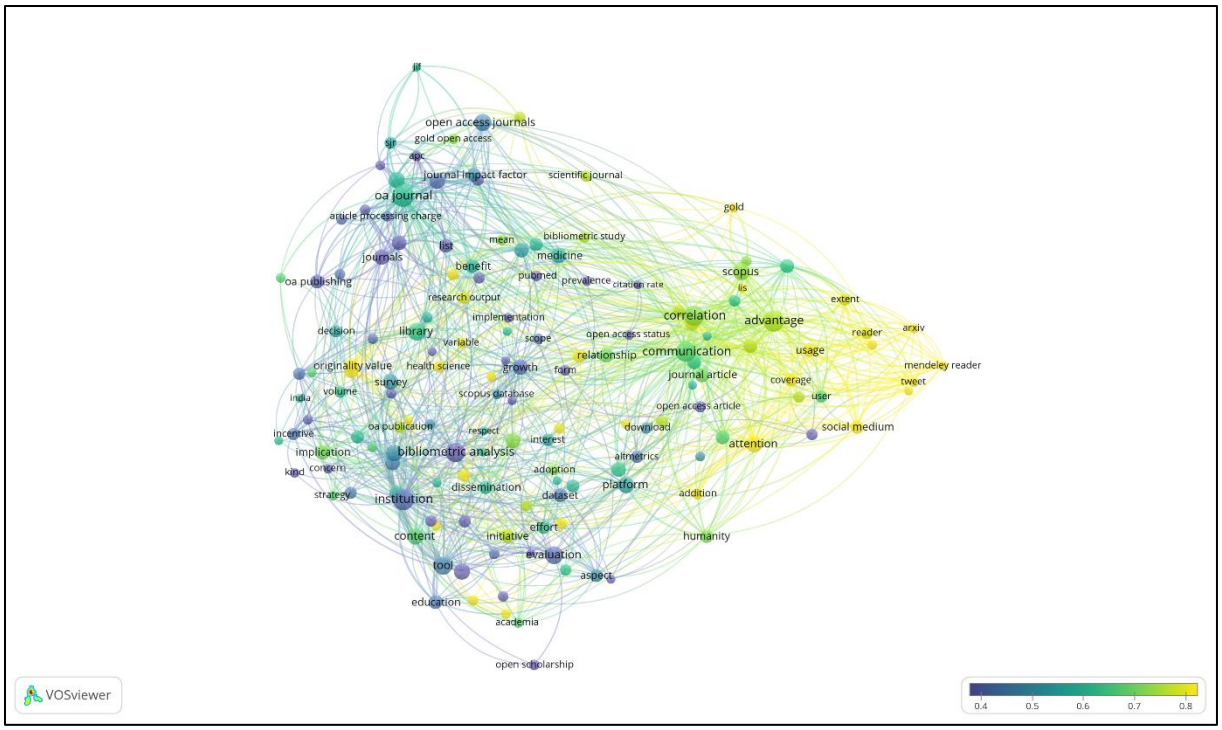

Figure 4. mapping review: visual representation of the subject category "Information and Library Science".

Figure 4 visualizes the most frequently represented discipline, "information and library science". The yellow nodes are strongly connected to the discipline; the blue ones have no relation to it. It is interesting to note that the second cluster (the green cluster in Figure 2) is most strongly connected to the discipline of library and information science (Figure 4).

As a final aspect, we consider the journals in which the articles of the mapping review were published (n=170). A total of 101 journals are listed as sources in the dataset, 79 of which occur only once. Table 8 shows which journals occur more than twice.
The journal “Scientometrics” is the most frequently cited, which we expected due to its focus on quantitative research assessment. Besides Scientometrics, several other journals are visible that as well cover scientometric or informetric areas (e.g. the Journal of Informetrics or JASIST). Those top journals indicate that educational science perspectives on open scholarship metrics are very weakly represented. Only 4 journal titles indicate such a perspective:

- International Review of Research in Open and Distributed Learning (n=2)
- Ried-revista iberoamericana de educacion a distancia (n=1)
- Journal of Distance Education (n=1)
- Educational Technology & Society (n=1)

In a further step, we examined whether the journals can be assigned to certain clusters of the network analysis. For this purpose, four of the most frequently used words were checked for their mention in titles and abstracts of the documents. As a result, it was possible to determine which of the 9 most frequently mentioned journals were represented in the different clusters and to what extent. The analysis showed that the journal Scientometrics belongs to the red cluster with 29.21%, to the green cluster with 38.33%, to the blue cluster with 24.82% and to the yellow cluster with 7.54% (Table 7).

Journal	Freq.	red	green	blue	Yellow
Scientometrics	47	29.21	38.33	24.82	7.54
Journal of the Association for Information Science and Technology (JASIST)	7	12.5	62.5	0.00	25
PLOS ONE	5	27.75	36.25	30.75	5.00
Publications	5	50.00	12.50	25.00	12.50
Journal of Informetrics	4	33.33	33.33	33.33	0.00
PEERJ	4	8.25	27.00	52.00	12.50
Professional de la Informacion	3	16.67	16.67	66.67	0.00
College & Research Libraries	3	45.00	22.50	0.00	32.50

Table 7. mapping review: representation of the journals in the clusters (in %).

The analysis shows that the distribution across the clusters is very diverse and does not follow a pattern. For some journals, the distribution is very even (for example, the Journal of Informetrics), while for others it is heavily weighted (for example, JASIST). The combination of journal and cluster analysis does not provide any revealing insights regarding the content orientation of the clusters or journals. What we have seen very clearly in the journal analysis, however, is that educational science journals play only a very minor role, and other social science or humanities fields are not among the most frequently mentioned sources.

3.3. Discussion

In conclusion, the mapping review revealed the following: First, we only found 8 indicators explicitly designed for open scholarship assessment. All other indicators are bibliometric or altmetric indicators that are applied for non-open research objects too. Second, the open scholarship objects best investigated are those that correspond to research practices traditionally examined in bibliometrics and altmetrics, i.e. OA articles or OA journals. Indicators related to open education are rarely applied in the dataset. As a subject, OER/MOOCS were only addressed four times by the open scholarship indicators. Even though OER were developed later than other OA documents and therefore there was less time to establish them as scientometric subjects, the empirical evidence shows that open teaching plays almost no role in scientometric measurements. In our view, this is problematic insofar as we understand open scholarship as a unit of open research and open teaching. Due to the weak presence of open teaching materials, we think they are not properly visible in scientometric measurements. Our assessment is supported by our empirical evidence in that the review shows that there is a political demand for broader coverage of academic performance (European Commission 2017(b)) and for open teaching (Inamorato dos Santos, Punie & Castaño-Muñoz 2016). The scientometric recording of OER is thus likely to be politically desired.

Furthermore, we noticed that the trivial indicators are most frequently used, i.e. indicators without time and field normalization or weighting (Table 4 or research data (1)). The bibliometric indicators include simple count indicators such as the "times cited score" (tcs) or the "number of papers" (p), as well as indicators combining these two such as the "journal impact factor" (JIF) or the "Hirsch index" (h-index). In comparison, more complex indicators with normalization, such as the "source normalized impact per paper" (SNIP), are rather rare. This is even more so the case for altmetric indicators, which consist exclusively of simple count indicators without time and field normalization and/or weighting. All altmetric indicators mentioned are based on the context-free counting of mentions or appearing on different websites. Among the openness indicators, only one normalized indicator can be found. The “normalized open access indicator” (NOAI) considers field-specific differences in open access publishing but also appears only once in the dataset. All other openness

indicators are also limited to the mere collection of contextless information. Leydesdorff, Wouters & Bornmann (2016) mention citizen bibliometrics, meaning o. a. "simple but invalid indicators that are widely used (e.g., the h-index)" on the one hand and professional bibliometrics, meaning e. g. "more sophisticated indicators that are not used or cannot be used in evaluation practices because they are not transparent, cannot be calculated, or are difficult to interpret". We too can see that professional bibliometrics is little used in the literature on open scholarship indicators. This is unfortunate - much of the criticism of the use of scientometric indicators relates to their limited explanatory power. This point of view could be countered using complex indicators, which is only done to a limited extent.

Furthermore, the review discloses that the indexing of the documents shows a strong bias towards research-related topics. Keywords related to university teaching hardly ever come into play ("education" only once). Documents that address open scholarship indicators are predominantly (74.33%) located in the disciplines "Information and Library Science", "Computer Science" and "Science and Technology". Other disciplines are only sparsely represented (<= 2.3%) which is also confirmed by the journal analysis.

We note that open research and open teaching are thought of together in discussions and debates on open scholarship. At the same time, the application of quantifying open scholarship indicators concentrates on research-related outputs like publications, journals and data. Educationally relevant outputs are rarely represented in our dataset. This might be, as mentioned above, due to the focused search based on scientometric terms. However, we see an imbalance here. If open scholarship refers to scholarly research and education in equal measure, open teaching and learning would need to become visible through quantifying indicators to incentivize open practices and balance the scholarly reward and recognition system. In summary, our review showed that teaching is not considered in scientometrics. There is research on teaching evaluation but this concentrates on aspects like student event critique, university rankings, teaching reports and peer reviews (Bargel & El Hage 2000). However, this is different from quantitatively measuring open practices in education. We see a research gap at this point and opportunities for future research.

3.4. Summary

In summary, the 248 coded documents of the mapping review contain 203 empirical studies that apply indicators and 45 discussion papers that provide recommendations or discussions about open scholarship indicators. Furthermore, it can be noted that the empirical papers use both classic bibliometric and altmetric indicators as well as indicators that are exclusively related to openness. The keywords of the publications cover a wide range of topics showing a tendency towards technical and scientometric terminology. Publications on the topic of open scholarship indicators are highly regarded from a library and information science perspective. Other disciplinary approaches did not substantially influence our mapping review.

Likewise, while open scholarship indicators consider both research and academic teaching, they have a very strong bias towards research-related topics. As mentioned above, I argue that this imbalance is problematic in terms of higher education policy and indicative of a blind spot in the RRS and scientometrics. Regarding an equal appreciation of research and teaching, I present below the development and discussion of open scholarship indicators that quantify open teaching/learning material.

4. Quantitative operationalisation of open HETP: OER Statistics

The development of the quantitative operationalisation of HETP emerges from a three-stage process. The first stage is a study in which the main idea of scientometric indicators that capture open teaching material was discussed with the open scholarship and scientometrics community in the form of focus groups (chapter 4.1). The results of the study were presented and discussed at the ISSI 2023 conference in Bloomington, USA (Weimer & Kullmann 2023). The second stage involved a concept evaluation, which was conducted in the form of expert interviews (chapter 4.2). The results of the study are published in the journal Scientometrics (Weimer & Kullmann 2024). The resulting framework sets out the quantitative operationalisation of open HETP (chapter 4.3) and is published in the journal *Information – Wissenschaft & Praxis (IWP)* (Weimer & Kullmann 2025). As with the previous chapters, the text is taken verbatim from published treatises. Changes were only made to ensure readability within the overall concept of this thesis.

4.1. Pre-study of OER Statistics

The pre-study of OER Statistics development aims to discuss the question of whether the scientific community in the field of scientometrics and open scholarship considers the operationalisation of HETP in the form of quantification of OER to be useful and desirable. The two research questions are as follows:

(1) How do experts in OER and/or scientometrics assess scientometric indicators for OER as a tool to make higher education teaching efforts more visible?
(2) What potential effects and impacts could OER indicators imply?

In the following, I present the results of the focus group discussion in which these questions were explored.

4.1.1. Method and the first version of the OER Statistics

We organized three focus group discussions between May and July 2022 with between three and six participants each. There were 13 participants in total. The conversations lasted a maximum of two hours each. The focus group method lends itself to our study because it ensures that different perspectives are heard and mutually enrich each other through interaction among the participants: "The hallmark of focus groups is the explicit use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group" (Morgan 1990, 12). Focus groups provide insight into the range of opinions of the entire group, as the exchange of arguments is analysed and evaluated at the end. The study is not about capturing individual opinions (Merton, Fiske & Kendall 1956).

Our focus groups consisted of researchers with expertise in either scientometric measurement and/or open scholarship respectively OER. Experts were contacted directly by email and asked to participate. We ensured an even distribution in gender and research experience, included female and male participants, and PhD students, post-docs and professors. All participants were working in Germany. The focus group discussions took place online.

Our preparation for the focus groups consisted of a presentation of outlined OER indicators as subject of discussion (Figure 5). The indicators were introduced at the beginning of each focus group (Table 8). In theory, existing open scholarship indicators could be transferred to the subject of OER.

Where classical open scholarship products, e.g. open access publications or open research data are counted, OER could be counted in the area of teaching material. Where the degree of openness of open access publications is recorded using the green, hybrid or golden road labels, the teaching material licenses could determine how open the materials are. Traditional bibliometric and altmetric indicators can also be applied to both open research material and OER. It would thus be possible to record how often an OER was cited, how often it was downloaded, viewed or shared on social media channels.

Open Access Indicators	*OER Indicators*
number	OER count
openness	degree of openness (weak, strong OER)
	granularity of OER (low, medium, high)
citations	citations of OER
downloads	downloads of OER
views	views of OER
bookmarks	bookmarks of OER
social media count	social media conversations about OER
re-use	reuse of OER

Table 8. transfer of OA indicators to OER.

In fact, there are several obstacles to consider because OER which are designed exclusively for teaching/learning purposes differ from scientific publications in many aspects. Some difficulties were briefly touched upon in the presentation and were then taken up and further discussed by the participants. One aspect is the diverse granularity of OER which coincides with different types of OER (e. g. videos, slides, exercises) as well as the degree of openness depending on copyright assigned to a resource by its creator. The discussion was not conducted at the level of individual OER indicators as outlined in table 8 but the overarching research questions were central to the discussions. Apart from the brief presentation of the exemplary OER indicators and the research questions, the focus groups were not structured. There was no guideline. Our intervention was limited to answering explanatory questions as well as inquiries if from our point of view, a clarification of how exactly a contribution was meant was necessary.

The focus groups were then transcribed by external service providers. The transcripts were afterwards analysed in a three-step process according to Bohnsack (2021). The first two steps are carried out in relation to the focus group discussions on their own, only in the third step are the focus group discussions brought together. The first step involved *formulating interpretation* (German: *Formulierende Interpretation*; Bohnsack 2021, 138) of the individual discussions to identify issues raised. The first step was carried out independently by my co-author and me. Inductively, we extracted codes from the text. In the subsequent "reflective interpretation" (German: *Reflektierende Interpretation*; Bohnsack 2021, 139), the codes within the individual transcripts were set in relation to each other by considering the terms in their conversational context. Umbrella concepts were found, and first codebooks emerged for each transcript. Afterwards, the three codebooks were discussed and condensed into a final codebook. In the last step, the *formation of types* (German: *Typenbildung*; Bohnsack 2021, 145), the themes identified with their respective references in the individual conversations are analysed on a metalevel in order to highlight overarching patterns.

Remarkably, the research method of focus group discussion reflects subjective assessments. Our work does not claim to represent the impact and effects of the OER indicators in their completeness. In this sense, the advantage of the method is at the same time its limitation.

DIPF
Leibniz Institute for Research and Information in Education

Focus Group Discussion

Project: University teaching as part of Open Scholarship

Open Access Indicators	OER Indicators
number	OER count
openness	degree of openness (weak, strong OER)
	granularity of OER (low, medium, high)
citations	citations of OER
downloads	downloads of OER
Views	views of OER
Bookmarks	bookmarks of OER
social media count	social media conversations about OER

Guiding questions

- How do you assess the use of OER indicators as a tool for making higher education teaching visible?
- What potential effects and consequences do you see in the use of OER indicators?

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Figure 5. first version of the OER Statistics

4.1.2. Results and implications for OER Statistics

4.1.2.1. Opportunities and limitations of the OER Statistics

Basic attitude towards scientometric indicators: The focus group participants shared a fundamental scepticism and criticism of scientometric methods. In particular, the impact factor and the h-index were used as examples of indicators that were often poorly applied or misleading. Overall, qualitative methods were favoured over quantitative assessment approaches (research data (2), line 522 – 523, 2158 – 2160). Participants criticized scientometrics erroneously conclude from quantity to quality (research data (2), line 172 - 177). Furthermore, discussants criticised that simple indicators often prevail over more complex ones because they are cheaper to apply and they can be implemented with fewer obstacles (research data (2), line 1319 - 1326, 2155 – 2158, 1331 - 1341). Both arguments against scientometric methods suggest that the indicators are overestimated regarding their informative value and thus interpretations are misleading and unjustified science policy decisions result. This scepticism is also expressed towards the potential OER indicators. They are discussed in the context of the critique of scientometric methods.

Qualitative evaluation procedures that should be preferred according to the participants (especially peer reviews as a central scientific quality assurance instrument) are very complex (research data (2), line 401 - 407). Future performance evaluation based on comprehensive qualitative assessments of teaching material is therefore classified as being desirable but not practical and very unlikely. Participants refer to the practical relevance and good manageability of scientometric indicators (research data (2), line 938 - 941). Furthermore, a steering function is attributed to them in the current system of science evaluation:

> *… I would like to introduce the indicators first in order to make teaching an equal object in the evaluation (research data (2), line 231 – 232)*

> *… So, from that perspective, to say we suggest an indicator to create a taste for teaching as performance, that can work, as I said, that can work. Because now you suddenly have something you can sort by (research data (2), line 943 – 946)*

The overall range of appreciation regarding OER indicators stretches from outright rejection (research data (2), line 2192 - 2199) to a fundamentally positive attitude (research data (2), line 231 - 237). The following contribution illustrates the two opposing positions very well:

> *… Oh, no more indicators. That was my first thought […] I also have the impression that quantity is more important than quality in the scientific field and I would simply be afraid or worried that this would lead to an intensification. On the other hand, I can also imagine that this, yes, somehow/it is about making the use of OER in teaching visible and about practicing openness in university teaching. And what is also an impression I have is that in any procedures, we have just talked about applications, or Ms. Weimer mentioned the classic appointment procedure for professorships, that this quantity is valued even more, that is, more attention is paid to paper publishing, external funding and so on, than to what is actually done in teaching. So far, less attention is actually paid to the aspects of teaching. And for this, it could perhaps be a good means of bringing teaching back to the fore in such procedures, if it is somehow framed in the area of openness. I think that would be good (research data (2), line 2167 – 2180)*

Measurement targets: All participants agreed on the need for greater visibility of higher education teaching, which is one goal of OER indicators. It seemed to be undisputed that this visibility of higher education teaching is currently only visible to a small extent and should be expanded (research data (2), line 638 – 643, 2177 - 2184). The fundamental suitability of OER as a tool for making teaching

visible as a measurement goal of an OER indicator was assessed differently. Positive voices saw OER as a suitable medium for this purpose (research data (2), line 726 - 727):

> *… OER is about accessibility, making things visible. […] That means we shouldn't talk about quality or see that as another dimension, but we should talk about what it means to make visible here. And I believe that the way open access makes science visible, also for a community and others, although I prefer the word accessibility […] also how I think about OER (research data (2), line 687 – 693)*

At the same time, however, there were also negative assessments. The relationship between the measured object of OER as open teaching material and the respective teaching actually carried out was rated as unclear (research data (2), line 624 - 640). Overall, OER were consistently seen as only a part of teaching and not as representative of teaching as a whole (research data (2), line 84 - 90, 533 - 547, 722 - 724).

> *… But that means the OER is the resource […] the material. Not the teaching. (research data (2), line 845)*

> *… OER is, so to speak, I would say, an add-on to good teaching. But it does not stand for good teaching. Good teaching is characterized by the fact that educational processes are initiated but not by the fact that OER are created. So, I would make a big distinction there. For me, OER would be an add-on (research data (2), line 1991 – 1995)*

Furthermore, the openness of teaching/learning material OER was seen as problematic. Teachers for whom OER are not a suitable type of material for personal reasons or due to the characteristics of the subject being taught could be disadvantaged in an OER-based indicator system and thus remain invisible.

> *… And if my subject, which has already been mentioned several times, is a subject in which OER do not play any role and in which I cannot integrate OER in a meaningful way, for whatever reason, or really only very selectively, then it is somehow no longer comparable with a subject where I can run it in a continuous loop, so to speak, both are very, yes, I am exaggerating. And if I'm a person who simply doesn't like dealing with OER, and I can perhaps use other methods to convey the content much more authentically, then OER won't help me. (research data (2), line 512 – 519)*

In summary, participants in the focus groups see OER as a part of teaching as a larger whole. From all the contributions to the discussion together, no clear opinion can be derived as to whether OER and an OER indicator are suitable for raising visibility of higher education teaching.

Measurement results: As could be expected, the measurement results of an OER indicator and its significance were also critically assessed against the background of the basic attitudes towards scientometric indicators. In particular, the question of the meaning and significance of OER indicators was raised (research data (2), line 258 - 268, 342 - 349). The first difficulty addressed in this context was the relationship between the measurement carried out and the actual measurement objective.

> *… the question is what you have measured - what you want to assess and represent somewhere? So, do you actually have this reference, does it actually represent it correctly? And that, I think, is always the difficulty, where you have to be clear about what you want to measure and whether it is represented by data, or where there are weaknesses in the data, where there are distortions. I think that is always the very difficult point when it comes to quantitative evaluations (research data (2), line 1152 – 1158)*

The measurement of individual performance via an OER indicator was consistently viewed critically. Measurements at the level of institutions, on the other hand, were viewed much more positively.

The possibility of drawing conclusions about the quality of the teaching practiced through an OER indicator was rejected (research data (2), line 700 - 702) but at the same time an emphasis on the quality aspect was urged (research data (2), line 2397 - 2411). In this context, the possibility that the openness of OER could indirectly improve the quality of teaching was also discussed (research data (2), line 705 – 711).

Measurement object: As already mentioned, the fundamental suitability of OER as a measurement object for making higher education teaching visible was controversial. Furthermore, the particularities of OER as an object of measurement compared to conventional scientometrically measurable products and documents (e.g. articles or books) were addressed from a more technical perspective.

For instance, participants discussed the different forms (research data (2), line 2278 – 2283) and granularities of OER (research data (2), line 32 - 38), which poses a challenge for scientometrics. OER can be very fine –grained (for example, short exercises or small-scale figures) or have a high granularity (for example, OER as entire online courses). Furthermore, OER were assigned rather static or rather dynamic characteristics due to the inherent dynamism of a subject and the associated rapid adaptation of the subject matter, which is related in particular to the characteristics of the teaching subject (research data (2), line 189 – 192). In addition, OER can be seen as finished "high-gloss materials", equivalent to scientific papers, or as unfinished material that can be further processed by the teaching community (research data (2), line 1895 - 1902).

The topic of versioning OER was also considered to be highly relevant for the implementation of OER indicators (research data (2), line 496 - 502). Due to further processing, different versions of OER are created over time to which different people have contributed to varying degrees. It is a great challenge to represent these different types of participation through indicators[2]. To deal scientifically with versioning of OER, the people involved need to be specified including their activities. This and similar information regarding the OER creation process is usually provided but this information is rather inconsistent, which indicates another characteristic of OER as a scientometric measurement object (research data (2), line 1343 - 1353).

Citation of OER was discussed in the focus groups as problematic for various reasons. An overarching theme was a currently non-existent, self-evident practice in the citation of teaching material. Teaching material should be properly referenced in the same way as scientific publications. However, doubts were expressed as to whether this is always the case in daily practice when creating teaching material (research data (2), line 1812 - 1817). Furthermore, participants noted that the OER citations are technically difficult (research data (2), line 16 - 24). OER are cited inconsistently. No generally accepted procedure has yet been established in this regard (research data (2), line 1812 - 1817). There are also various recommendations for classic, scientific citations (e.g. the citation style according to APA or Harvard), but they all follow the same pattern. OER citations, on the other hand, follow different structures depending on whether they are based on classic, scientific citations (author, year, title, place of publication), follow the TULLU rule[3] (title, author, license, link, place of origin) or the creative commons recommendation[4] (title, author, source, licence). It is therefore difficult to automatically process OER citations.

[2] We see similar problems, for example, with work-in-progress papers or the publication of a paper as a preprint and as a print (e. g. research data (2), lines 1910 – 1918).
[3] TULLU rule: https://open-educational-resources.de/oer-tullu-regel/ [retrieved 01/12/2025]
[4] Creative Commons: https://creativecommons.org/use-remix/ [retrieved: 01/12/2025]

Use Cases: The application of OER indicators is discussed in the focus group interviews on three different levels: on the individual level (especially application and appointment procedures), on the institutional level (university or institute evaluations) and in the application as a research method to identify and analyse changes in teaching cultures. In particular, the use of indicators in application and appointment procedures is viewed very critically. Participants point out that quantitative performance evaluations do not reflect the individual high-quality work and are thus problematic in their application (research data (2), line 2142 - 2148).

The application of OER indicators at the institutional level is seen far more positively. Individual contributions are very open to this application:

> *… I actually find this aspect of institutional evaluation and visibility very important. Because if you think about where the digitalization of teaching and learning is heading from a university strategy perspective, there will certainly be a number of universities that decide not to be visible with their research profile, like Heidelberg University or so, but rather say: we want to develop a strong teaching profile, an international teaching profile, an open teaching profile, an open university, permeability, these are important topics. And you can present yourself very well by saying as a university: We support our teachers and perhaps also develop an OER policy where support structures are simply offered with the aim of publishing as many high-quality materials as possible on the national OER portal and then also be able to present this in the appropriate place. So, I would like to emphasize this use case again as important (research data (2), line 149 – 161)*

Furthermore, as a third potential application, people discussed that the OER indicators could be used as a research method. In particular, capturing a change of culture was mentioned as a possible area of application:

> *… I think that your OER indicators don't work if you want to somehow measure individual performance. If you want to measure a cultural change, then maybe an indicator, so to speak, is there a change in a certain discipline, in a certain community? You could use it for that (research data (2), line 2227 - 2231)*

In this case, the OER indicators work less as a means of making university teaching visible and more as a monitoring tool for the adoption of open practices in higher education.

Consideration of disciplinary differences: In addition to the object of measurement itself and the different use cases, the differences between the subject disciplines played a major role in the focus groups. They noted that different subjects relate to different types of teaching material and that these differences in performance evaluations should not disadvantage individual subjects (research data (2), line 49 - 54, 300 - 313). The solution to this problem was also discussed by the focus group: field normalization prevents disadvantages of individual subjects compared to others and is fundamental to subject-specific OER indicator applications and the corresponding fair comparison between disciplines (research data (2), line 189 - 191).

4.1.2.2. OER Statistics effects

In summary, the desirable effects and impacts of OER indicators relate to the equal treatment of higher education teaching and research within the RRS (research data (2), line 231 - 237). This is about enabling academics to gain a reputation and attention for the time and effort they invest in designing teaching materials (research data (2), line 1311 - 1317). This means that one effect of the OER indicators could be the increased visibility and appreciation of teaching activities and thus a reputational gain for teachers. However, this position was not uncontroversial. At the institutional

level, possible positive effects of OER indicators were highlighted in the context of the formation of teaching profiles (analogous to research profiles) of higher education institutions (research data (2), line 751 - 763). As a side effect, the potential effect that the OER indicators act as an incentive structure for the design of OER in higher education teaching was discussed. Openness in teaching would be encouraged and potentially duplication of work would be avoided as people could build on each other's work. At the same time, these desirable effects could turn into negative ones (research data (2), line 568 - 573).

The most often discussed effect is the concern about an intensification of the focus on quantitative aspects in science (research data (2), line 2168 - 2170). There are warnings about the "simplified-counting trap" (research data (2), line 368), which means that simple indicators will be used. In a sense, we do not expect the RRS to improve from the inclusion of OER indicators but merely expanded or shifted. Participants also expected that the non-intended effects of classical scientometric indicators would be transferred to the OER indicators (research data (2), line 2331 - 2339). An explicit mention here concerns strategic publishing of documents in the "smallest publishable unit" (research data (2), line 2152). There is a fear that this trend will be transferred from the research process to the subject of OER.

Furthermore, non-intended effects were also discussed, which only apply to teaching-related practices. In this regard, it is worth mentioning the fear that OER indicators as performance indicators could lead to an efficiency logic that does not make teaching more visible but rather more cost-effective for universities in the long run. On the one hand, basic lectures might no longer be updated but the same teaching materials might be used for years (research data (2), line 563 - 573). And on the other hand, the effect was discussed that teachers who used OER would receive credit for completing fewer courses:

> *… But as soon as you get into these things and measure something like downloads, then all of a sudden, downloads are no longer an indicator for the quality of what you have deposited there, but an indicator that needs to be done elsewhere less, so. If less has to be done in one place, you can imagine what happens to the discussion about teaching loads. Then people say: "How? You are using Open Educational Resources to build your whole course? And now you want me to give you two SWS? Are you out of your mind? I'll give you one." (research data (2), line 590 – 597)*

This means that there is a fear that teachers using OER will have to teach two courses instead of one in the future.

Another teaching-related, non-intended effect could be the elimination of the need for university teaching if OER design led to students being able to gather their teaching materials independently at home, thus making universities and university lecturers obsolete (research data (2), line 599 - 603):

> *… should I really hire someone at my university to knock out everything that is there in terms of teaching? Why should students still visit me?" (research data (2), line 978 - 980)*

In this context, participants saw it as particularly problematic that universities are paid according to their number of students and need students to depend on the university lecturers:

> *… because universities get paid by how many students are enrolled. That is the main source of income. That's what they get paid for. But if I now say that half of my students don't have to be at my university, but can do coursework online, then the university only gets half the money and is broke (research data (2), line 1691 – 1695)*

Finally, the negative effect that teachers who are not comfortable with the design and use of OER are disadvantaged by OER indicators should be mentioned. This is not desirable, as teaching should be authentic and there should be no compulsion to use OER (research data (2), line 526 - 531).

4.1.2.3. Preconditions of the OER Statistics

In the focus group discussions, the potential OER indicators are discussed both on a practical action level and on a structural meta-level. Regarding the latter, the development towards equal visibility of research and teaching is discussed as a cultural change (research data (2), line 2274 - 2275). The prerequisites for this change are seen on a social, an infrastructural and a political level.

The social preconditions are discussed in relation to practices in creating and re-using OER. In this respect, a new attitude would have to emerge that supports and promotes the willingness for open practices (research data (2), line 2368 - 2391). This includes the establishment of a reference culture of OER to counteract the concern that material is illegally reprocessed (research data (2), line 1263 - 1267) but also the emergence of a recognized error culture. The aim is that drawing attention to errors is seen as part of the scientific process and does not have to be prevented at all costs (research data (2), line 1258 – 1263, 2368 – 2391).

Furthermore, technical obstacles were seen for the application of the OER indicators. Certain infrastructural requirements would therefore be necessary such as providing OERs with unique identifiers (e.g. DOIs) (research data (2), line 24 – 31) and marking different versions (research data (2), line 1864 - 1872). In addition, references must be identified as such and the number of citations for an OER must be tracked (research data (2), line 16 - 24). Finally, an infrastructure is desirable that records the reuse or further development of the OER and allows comments or feedback (research data (2), line 2420 - 2424).

There is consensus that political preconditions of OER indicators are needed and that structural change towards a greater visibility of teaching needs to be politically steered (research data (2), line 1677 - 1683).

> *… Visibility is about power and power structures. I can't just say: "Hm, publish more OER, publish open access". It just doesn't work that way. The only thing that helps is pressure, brute force. DFG saying: "Friends, if you want money from us, you have to publish in open access format". That's the only way to break up cultures. To actually break down power structures. And in this respect, if you want to develop OER indicators, develop them for research funding. Because then you have the sledgehammer, so to speak, with which you can smash kneecaps and persuade professional societies to ultimately buckle. Anything else will somehow not work in the long run. And we have experienced it with digital editions that have been mandatory since 2016: Hm, you can do everything, but you have to publish electronically first. And if you then justify well that you want to kill trees to produce books, then you might get money for it. But you publish electronically first. And that worked. And everything else, somehow, with good arguments or, yes, trying to convince people, doesn't work. Because the culture and the power structures are simply too entrenched (research data (2), line 2568 – 2583)*

Allegedly, a "central distribution mechanism" would have to incentivize institutions through the means of OER indicators (research data (2), line 322 - 324) in order to enable structural change. In particular, higher education institutions that do not focus on research could strengthen their teaching profile and focus on this area of activity through OER policies (research data (2), line 753 - 761).

4.1.2.4. Alternatives to the OER Statistics

As already mentioned, scientometric factors were generally viewed critically by the participants in the focus groups, albeit to varying degrees. Several alternatives were listed which according to the discussants are better suited or complementary to quantitative indicators to make higher education teaching more visible.

Peer reviews of teaching material were mentioned as an alternative, i.e. teaching material is reviewed by third parties in the same way as publications. However, this option is considered to be very difficult to implement due to the already high workload in the science sector (research data (2), line 401 – 403).

Procedures were welcomed by which students are given a more significant voice in identifying and publicizing teaching efforts (research data (2), line 2002 - 2004). Teaching evaluations are common at universities at the end of the semester and where students evaluate the courses, they have attended according to various predefined criteria were mentioned here, but these were judged unsuitable and in part rather attested to the character of popularity contests. Suitability for the actual visualization of achievements in the area of higher education teaching was seen less for teaching evaluations (research data (2), line 925 - 935).

Alternatively, open science portfolios were mentioned:

> *... for example, I have a section in my CV that says OER, and I simply list what I have done without writing any figures on it, which I find absolutely legitimate. [...] And at the moment when we don't count, I don't have to list every single course, but I can simply say: "Here, I've put this course online, here and here you can find it, here and here you can look at it". That, I think, is also the important thing about making it visible, that you don't just say I'm doing this, but you can also take a look at my work. (research data (2), line 2611 - 2623)*

These portfolios could present the activities of a person or institution in detail in various scientific fields. In this context, it would be conceivable to add courses and teaching materials to scientists' CVs in analogy to the information about their own scientific project and publication activities (research data (2), line 2288 - 2305).

4.1.3. Summary

In the focus groups, the questions of the suitability of OER and an OER indicators for making HETP visible as well as the expected positive and negative effects of OER indicators were discussed. A clear position shared by all participants on these questions cannot be derived. The results in their complexity can be presented as follows: OER represent a part of teaching but not teaching practice in its entirety. The openness of OER makes them visible and accessible for outsiders. They are thus fundamentally suited to making teaching visible as part of science, in analogy to research.

Qualitative procedures for science evaluation are preferred due to the inadequacies of quantitative procedures, especially with regard to the lack of statements on the quality of work results. Also, scientometric OER indicators cannot make qualitative statements about the underlying resources so scientometrics in performance evaluation should only be seen as an accompanying instrument, never as a stand-alone assessment criterion. Against the background of the resource-related impossibility of proceeding purely qualitatively in the evaluation of scientific achievements, quantitative methods nevertheless have a raison d'être. Particularly in the current situation where quantitative methods are predominant, a set of indicators for OER could contribute to making OER and thus also teaching topical within the framework of science evaluation.

OER measurement is very complex, changeability can always lead to new versions by editing and mixing OER with other resources, raising questions about the appropriate consideration of contributors and the attribution of reputation. Furthermore, there are currently structural obstacles such as a lack of citation practice for teaching/learning materials in general and an infrastructure that is not fully suitable for scientometrics.

With a view to a potential OER indicator set, the significance and importance of the measurement results achieved need to be classified against the background of the measurement objective of making teaching more visible. Regarding the measurement levels, the institutional level is particularly interesting. Here, an OER indicator set could contribute to the development and presentation of teaching profiles for higher education institutions. Furthermore, a cultural change towards open teaching could be visualised via OER indicators. Measurement at the individual level of teachers is viewed critically due to negative experiences from the publication sector.

In developing the potential OER indicator set, the ten principles of the Leiden Manifesto (Hicks et al. 2015) should be considered. Based on the discussions held in the focus groups, these include the demands for support of qualitative methods through scientometric applications (Principle 1), the consideration of discipline-specific subject cultures (Principle 6) as well as the appreciation of individual achievements in addition to scientometrically determined indicators. A transfer of the Leiden Manifesto principles related to the world of scholarly publishing to the world of OER is imperative.

As an alternative to an OER indicator, there are other qualitative options to visualize teaching. At this point, it is necessary to clarify how these can find their way into a science evaluation. Regarding potential OER indicators, it is interesting to see how the two approaches can complement each other in terms of an informed peer review.

The participants in the focus group discussions clearly rejected simplified scientometric indicators for OER like counting without consideration of the special characteristics of the measurement object OER. They argued in line with the position paper of the German Research Foundation (DFG), which rejects the limited use of bibliometric indicators and promotes a more comprehensive science assessment (DFG 2022). Despite comprehensive concerns, however, a balanced set of OER indicators, especially at certain levels of measurement (e.g. at the level of institutions), was considered useful by the focus group members. Likewise, a combination of qualitative and quantitative methods to make teaching visible and appreciated as a separate performance category of science assessment was viewed positively.

From our point of view, the estimation of different effects and impacts of the OER indicators by the focus group participants is justified and enriching. Some criticism, on the other hand, is directed less against the use of scientometric indicators on the subject of OER but rather against the misuse of scientometric indicators in general. These dangers are well known to the scientometric community and are considered in the practice of responsible scientometrics. Against this background, further development and exploration of the idea of an OER indicator set appears worthwhile. The following chapter explains how the OER Statistics were further developed and evaluated in order to enable an appropriate quantification of open HETP and to take the characteristics of OER into account.

4.2. Framework evaluation of OER Statistics

As we saw in the pre-study, the OER Statistics contain potential but also some difficulties and pitfalls. To operationalise HETP appropriately, the first version of the OER Statistics (for version one: chapter

4.1.1) was enriched with the results of the focus group discussions and further developed accordingly (for version two: chapter 4.2.1). This second version of the OER Statistics was evaluated based on expert interviews. This chapter presents this step in the development of OER Statistics. The research question is: *What are appropriate statistics to meaningfully quantify OER, and how do these statistics need to be embedded?* In order to answer this question, I will present the second version of the OER Statistics and the method used to evaluate them. I then present the results of the expert interviews and discuss what this means for the operationalisation of HETP.

4.2.1. Method and the second version of the OER Statistics

The development of the OER Statistics Framework is rooted not only in the results of the pre-study (chapter 4.1.1; Weimer & Kullmann 2023), but also in the examination of OER as a measurement object (Kullmann 2025).

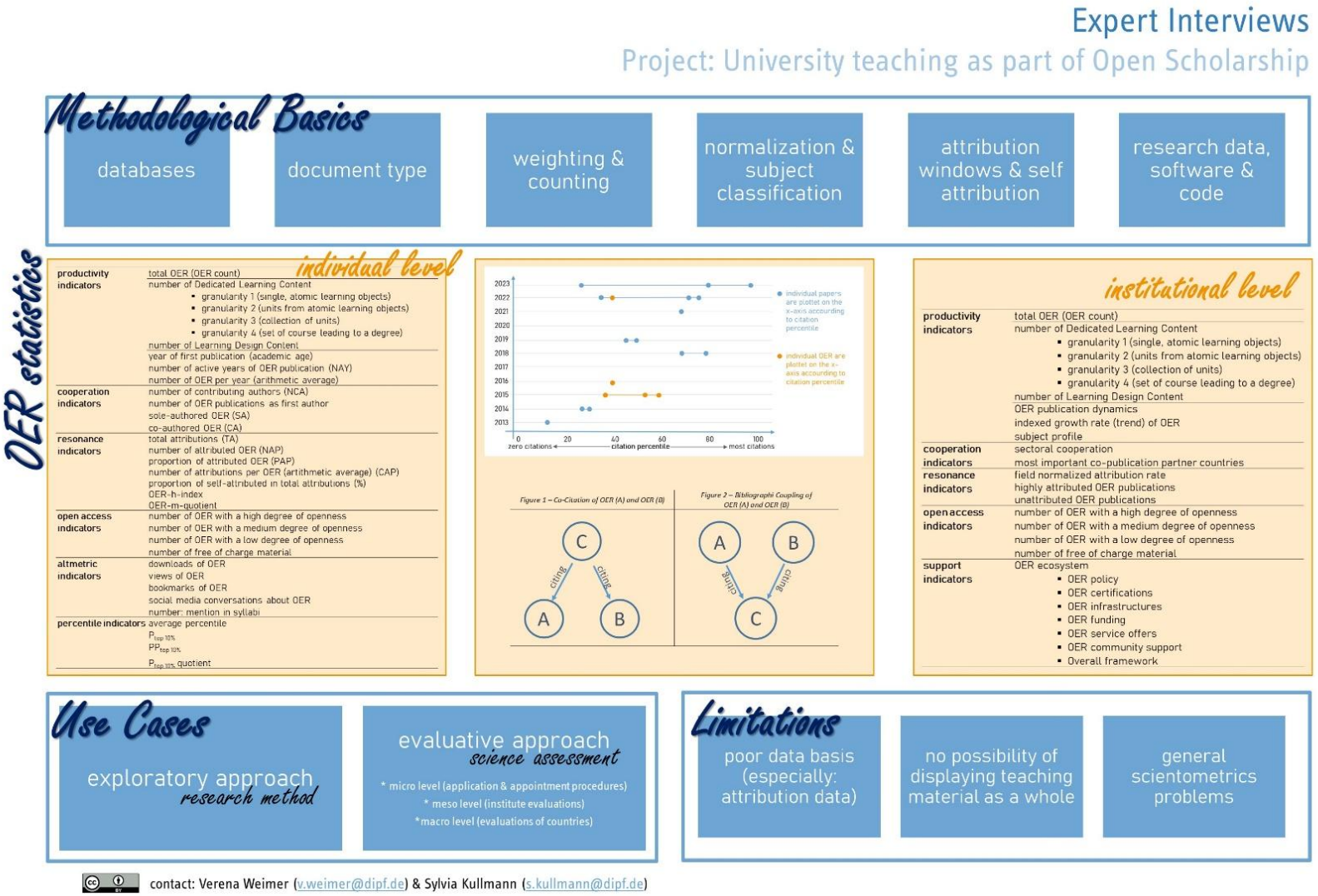
Following the pre-study, we embedded the pure statistics in a context. Figure 6 shows that the second version of the framework of OER Statistics can be divided into four parts. The first part is called “methodological basis”, referring to fundamental scientometric approaches and decisions which always have to be considered in relation to such analyses. Part two is called “OER Statistics” and relates to the actual metrics. Part three is called “use cases” and considers where the OER Statistics can be applied. The last part is called “limitations” and refers to the restrictions of the OER Statistics that should always be considered in the analysis.

(1) The methodological basis of the second version of the framework (part one in Figure 6) is represented by the data basis, the document types which are quantified, weighting procedures to give some artefacts more importance in comparison to others (weighting and counting), subject classification and normalization procedures for comparisons between different disciplines, the dealing with citation windows and self-citations and the necessity to determine the exact way of calculating indicators by naming data and instruments like software and code. When transferred to the world of OER, we adjusted this generally accepted methodological basis which led to a change of terminology. The term “citation” was replaced with “attribution” as the equivalent for CC-licensed artefacts to the reference practice of research publications (Creative Commons 2022).

(2) The framework focusses on the OER Statistics with two different levels of measurement (part two in Figure 6). The individual level enables the representation of the individual achievements in the OER field. It comprises six different indicators and two different categories of measurement objects. The indicators are well known to bibliometric measurements and are adjusted to the specificities of OER: indicators for productivity, cooperation, resonance, openness, altmetrics and percentiles. The adjustment to OER is further illustrated by the use of the two categories “Dedicated Learning Content” and “Learning Design Content” instead of different document types. The summarization into categories instead of focusing on concrete artefact types has the advantage of dealing with the large variety of open teaching/learning materials in a measurable way and at the same time committing to the creation of OER in a way that can be easily recorded. In addition, four levels of granularity are introduced to categorize OER according to their complexity. This approach was adopted from the OER world and it has the advantage of allowing depiction of differences in the complexity of measurement objects without stating values, as it would be the case with weightings. It should also be noted that highly granular, complex OER can lead to counts at all four levels of granularity, provided that the OER allows authors to split the highly granular OER into individual OER with lower levels of granularity. The institutional

level focuses on institutions that engage in open education by supporting the creation, dissemination and reuse of OER. The indicators for productivity, cooperation and resonance at the individual level can also be found here. These indicators can help institutions such as universities present their open education profile. In addition, the new category of support indicators is introduced that deals with supportive activities of institutions and it presents the institution's OER ecosystem. The OER ecosystem as outlined in the OER definition for scientometric purposes (Kullmann 2025) focuses on the existence of an OER policy, OER certifications (VFNM 2022), OER infrastructures like OER repositories, funding for OER projects, services for OER authors and activities to support the OER community.

Figure 6. second version of the OER Statistics



(3) The third part of the OER Statistics Framework concerns the use cases (part three in Figure 6). On the one hand, the OER indicators can be used as a research method in exploratory studies with dedicated research questions. On the other hand, they are suitable for evaluative purposes on an individual and an institutional level.

(4) Limitations are another important area of the OER Statistics Framework draft and round it off (part four in Figure 6). First, the general challenges of scientometric measurements documented in the Leiden Manifesto (Hicks et al. 2015) are mentioned. In addition, the currently poor data basis for OER in general is an important issue. In principle, OER repositories can be used for scientometric analyses. They usually offer an interdisciplinary range of OER in various formats and levels of granularity. However, OER repositories are currently not comparable with research databases such as Web of Science or Scopus. First, OER are not published by all teaching researchers or teachers in higher education but only by relatively few people. Second, OER repositories do not usually provide attribution data. OER repositories usually only contain openly licensed artefacts. Artefacts without an open license that are available and accessible free of charge are not included. Finally, OER are a part of open education but do not represent teaching in its entirety.

Taken together, these four areas (methodological basis; OER Statistics; use cases and limitations) result in the second version of OER Statistics (Figure 6). In addition to the four areas, two visualizations also appear in the second version of the framework. On the one hand, we see a fictional visualization of a scientist's performance based on percentile indicators. This shows the time course between 2013 and 2023 on the y-axis and the percentiles between 0 (0 citations) and 100 (highest number of citations in the period in a specific discipline) on the x-axis. The blue dots indicate the publication of a paper; the orange dots indicate the publication of an OER. The visualisation shows how many publications someone has published and how these publications compare to others in the same discipline in terms of citations. The second visualization shows the theoretical concept of co-citation and bibliographic coupling of OER, it describes the transfer of the well-known concepts from scientometrics.

For the evaluation of the second version of the OER Statistics, we organized six expert interviews with expertise in scientometrics. The interviews took place in September 2023. Two of the interviews were conducted online, the other four were held face to face. The conversations lasted no more than one hour each. For the interviews, we prepared a presentation that shows the second version of the OER Statistics Framework (Figure 6) which was introduced at the beginning. The draft was then discussed in detail with the interviewees; the four areas of the framework being addressed in detail. Our open research data in the form of interview transcripts can be found in research data (3). The evaluation was carried out deductively, following Mayring (2015). The categories used were identical to the four dimensions of the framework, which were "methodological basis", "OER Statistics", "use cases" and "limitations". The analysis focused on critical comments that lead to changes in the framework. The evaluation was carried out in two stages. At first, the interviews were analysed independently by my co-author and me. The results were discussed and summarized in a second step, which focuses on the expert interviews that lead to adjustments to the existing framework.

4.2.2. Results and implications for OER Statistics

The following chapter outlines the critical comments on the second version of the OER Statistics framework. The changes resulting from the experts' input are described in this context.

Methodological basis: During the expert interviews, elements of the second version of the framework were confirmed. However, there were also several critical comments that led to changes.

The most important change is a fundamental separation between the individual and the institutional level, which goes beyond the separation regarding the concrete OER Statistics and includes the methodological basis, the use cases and limitations. Accordingly, we present the framework in the evaluated version on two different visualizations (Figure 7 and 8).

The determination of a statistical data basis is generally challenging in scientometric analyses and is associated with many uncertainties that can falsify results. This is particularly difficult with evaluative assessments of individuals. To avoid this methodological weakness and incorrect or incomplete data in individual statistics, the data base should draw on support from the individual being evaluated—see the following quote:

> *... we should give more responsibility to those being evaluated making sure we have the data that we need. The academics, if they feel that what they are doing really matters like these contributions to OER, and they feel like they deserve to be recognized and rewarded for this, then there is a responsibility on their part to make visible the work they have been doing. […] And based on that, we should invite them or make them partly responsible for registering the things that matter to them. (research data (3): interview 2, page 14)*

Existing systems could be used to provide such lists, such as ORCID as a public data base or also current research information systems (CRIS) as they are common at universities and research institutes (research data (3): interview 4, page 23, 24). Of course, OER repositories can play a role here. However, these usually only include openly licensed artefacts and OER that can only be used free of charge but do not grant third parties any further rights of use. Consequently, the "data bases" (Figure 6) is renamed "use of manually compiled databases (in cooperation with those to be evaluated)" (Figure 7 and 8). The examination of a sufficient level of creation, especially in the case of revised or remixed OER, as well as sufficient quality as entry requirements for the OER Statistics, must then be carried out for the OER in the list. This qualitative approach leads to an enhancement of the methodological basis which is expressed by a new category "accompanying qualitative assessment" (Figure 7 and 8).

The determination of the document types to be counted is very important in the context of scientometric studies. For publications, the term "document type" is highly appropriate. However, teaching/learning objects such as OER can have many different representations (figures, slides, videos, tables, software etc.). The term "document" was therefore not considered to be a precise fit by the interviewees. To reflect this diversity in the methodological basis, the original term "document type" (Figure 6) is changed to "open artefact type" (research data (3): interview 2, page 2 – 3; interview 4, page 3, 4) (Figure 7 and 8).

The question which artefact types are considered is important in scientometrics in order to record work results provided by different counting units according to the same procedure and thus establishing comparability. The change in the recording procedure at the individual level results in further changes in the area of counting and weighting. At the individual level, all artefacts created by a person and recorded in their record of achievement for OER are fully counted, provided they meet the entry requirements of a sufficient level of creation and quality and are freely accessible and available. This includes OER at all levels of granularity. If a higher level of granularity OER (e.g., a textbook or course) is split into its individual parts and these lower granularity elements (e.g., chapters or figures) are also published as OER, this is explicitly permitted. The following quote stresses this point:

> *... I like the idea of small pieces that build others. (research data (3): interview 4, page 18)*

Due to our changes, we dispense the categorisation in terms of granularity on the individual level. In this way, we are responding to the fundamental criticism of the quantitative recording of the performance of individuals and the desire for a more qualitative assessment at this level. At the institutional level, all OER that fulfil entry requirements are recorded in the OER Statistics. The categorization by levels of granularity continues to happen here (research data (3): interview 2, page 3; interview 4, page 5, 15–16). "Attribution" is to OER what citation is to publications. Due to the adjustments to the methodological basis at the individual level described above, all OER meeting entry requirements are counted. As a logical consequence, all attributions must also be considered (research data (3): interview 2, page 4 – 5). "Weighting and counting" (Figure 6) is renamed "full counting of authorship and attributions" for both levels (Figure 7 and 8).

Normalisations and subject classifications are used in scientometrics for comparisons between different domains with different publication cultures and have become established there. At the individual level, a more qualitative approach is now chosen. Therefore, comparisons based on quantitative data are no longer focused as it can be on the institutional level. While subject classifications were seen positively due to their descriptive character, the usefulness of normalizations with the aim of comparisons was seen critically:

> *I see value in having some subject classification for descriptive purposes. Normalization we do for comparisons. So, what we want is to compare papers in chemistry with papers in humanities, for example. Unless it's super necessary I wouldn't bother. (research data (3): interview 4, page 6)*

This perspective was supported by others (research data (3): interview 6, page 14). Consequently, "normalisation & subject classification" (Figure 6) is deleted. At the institutional level, "disclosure of well selected subject classifications" remains (Figure 8).

For the correct interpretation of scientometric analyses, the underlying data and the tools and programming code used to perform the analyses are important. To avoid confusion, we adjust the terminology from "research data, software & code" (Figure 6) to "disclosure of research data, software and code" (research data (3): interview 4, page 10) (Figure 7 and 8).

Investigation of OER is highly complex, which requires a specific definition for a fair attribution of artefacts and services. This should include a sufficient level of creation and quality as a basic prerequisite for the countability of OER which was also emphasized in the expert interviews:

> *So, one question I have is ultimately the question of quality control. When we talk about scientific publications, you can't just publish in a journal, so to speak, but ultimately journal publications are always something that is also quality-checked. How is that with OER? Who does the quality assurance there? (research data (3): interview 1, page 3 – 4)*

The broad perspective on OER regarding their openness is important. The framework treats all artefacts as OER which are created for learning/teaching purposes and are freely accessible and available. An open license is not necessary as long as the artefact can be accessed and used free of charge. Furthermore, it is important that OER can be clearly identified in scientometric analyses (research data (3): interview 1, page 6). Accordingly, "consideration of OER requirements (persistent identifier; sufficient level of quality; sufficient level of creation)" was added to the framework for the individual and institutional level (Figure 7 and 8).

OER Statistics: Changes also occurred in the area of OER Statistics and their metrics. These derive in particular from the fundamentally stricter separation between the individual and institutional levels and the resulting different methodological bases.

At the individual level, the weaker emphasis on quantitative recording and a more qualitative assessment of services leads to an abandonment of the categorisation of OER in terms of granularity regarding the productivity indicators (research data (3): interview 2, page 6, 7). For this, qualitative methods are included (research data (3): interview 1, page 13–14; interview 2, page 4), which at the same time leads to a new box "accompanying qualitative assessment" (Figure 7 and 8). The following quote suggests the desirable integration of qualitative measures:

> *And by starting from some of these fundamental notions of what quality in that area means to then consider how can we demonstrate that quality in some kind of evidence that could be used in evaluations. […] Typically, then the alternative would be narratives for instance. (research data (3): interview 3, page 3)*

At the institutional level, however, the categories regarding levels of granularity remain (research data (3): interview 4, page 18, 19). We argue that qualitative assessment at an institutional level is no longer possible in detail and therefore coarser classifications are appropriate. Maintaining granularity can be useful in this context to give an impression of teaching performance. Nevertheless, qualitative methods can also be used at an institutional level. In this case, a report on teaching practices that also addresses OER as a component of open teaching practice would be conceivable. An institution's teaching profile could be described in these reports.

Percentiles could help in the evaluation of the position of an assessed entity (publication or researcher) within a citation distribution of their field (Waltman & Schreiber 2013; Bornmann & Marx 2014). For the calculation, a high-quality database is necessary. Percentiles could be calculated on the basis of attributions of OER as an equivalent to citation of publications. Due to the rather negative attitude shown by participants towards percentiles for OER, these were removed from the framework. The main criticism refers to the false accuracy suggested by percentile indicators. Ratios change strongly when only small changes were made to the data basis. These indicators are thus anything but robust and precise (research data (3): interview 2, page 6 – 7, 9). However, against the background of a possible profile representation, the idea of visualisation was transferred to simple counts of created artefacts. In this approach analogous to percentiles, the numbers of OER produced at certain time periods are plotted together with other scientific outputs (publications, data sets, etc.) also produced in these time periods (research data (3): interview 4, page 12).

One change to the indicator name relates to the indicators of openness known in bibliometrics. They were renamed from "open access indicators" (Figure 6) to "openness indicators" (Figure 7 and 8) to adapt them to the language used in the OER sector. Two indicators were removed from the framework: the OER-h-index and the OER-m-quotient. We do not base the deletion on comments from the interviews (these two specific indicators were not explicitly discussed), but there is general criticism of the indicators in scientometrics. This can be read in the following blog post and can be summarised with the following quote: "The use of a single unrepresentative, and in many cases even unfair, indicator based on publication and citation counts is not acceptable" (de Rijcke, Waltman & van Leeuwen 2021).

We included two new indicator types in the framework. The first new indicator focuses on the transfer of knowledge via OER from research to teaching and vice versa (research data (3): interview 1, page 6). These "transfer indicators" can record when, for example, research projects produce OER for teaching in addition to other output for both the individual and institutional level. The second new indicator is derived from the existing indicator on "OER certifications" at the institutional level and takes this dichotomous approach to the individual level (Figure 7 and 8).

Use cases: The use cases of the framework basically remain but are further specified. The explorative area at the institutional level is supplemented by the aspect of network analyses for researching

structures in the OER sector, e.g., at the level of the universities (research data (3): interview 2, page 16). The evaluative area experiences two additions with the inclusion of use case monitoring (research data (3): interview 2, page 11–12; interview 4, page 31) and the explicit mentioning of teaching profiles and incentive structures (Figure 7 and 8) which is clearly expressed by the following quote:

> *So, in the end, I need an incentive somewhere that I can also create when I say that in appointment procedures or in other contexts, they also look at what I have taught. (research data (3): interview 1, page 5).*

Limitations: The experts' opinions have also resulted in changes to the framework in terms of limitations. Currently, the data base is still slim due to a still insufficient culture in the creation, publication and subsequent use of OER, a differentiation has resulted. A distinction is now drawn between the technical and the statistical/mathematical dimension (Figure 7 and 8) to which the following quote refers:

> *You already have very, very small numbers for publications at the level of individuals. In other words, the number of publications by a person is difficult to determine statistically because the numbers are so small. The question for me now is, what does that look like for OER? I simply assume that the number of publications is even higher than the number of OER. That's why I'm not sure if we're not also moving in this area of small numbers or if the numbers are perhaps even smaller than for publications, to what extent this is actually statistically tangible. (research data (3): interview 1, page 3–4).*

OER Statistics focus on OER as artefacts for teaching and additionally as services within the framework of an OER ecosystem at the institutional level. The fact that OER can only represent a part of the teaching artefacts created and used is already covered by the previously outlined limitations. In order to clarify that teaching as a whole cannot be represented by OER alone, the framework has been expanded here. This can be seen in the figure of the framework by the formulation "no possibility of displaying teaching as a whole" ("material" was deleted) (research data (3): interview 3, page 20) (Figure 7 and 8).

Many limitations have been formulated in connection with scientometric studies in general which are outlined in the Leiden Manifesto (Hicks et al. 2015). Readers of these studies are also responsible for interpreting the quantitative results presented against the background of their calculation modalities and limitations (research data (3): interview 3, page 3 – 4, 19; interview 5, page 12). To emphasize this, we have added the aspect of "missing metric literacy" to the critical points summarized under the limitation "general scientometric problems" (Figure 7 and 8). The following quote stresses this point particularly clearly:

> *So, there's a question about literacy. Literacy of kind of what is in terms of understanding, what can people handle? The literacy that they have of metrics, indicators, data. And we need to recognize that in most settings that is limited. And that's not a problem. That's just a fact of life. But we should adjust the way we deal with data to the literacy that the people that need to ultimately make decisions that they have. (research data (3): interview 2, page 16)*

Furthermore, we include two new limitations. The first concerns the current lack of theoretical foundations (Figure 7 and 8), which are extensively available for bibliometric studies, but must first be carried out for the area of OER. This effect, for example, questions about the diversity of subject domains in teaching or attribution behaviour (research data (3): interview 1, page 12; interview 5, page 9–10, 19). The second supplement documents limitations that arise from the object of study OER itself. First and foremost, the voluntary nature of the creation, publication and subsequent use of OER should be mentioned, which represents a significant distinction from other academic output:

> *Then you probably need an institutional policy or something that says: You have to do this now. You have to upload your teaching materials onto these platforms so that we can map them accordingly. But I think that would probably not be entirely unproblematic. (research data (3): interview 5, page 4)*

Furthermore, the attribution practice of OER (research data (3): interview 1, page 6; interview 5, page 17), which is fraught with difficulties, as well as the great variety of possible forms and the resulting difficulty in comparing artefacts should be mentioned (research data (3): interview 1, page 14; interview 5, page 5). In summary, we added "OER-specific limitations (attribution practice of OER; large variety of possible forms of OER; difficulty to compare artefacts)" (Figure 7 and 8).

4.2.3. Summary

In summary, chapter 4.2. discusses the evaluation of the OER statistical framework by experts in scientometrics and the changes resulting from this evaluation. As a particularly relevant improvement through the evaluation, I would like to emphasize the addition of the qualitative dimension to the OER Statistics. It is important to show that the proposed framework is not a stand-alone instrument that by itself succeeds in making higher education teaching more valuable. Like all other scientometric methods, our contribution should be accompanied by qualitative peer assessments (chapter 2.4). I would also like to emphasize that I do not see the framework as final and conclusive but as dynamic and fluid. We would like our work to initiate a discourse. Actual appreciation of university teaching depends, at the end of the day, on the values and norms of the people who shape and form the academic landscape daily.

4.3. OER Statistics Framework

Chapter 4.3 presents the concept for the quantitative operationalisation of HETP for the academic RRS. In the following chapter 4.3.1, I address the basic principles of the OER Statistics Framework. Building on this, I consider the OER Statistics, i.e. the quantification of OER (chapter 4.3.2). At this point, I differentiate between the application and interpretation at an individual and institutional level. I see this distinction as one of the main changes that came from the framework evaluation (chapter 4.2). To conclude the chapter, the OER Statistics are discussed (chapter 4.3.3) and summarized (chapter 4.3.4). The concept of OER Statistics is published by the journal *Information – Wissenschaft & Praxis (IWP)* (Weimer & Kullmann 2025). The text sections have been adopted verbatim. Changes have only been made to ensure readability in this thesis.

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OER Statistics – individual level

Methodological Basics

- use of manually compiled databases (in cooperation with those to be evaluated)
- naming of all open artefact types considered
- full counting of authorship and attributions
- consideration of OER requirements (persistent identifier; sufficient level of quality; sufficient level of creation)
- disclose research data, software and code

Use Cases

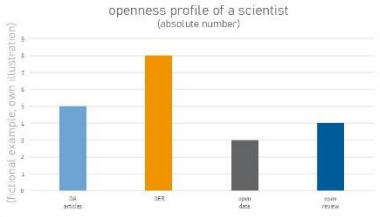
exploratory approach *(research method)*

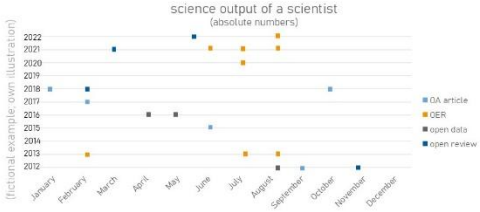
evaluative approach

- informed statistics for assessment purposes
- monitoring
- incentive structure for the future
- strengthening the second career path (teaching profile)

accompanying qualitative assessment

productivity indicators	total OER (OER count)
	number of Dedicated Learning Content
	number of Learning Design Content
	year of first publication (academic age)
	number of active years of OER publication (NAY)
	number of OER per year (arithmetic average)
cooperation indicators	number of contributing authors (NCA)
	number of OER publications as first author
	sole-authored OER (SA)
	co-authored OER (CA)
resonance indicators	total attributions (TA)
	number of attributed OER (NAP)
	proportion of attributed OER (PAP)
	number of attributions per OER (artithmetic average) (CAP)
	proportion of self-attributed in total attributions (%)
openness indicators	number of OER with a high degree of openness
	number of OER with a medium degree of openness
	number of OER with a low degree of openness
	number of free of charge material
altmetric indicators	downloads of OER
	views of OER
	bookmarks of OER
	social media conversations about OER
	number: mention in syllabi
transfer indicators	attribution in an OER to research material
	citation in a research material on OER
	OER material resulting from research projects
OER certification	(existing/not existing)





Limitations

- poor database (technical & statistical dimension)
- no possibility of displaying teaching as a whole
- general scientometric problems (missing metric literacy)
- lack of theoretical background
- OER-specific limitations (attribution practice of OER; large variety of possible forms of OER; difficulty to compare artefacts)

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Figure 7. third version of the OER Statistics (individual level)

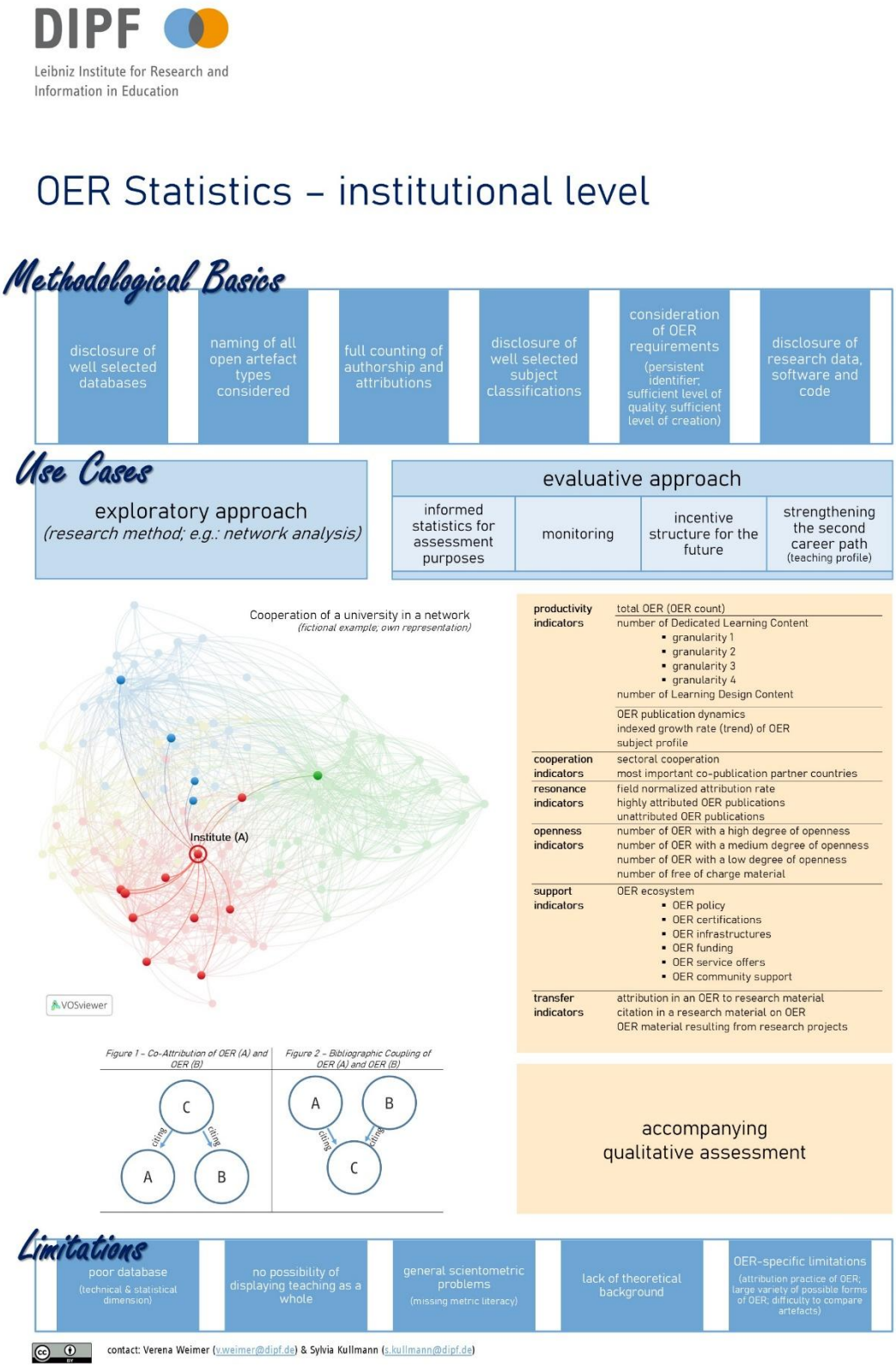

Figure 8. third version of the OER Statistics (institutional level)

4.3.1. Basic Principles of the OER Statistics Framework

First it is necessary to outline some basic principles that guide the development and application of an OER Statistics Framework. Researchers intending to apply scientometric methods to the object of OER need to make several key decisions.

1. Selection of materials: The first decision concerns which openly available teaching and learning materials are considered OER and thus included in the analysis. Like scientometric analyses in research evaluation, where the question arises which research output to count, OER evaluation requires clear entry criteria. The development and evaluation of the OER Statistics Framework (Weimer & Kullmann 2024) have shown that OER should be explicitly created for teaching/learning purposes and meet a sufficient level of personal contribution as well as an adequate quality standard (Kullmann 2025; Kullmann & Rasulzade 2025). Materials that are not intended for teaching should not be included, even if they are freely accessible, as these are already covered in academic evaluations in the research area (e.g.: research articles, research data, etc.). The authors stress that quality can be assessed through formal instruments such as IQOER (Müskens, Zawacki-Richter & Dolch 2022) or by certifications (Schön et al. 2021), but also through the professional qualifications of authors (Weimer & Kullmann 2024, 6069).

Furthermore, persistence and metadata are important prerequisites. OER should have a persistent identifier and be accompanied by structured metadata to ensure traceability and comparability (Weimer & Kullmann 2024, 6080; Kullmann 2025). In terms of categorisation, the OER Statistics Framework distinguish between *Dedicated Learning Content*, *Learning Design Content*, and contributions to the *OER ecosystem* (see chapter two of this paper), which helps to structure the diversity of resources. The development and evaluation of the OER Statistics Framework has shown that different levels of granularity must be considered, ranging from atomic objects like single figures to complex degree courses (Weimer & Kullmann 2024, 6080). Finally, we argue that at least evaluated individuals should ideally contribute to compiling their own OER dataset to ensure completeness and reliability (Weimer & Kullmann 2024, 6079). This would also be the best approach to institutional assessments.

These judgments determine the scope and comparability of the data set. They are made manually based on qualitative evaluation criteria. This procedure is similar to that of peer reviews. By demanding the unity of quantitative and qualitative procedures, we are in line with current RRA requirements (e.g., CoARA 2022).

2. Data access: A major challenge lies in the fragmented and heterogeneous landscape of OER repositories. The development and evaluation of the OER Statistics Framework revealed that one issue of conducting scientometric analyses on OER stems from the fact that repositories are frequently dispersed with inconsistent metadata and vary significantly in terms of their scope and accessibility (Weimer & Kullmann 2024, 6079). This makes it difficult to ensure complete coverage when constructing datasets for assessment purposes. The development showed that, unlike bibliometric databases for research publications, there is currently no centralised, comprehensive index for OER. Therefore, it remains unclear how representative the data is if the evaluated person does not actively compile their own OER portfolio. In addition, coverage gaps and redundancies across repositories can affect comparability between analyses. These issues raise significant questions of coverage, reliability, and transparency in the use of OER Statistics.

The solution to the infrastructure problem must be based on creating individual OER lists, ideally in collaboration with the researcher or the institution in question (Weimer & Kullmann 2024, 6076-6078). As with the selection of material, the solution to this decision-making problem lies in very careful, manual approaches rather than data-driven ones. All decisions must be carefully documented. It should be clear which databases were used and why.

3. Counting method: Another methodological decision is whether to apply full counting (crediting each co-author with one full contribution) or fractional counting (dividing credit among co-authors). The development and evaluation of the OER Statistics Framework pointed out that this choice has a strong impact on the comparability of results, since OER are often created collaboratively and may involve not only academic staff but also designers or IT specialists. Full counting can inflate output measures by giving each contributor equal full credit, while fractional counting distributes credit more proportionally. We emphasise that scientists must explicitly state which approach they use, as the interpretation of productivity and collaboration indicators in OER Statistics depends on this methodological decision. This choice significantly influences output measures and comparability across scientists and institutions (Weimer & Kullmann 2024, 6083). It is advisable to specify both counting methods to ensure the most comprehensive insight into the data possible. Specifying the full counting method and the fractional count allows the different results to be compared.

4. Attribution window and self-attribution: Researchers also decide which attribution window to use for counting attributions (analogous to citation windows in research evaluation) and how to handle self-attributions. The development of the framework has revealed the significant impact of these methodological constraints on the resonance indicators of OER Statistics. A short attribution window may underestimate long-term reuse of OER, while a longer window risks diluting the signal with noise. The results of the framework evaluation also showed that self-attributions - when creators themselves reuse their own OER in new contexts - can artificially inflate resonance measures if not clearly separated from external attributions. Therefore, explicit reporting on the chosen attribution window and treatment of self-attributions is essential to ensure transparency and valid interpretation of OER impact (Weimer & Kullmann 2024 6083). As with decision regarding counting methods, it is better to include more information than less in scientometric analyses. Different attribution windows can be specified (e.g., three years and 10 years), and calculations with and without self-citations can be specified.

5. Field normalization: Finally, the question arises whether field normalisation should be applied to OER indicators. The results of the framework evaluation suggest that disciplinary differences in teaching practices and OER uptake between disciplines can have a significant impact on raw counts. Applying field normalisation can therefore help to make outputs from different subject areas more comparable. However, this requires a justified decision on which classification scheme to use, as various taxonomies exist and each brings specific advantages and drawbacks. Without clear justification, normalisation may introduce new bias rather than eliminate it. If normalisation is applied, the rationale and chosen classification system must be documented transparently, since it shapes whether differences reflect genuine disciplinary variation or field-specific practices (Weimer & Kullmann 2024, 6079). Field normalisations make no sense at the individual level, as comparisons between individuals should generally be avoided. At the individual level, publication sets are often too small to yield statistically robust values, making results highly sensitive to single outliers. Moreover, career stage, role in collaborations, and diverse forms of academic contributions cannot be adequately reflected in normalised citation scores. Using them to compare individuals therefore risks oversimplification and misinterpretation and contradicts widely accepted principles of responsible research assessment. At the institutional level, it is advisable to present results with and

without field normalisations. Interpretations should take both approaches into account and explain how the results differ in each individual case.

These principles serve as the foundation for the operationalisation of OER Statistics and are essential to ensuring methodological transparency and comparability. Based on these methodological decisions, scientometric indicators can be applied.

4.3.2. OER Statistics

In the following, I present the OER Statistics separately for the individual (chapter 4.3.2.1) and institutional level (chapter 4.3.2.2). The application of OER Statistics at the individual level means the scientometric evaluation of OER performance of individual scientists. The institutional level on the other hand refers to the analysis of universities, research institutions or similar organizations. We separate these areas here because the context and use cases are different, as are the circumstances of the evaluations. With respect to the basic methodological assumptions, there are potentially different choices to be made, and some metrics and visualisations only make sense at one level but not the other.

We do not consider the OER Statistics as presented here to be a rigid evaluation concept, but we rather think this is a suitable basis for conducting scientometric studies on the topic of OER. It is just as important to realise that a concept for OER Statistics is presented here but not associated rules for implementation. These should clarify key issues such as the fulfilment of the entry requirements (sufficient quality and level of creation) for eligible OER resulting from the underlying OER definition.

4.3.2.1. Individual Level

OER Statistics at the individual level show both how much and in what form individual academics have published open teaching/learning material and the extent to which this has been received. Table 9 lists scientometric indicators for the recording of OER.

productivity indicators	**total OER (OER count)** ▪ number of “Dedicated Learning Content” ▪ number of “Learning Design Content”
	year of first publication (academic age) number of active years of OER publication (NAY) number of OER per year (arithmetic average)
cooperation indicators	number of contributing authors (NCA) number of OER publications as first author sole-authored OER (SA) co-authored OER (CA)
resonance indicators	total attributions (TA) number of attributed OER (NA-OER) proportion of attributed OER (PA-OER) number of attributions per OER (arithmetic average) proportion of self-attributed in total attributions (in %)
openness indicators	number of OER with a high degree of openness number of OER with a medium degree of openness number of OER with a low degree of openness number of free of charge material
altmetric	downloads of OER

indicators	views of OER bookmarks of OER social media conversations about OER number of blogposts number: mention in syllabi
transfer indicators	attribution in an OER to research material citation in a research material to OER OER material resulting from research projects
OER certification	(existing/ not existing)

Table 9. OER indicators on individual level

The indicators are grouped into seven categories, each reflecting a different dimension of OER activity and/or impact: **Productivity indicators** measure the overall output of OER creation. These include the total number of OER (OER count), the number of specific types such as "Dedicated Learning Content" and "Learning Design Content," the academic age (year of first publication), the number of active years of OER publication (NAY), and the average number of OER published per year. **Cooperation indicators** capture collaborative aspects of OER creation. This includes the number of contributing authors (NCA), the number of OER published as first author, as well as distinctions between sole-authored (SA) and co-authored (CA) OER. **Resonance indicators** focus on the extent to which OER are attributed and reused. Metrics include total attributions (TA), the number of non-anonymous attributions (NA-OER), the proportion of attributed OER (PA-OER), the average number of attributions per OER (CA-OER), and the proportion of self-attributions in total attributions. **Openness indicators** evaluate the degree of openness. These include the number of OER with high, medium, and low degrees of openness, as well as the number of free-of-charge materials. **Altmetric indicators** assess the broader visibility and engagement with OER through alternative metrics. These include downloads, views, bookmarks, social media discussions, blog posts, and mentions in syllabi. **Transfer indicators** reflect the connection between OER and research. They track whether an OER attributes research material, whether it is cited in research outputs, and whether it originates from a research project. **OER certification** simply notes whether certification for the OER exists or not (Schön et al. 2021).

All indicators can be taken from corresponding data sets if the data is recorded and made available.

4.3.2.2. Institutional Level

To gain a comprehensive understanding of how OER are embedded within higher education institutions, it is essential to look beyond individual contributions and examine aggregated data at the organisational level. Institutional OER Statistics capture the structural, strategic, and collaborative dimensions of OER engagement, encompassing productivity trends, openness levels, attribution patterns, and institutional support systems. The indicators outlined in Table 10 provide a multidimensional framework for evaluating how institutions contribute to and sustain OER ecosystems, including aspects such as co-publishing networks, policy development, funding mechanisms, and links between research and teaching through OER. These metrics enable comparative analyses across institutions and inform strategic decision-making for advancing open education at scale. Established methods for evaluating institutions served as a basis here (see for example DZHW (2021)).

productivity indicators	**total OER (OER count)** ▪ number of "Dedicated Learning Content" • granularity level 1 (single, atomic learning objects) • granularity level 2 (units from atomic learning objects) • granularity level 3 (collections of units) • granularity level 4 (set of courses leading to a degree) ▪ number of "Learning Design Content"
	OER publication dynamics indexed growth rate (trend) of OER subject profile
cooperation indicators	sector cooperation most important co-publishing partner institutions most important co-publishing partner countries
resonance indicators	mean normalized attribution score (MNAS) highly attributed OER unattributed OER
openness indicators	number of OER with a high degree of openness number of OER with a medium degree of openness number of OER with a low degree of openness number of materials free of charge
support indicators	OER ecosystem ▪ OER policy ▪ OER certifications ▪ OER infrastructures ▪ OER funding ▪ OER services ▪ OER community support
transfer indicators	attribution in an OER to research material citation in a research material to OER OER material resulting from research projects

Table 10. OER indicators on institutional level

The OER indicators at an institutional level are grouped into six categories, each capturing a different dimension of institutional OER activity. **Productivity indicators** reflect the volume and characteristics of OER output produced by an institution. This includes the total number of OER as well as distinctions between "Dedicated Learning Content" and "Learning Design Content." Dedicated content is further categorized by levels of granularity - from atomic learning objects (level 1) to full course sets leading to a degree (level 4). The "*OER publication dynamics*" represent the average growth per year in a defined observation period. The calculation is defined as

$$\text{OER publication dynamics } (t_0, t_T) = \left(\frac{OER(t_T)}{OER(t_0)}\right)^{\frac{1}{|T|}} - 1$$

where t_0 and t_T denote the first and last year of the observation period and |T| the number of observation years.

Regarding the "*indexed growth rate (trend) of OER*", the publication figures for the first year are set equal to 100. A relative value is calculated for the following years, which can be used to read off the percentage difference. Values above 100 indicate growth and values below 100 indicate a decline in the OER growth rate. These two indicators are particularly interesting for a new field such as OER. There might be many institutions that have published no or very few OER. If these institutions are now slowly starting to create and publish OER, then it is valuable to track this development.

Determining a "*subject profile"* of an institution can be very helpful to indicate in which disciplines the organization is strong in open teaching.

Cooperation indicators address the extent and nature of institutional collaboration in OER production. They capture sector-level cooperation and identify the most frequent co-publishing partner institutions and countries, providing insight into the geographic and organizational scope of OER partnerships.

The **resonance indicator** "*mean normalized attribution score*" (MNAS) indicates how often the OERs were attributed in relation to similar comparison values (field- and time-normalized benchmarks). The calculation is as follows:

$$MNAS_o = \frac{1}{|P_o|} \sum_{i=1}^{P_o} \frac{c_i}{EAR_i^{field}}$$

P_o is the number of publications of the object o (institution), c_i the attributions of the i-th OER in the selected timeframe and EAR_i^{field} the expected attribution rate of the field the OER is assigned to. The global expected value is 1. A higher value can be rated as above average and a lower value as below average. Average values can provide very interesting insights into the data but should also be treated with caution - they are only meaningful when the data is normally distributed.

"*Highly attributed OER*" can also be of significance. This indicator shows what percentage of the data set belongs to the 10% of the most frequently attributed OER in the subject area and publication years. The expected value is 10%. If an institution has more than 10% in the top 10% attributed OER in the time and discipline under consideration, then we can assume that the OER are exceptionally highly attributed. As a final resonance indicator, we consider the percentage of "*unattributed OER*".

Openness indicators evaluate the degree of openness of OER materials. They distinguish between OER with high, medium, or low levels of openness and include the number of materials that are freely accessible to users, thereby highlighting the accessibility and licensing characteristics of institutional OER output.

Support indicators describe the institutional ecosystem that enables OER development and sustainability. This includes the presence of OER policies, certification programs, supporting infrastructures, dedicated funding, institutional services, and the degree of community support for OER initiatives within the organization.

Transfer indicators focus on the relationship between OER and research. These measure whether research outputs are cited in OER, whether OER are cited in research publications, and whether specific OER materials have emerged directly from research projects.

4.3.3. Discussion

4.3.3.1. Possibilities and desired effects

OER Statistics can be used to make university teaching visible in science evaluations and thus accessible for academic recognition and reward. Through their application, they can contribute to an equal consideration and appreciation of research and teaching if published teaching material in the form of OER is recognised as the equivalent of published research output.

At the micro level, this can imply that OER Statistics are used in application and appointment processes. This means that applicants include in their applications (resp. in their CVs) not only

published achievements in research (for example, articles and book chapters) but also publicly available achievements in university teaching (e.g., public teaching materials). This practice can address the imbalance in the value placed on research and teaching that has existed to date. Mentioning teaching material can provide a more nuanced insight into the applicant's academic performance. Another advantage is that the person can explicitly list what his or her strengths in teaching are and what he or she focuses on. The reviewer has the direct opportunity to gain an insight into the applicant's teaching material. They can decide whether expertise in the required field is available and whether there are content-related dissimilarities. Possibly the applicant and the reviewer disagree about paradigmatic details. This could lead to interesting insights before the interview and be the basis for engaging discussions. In addition to disclosing content, applicants could also show that they are interested in implementing Open Science practices. For example, it could be argued that people of course also could submit (non-open) teaching samples with their applications. By publishing OER, however, applicants can also show how they work in their teaching activities and that they are happy to share knowledge and act in accordance with Open Science practices. If these practices are desired in the department, then it could be an advantage for the applicant and both teaching and Open Science practices would be successfully established in science evaluations.

At the meso and macro level, the OER Statistics could for example be used in the context of institutional evaluations. The science evaluations could thus be further differentiated with respect to the area of university teaching. Through the quantifying perspective on teaching performance, this area can be represented in a more multidimensional way and lead to an equal appreciation of research and teaching. In addition, universities and institutions have more of a chance to develop an individual profile. Research profiles are customary to universities. Individual universities often claim to be highly research-oriented in a particular field of science. OER Statistics could highlight the possibility that universities and institutions also boast a special teaching profile, it could then be said that a university is particularly strong in teaching a subject.

Besides the use in science evaluations, OER Statistics could also be a monitoring tool. For example, in higher education policy monitoring: if a university or institution decides to adopt an OER policy, then the question of whether this policy leads to the desired goal is relevant. Does the adoption of the policy have an effect? To investigate such and other questions of higher education policy, differentiated instruments are needed. OER Statistics can help to answer this question comprehensively and to monitor the OER landscape. The same applies to the use of monitoring tools in the Open Science context. The promotion of Open Science is a frequently made demand, both from the political and the practical side. In this respect, monitoring is also interesting: are Open Science efforts limited to the research area, or do they also take teaching practice areas into account? For such and similar questions, the OER Statistics can be a suitable monitoring tool.

Finally, the OER Statistics Framework can be used for exploratory research. Questions about typical characteristics of OER authors, author networks, particularly OER-friendly subject areas, or typical points in academic careers at which OER are created more frequently are just some of the many research questions that can be asked.

The OER Statistics Framework was designed for these purposes and use cases. As has become clear, its intended effects are as follows.

The OER Statistics Framework aims to enhance the visibility and recognition of teaching in the academic context, which, compared to research, has traditionally been undervalued. Through measurable indicators, educators can demonstrate their achievements in the field of OER, thereby expanding the framework for evaluating academic work and supporting the goals of RRA. The

overarching objective is to provide scholars with the opportunity to gain recognition and visibility for the time and care they invest in the development of teaching materials. In this way, OER indicators may contribute to teaching activities being more strongly acknowledged and valued — ultimately leading to a reputational gain for educators (Weimer & Kullmann 2024, 6085).

In addition to this primary objective of the OER Statistics Framework, three further positive side effects can be identified: first, the promotion of open science practices; second, the possibility of developing institutional teaching profiles; and third, the potential for assessing the impact of OER strategies.

OER Statistics can foster open science practices by making visible the extent to which openly licensed teaching materials are used, adapted, and reused. This visibility increases the value of such materials and creates incentives for both educators and institutions to share their knowledge. By making the relevance and outreach of OER measurable, OER Statistics also strengthen the motivation to develop innovative didactic concepts and make them accessible to the academic community. Thus, OER Statistics do not only contribute to the establishment of a culture of sharing but also reinforce the fundamental principles of Open Science (Weimer & Kullmann 2023, 676).

At the institutional level, OER Statistics can serve as a tool for higher education policy and governance. By systematically recording the areas and intensity in which OER are developed and applied, they make the teaching profiles of universities visible—analogous to the already established research profiles. This transparency enables institutions to highlight strengths and focus areas in teaching, identify fields for development, and sharpen their positioning in both national and international competition. In doing so, universities gain a data-driven foundation for making more informed strategic decisions in the field of teaching (Weimer & Kullmann 2023, 676).

Finally, OER Statistics play a crucial role in the evaluation and further development of institutional OER strategies. By capturing the use, outreach, and impact of open teaching materials, they reveal the extent to which strategic measures to promote OER are effective. As a result, they provide an important feedback instrument for university leadership, funding bodies, and policymakers, enabling reflection on existing strategies, necessary adjustments, and transparent communication of their effectiveness. Linking measures with measurable outcomes makes progress traceable and supports the evidence-based advancement of institutional and national OER policies (Weimer & Kullmann 2023, 676).

4.3.3.2. Limitations and undesired effects

Quantitative methods are always accompanied by a limited view of products, practices and processes. Just as scientometrics does not measure performance and/or quality in research, OER Statistics do not measure the performance and/or quality of academics in university teaching. Just as scientometrics can quantify research output, scientometrics can quantify published teaching output. No conclusions about quality or similar should be drawn from the pure statistical numbers. Furthermore, it must be emphasised that OER Statistics only refer to published free of charge and ideally in addition openly licensed teaching material and do not provide any insight into university teaching in its entirety. Of course, much more happens in universities that cannot be represented by teaching material. This is also a scientometric limitation that applies to the area of university teaching just as much as to the area of research. This circumstance must be dealt with by working carefully in the interpretation of science evaluations.

These limitations mean that OER Statistics can have undesirable effects if not used carefully. Four of these are discussed below: The risk of one-sided quantification, the transferring of problematic

effects from research, potentially problematic efficiency logic and potential distortions in teaching and inequality due to lack of OER experience.

The most prominent negative effect is the frequently raised concern, that OER Statistics may further intensify the focus on measurable outputs. Instead of placing the quality of teaching at the centre of evaluation, the system could simply expand to include additional metrics. This trap of (ac)countability implies that easily measurable indicators – such as the sheer number of OER published – would become the main benchmark. As a result, pedagogical effectiveness or content depth may be overshadowed by quantity. For the academic community, this would mean that the system of recognition and rewards does not fundamentally improve but is merely extended by yet another quantitative component, without adequately capturing the true quality of teaching (Weimer & Kullmann 2023, 676). To counter this effect, quantitative effect, quantitative indicators should always be complemented by qualitative assessments, such as peer review or narrative evaluations, ensuring that the educational value of OER remains central to evaluation processes.

Another unintended effect points to parallels with well-known side effects of classical research metrics. Many fear that mechanisms such as the strategic fragmentation of publications could also be applied to OER. In research, this is described as publishing in the least publishable unit (salami-slicing). In the OER context, it could mean that instructors split their teaching materials into numerous small parts to inflate the number of countable OER. While this might satisfy the metrics, it would add little pedagogical value. Instead, the authors risk generating a flood of fragmented resources that lack coherence and quality. For teaching practice, this could mean that not the best or most innovative OER are highlighted, but rather those that are easiest to multiply and count (Weimer & Kullmann 2023, 676). This risk can be mitigated by carefully selecting OER for scientometric analysis, as outlined in chapter 4.3.1.

There are also concerns about unintended effects that specifically affect teaching practices. If OER indicators become a standard component of evaluation, they might promote a logic of efficiency that emphasizes cost reduction rather than enhanced visibility of teaching. For instance, core courses or introductory modules might continue to rely on the same OER for years, with little incentive to revise or update them once they have been published and recognized. Furthermore, it has been discussed that instructors who use OER could, in some cases, be accredited with fewer teaching achievements than colleagues who do not. This could result in them having to teach more courses to receive the same recognition. In such a scenario, instead of empowering teaching, OER Statistics could become a mechanism that increases workload while primarily serving institutional efficiency (Weimer & Kullmann 2023, 676). Addressing this risk requires a broad, ongoing discourse that involves not only policymakers and higher education leaders but also researchers, instructors, and other stakeholders. Only through such collective negotiation can OER indicators be designed in a way that promotes meaningful teaching practices rather than reinforcing narrow efficiency logics.

A final critical point concerns the unequal starting positions among instructors. Not all educators have the experience, resources, or skills to create or consistently use OER. If OER indicators become part of performance assessments, those without such experience risk being disadvantaged, even if their teaching is of high content quality and didactic value. This outcome would not only be unfair but could also exert pressure on faculty to produce OER for strategic rather than educational reasons. The danger is that authenticity and diversity in teaching would suffer, as instructors might feel compelled to conform to a standard that does not fit all disciplines or teaching approaches. Instead of OER being understood as a voluntary enrichment of teaching, an implicit obligation could emerge, undermining the original idea of openness and autonomy. Practical remedies include offering professional development, infrastructure, and support services that enable all instructors to

engage with OER voluntarily and at their own pace, while ensuring that high-quality teaching without OER continues to be valued equally.

Overall, scientometric analyses of OER have the potential to enhance teaching within academic evaluation and strengthen open educational practices. However, these opportunities can only be realized if the methodological challenges are addressed transparently and possible undesirable side effects are continuously reflected upon.

4.3.4. Summary

Chapter 4.3 presents and discusses OER Statistics. It describes scientometric instruments that quantify freely accessible teaching/learning material (with a sufficient level of creation and quality) and make it accessible for scientometric science evaluation. The chapter explains the basic principles of the OER Statistics Framework and the OER statistic indicators itself at individual (chapter 4.3.2.1) and institutional level (chapter 4.3.2.2). I discuss the potential of OER Statistics in the context of science evaluation as part of the RRS. It is clear that the emergence of OER brings along the opportunity to consider teaching in the context of scientometric performance evaluations and therefore broadens the view on academic performances. The main opportunity here lies in the simultaneous visibility and appreciation of research and teaching in the evaluation of science.

Furthermore, limitations are highlighted. Just as scientometrics does not measure performance and/or quality in research, OER Statistics do not measure the performance and/or quality of academics in university teaching. Just as scientometrics can quantify research output, scientometrics can quantify published teaching output. Metrics literacy and sound documentation of scientometric analysis (Ng et al. 2024) are therefore necessary conditions in both areas to prevent the misinterpretation and misuse of scientometric data. The Framework warns against the misuse of OER Statistics, as is often the case with the h-index or Journal Impact Factor (JIF). OER Statistics provide analyses and results that should be considered and evaluated in their context. They cannot stand alone and be meaningful based on pure figures. Especially at an individual level, these statistics must always be accompanied by qualitative assessments to say something about what should be recognised and rewarded. OER Statistics can only support these qualitative processes. The statistics can provide an overview of a person's work. Outstanding work can be identified (e.g. through the indicators "total attributions (TA)" or "download of OER"), which should be then examined for content in a subsequent peer review.

The concept of OER Statistics presented here is purely theoretical. Practical questions and feasibility analyses based on the actual situation, for example regarding current practice and the available infrastructure for data collection, have deliberately not been considered to prevent the influence of possible limitations in practice from affecting the conceptual level.

5. Conclusion

5.1. Summary

First, I present a summary of the operationalisation of HETP, and its subsequent contribution to the appreciation of university teaching within the academic RRS. In chapter 2, I examined HETP from three educational theory perspectives. I found that an operationalisation of HETP, in both the Humboldtian sense (chapter 2.1) and the subject education perspective (chapter 2.2), only makes sense when qualitative tools are used. Both understand higher education and higher education teaching as complex structures in which the individual (i.e. the student) is at the centre and educationally relevant processes take place in interaction and interrelation with their environment. The educational goal here is not the specific development of certain skills that are useful in the labour market, but rather holistic personal development. From this perspective, HETP can only be measured qualitatively. Achievements in higher education teaching must be understood in their multidimensionality in the sense of Humboldt and subject education. Following on from this, chapter 2.4 deals with the qualitative operationalisation of HETP. It explains how university teaching performance can be assessed if a procedure similar to the peer review process is used. For example, it is discussed that a description of the didactic preparation of university teaching can be meaningfully collected as well as the question of whether the aim is to promote the personal development of students and a description of whether the teaching is socially relevant (chapter 2.4).

We see that a Humboldtian understanding of education and the subject education perspective provide a theoretical foundation for a qualitative operationalisation. In addition, the systems theory approach expands the view of HETP (chapter 2.3) and thus provides an argument for quantitative operationalisation. From a systems theory perspective, higher education is a functionally differentiated subsystem of society that primarily serves the production and reproduction of knowledge. It operates by means of specific forms of communication, such as lessons, teaching material and examinations, which are geared towards the codes true/untrue and pass/fail. It is therefore not about a complex structure of personality development but reduces complexity to manageable codes in order to make the structure tangible. This perspective makes it possible to define, quantify and compare HETP as system-relevant outputs. Quantitative operationalisation of HETP is sensible and desirable against the background of a systems-theoretical view of university teaching. This was explored in chapters 3 and 4.

Open scholarship enables the quantification of openly accessible outputs in higher education teaching. Free access to data and information allows for scientometric measurements in teaching that would not be possible without open scholarship. This is a great opportunity for the inclusion of university teaching in the RRS. The limitation, however, is that this data-driven approach can only take into account data that is available. Activities and products of university teaching that are not accessible are not taken into account.

To situate the quantitative operationalisation within a broader debate on scientometric open scholarship indicators, chapter 3 presents a mapping review. Extensive research was conducted into which open scholarship indicators are currently being used or discussed. The review has shown that these indicators focus on the area of research and largely ignore the area of teaching, although open scholarship as a concept is seen as more extensive than only research and also considers teaching (Tennant et al. 2019). The review highlights that there is a research gap in the scientometric measurement of university teaching output. A total of 248 documents were reviewed, of which 203

were empirical studies and 45 were discussion papers. In the review, the open scholarship indicators used were identified and presented in detail (chapter 3; Table 4). It is particularly relevant at this point that the indicators were only applied to OER or MOOCs four times (chapter 3; Table 5). All other empirical studies (199 studies) relate to research output or research infrastructure. This result was underpinned by the finding that the indexing of the documents shows a strong focus on research-related topics. There are hardly any teaching-related keywords (*education* only once), and the documents included in the review are predominantly (74.33%) in the disciplines of *information and library science, computer science* and *natural sciences and technology*. Other disciplines are only represented to a small extent (≤ 2.3%). The review has shown that scientometrics has a blind spot in the field of higher education teaching.

Chapter 4 presents the development of OER Statistics and thus the quantitative operationalisation of open university teaching output. At this point, I argue that teaching material as the published products of university teaching is the scientometric equivalent of published research output. In the RRS, scientometric measurements of OER are thus the counterpart to the scientometric measurement of journal articles, books, conference proceedings or similar output in research. OER Statistics are developed in a three-stage process: a pre-study (chapter 4.1), a concept evaluation (chapter 4.2) and the presentation of the concept (chapter 4.3).

The pre-study includes a discussion of OER Statistics in their potential role in raising awareness of HETP in the RRS as well as positive and negative effects of these potential indicators (chapter 4.1). A focus group discussion with experts in the fields of OER and scientometrics was applied. The participants agreed on the possible consideration of OER as a teaching-related equivalent to research output and, due to the openness of OER, considered them to be fundamentally suitable for making teaching visible as part of open scholarship. However, they were also skeptical about the use of scientometric indicators. OER Statistics were rated more positively at an institutional level than at an individual level. For example, it was seen as an opportunity for universities to use OER Statistics to present and emphasize a teaching profile to the outside world. OER Statistics could also be used to present and monitor cultural change in open scholarship. The participants expressed their greatest concerns and worries about unintended effects regarding the use of scientometric indicators in teaching at an individual level. This was justified by negative experiences from the field of research. The concern was discussed that OER Statistics could create unintended incentives, so that OER would not be created primarily to give students free access to teaching material, but merely to increase their own OER count. This could have negative effects on the quality of OER and teaching. OER should be designed in such a way that students derive the greatest benefit from them and not in such a way that the OER count of teachers quickly skyrockets. In this respect but also in relation to institutional evaluations, the need for an accompanying qualitative evaluation was emphasized.

Based on these results, the concept of OER Statistics was then developed, considering all the concerns identified in the pre-study. This concept was evaluated by means of expert interviews (chapter 4.2). The evaluation led to a differentiation of the concept, i.e. the indicators were adapted following the expert interviews. For example, following detailed discussions about percentile indicators, it was decided that these would not be used in the OER Statistics. This decision is because these indicators claim to achieve a level of precision that they can only meet under certain data-related conditions. To avoid misinterpretations in this respect, we decided against indicators whose complexity could lead to misinterpretations. Two categories of indicators were added to the concept of OER Statistics at the individual level. The first relates to the reporting of OER certifications, which records whether the individual or institution is certified or not. Secondly, it refers to the transfer indicators that had also been added at institutional level, recording the exchange of knowledge from research to teaching and vice versa.

Finally, the concept of OER Statistics is presented (chapter 4.3). Considering the tension between accuracy and detail, the concept distinguishes between the different aggregate levels (institutional level and personal level). These different levels require different indicators (Rescher 2006). The concept of OER Statistics addresses the following indicators at both individual and institutional level: productivity indicators, cooperation indicators, resonance indicators, openness indicators and transfer indicators. At the individual level, altmetric indicators and OER certifications are also considered. For the institutional level, support indicators are also discussed, which include OER certifications for institutions. For contextualization, the theoretical background of scientometric methods was presented in detail, the OER definition underlying the concept is explained and possible evaluative and explorative applications of OER Statistics are discussed.

5.2. Limitations of the operationalisation of HETP

The primary limitation of this thesis and the operationalisation of HETP is that it can only serve as a representation of actual performance, never as the performance itself. Every operationalisation (both qualitative and quantitative) reduces the complexity of performance to measurable units and is therefore only an approximation. Every form of measurement abstracts from reality and inevitably entails distortions. This applies not only to the measurability of university teaching but also to the measurability of research. Operationalisations (including scientometric methods) can make both research output and teaching output tangible and thus accessible to the RRS, but this tangibility always represents a limited view of performance. Just as, for example, scientometric performance measures cannot represent research in its entirety, neither can they represent teaching in its entirety. To counter this limitation, a transparent presentation of the operationalisation process is essential. It must be clear whether the HETP has been assessed qualitatively or quantitatively, on what data the assessment is based and what criteria were used. This is the only way to ensure that the recorded teaching performance is not only measurable but also appropriately interpreted in its context.

This thesis examines both the qualitative and quantitative operationalisation of HETP, with a focus on the quantitative perspective. This is due to the fact that the academic RRS is significantly characterized by quantitative procedures and there are political calls for a broadening of the range of accepted publication formats (DFG 2022). This demand is the central starting point of my thesis. However, qualitative methods also play an important role. They are not only complementary, but also indispensable in order to effectively support quantitative methods and increase their informative value. For this reason, the thesis also deals with the qualitative approach.

I see three limitations in the qualitative operationalisation of HETP. First, it is inherent in the qualitative method that there is little standardization and limited generalizability. Qualitative data provide in-depth insights into specific teaching material and teacher performance but are difficult to generalize and compare. This goes hand in hand with the second point: qualitative operationalisation is highly subjective, and assessment depends on individual perspectives, which can lead to different interpretations of the same teaching performance. Peer review can also be influenced by social factors such as personal relationships, hierarchies or institutional interests. Third, these procedures are very time-consuming and resource intensive. For example, if the performance of an entire country is to be considered, it would be difficult to qualitatively assess all the OER in an entire country. The choice between qualitative and quantitative methods depends on the use case.

The disadvantage of the qualitative approach is also the advantage of the quantitative approach (Figure 9). The qualitative approach (peer review) has its limitations more between the macro and

meso levels, i.e. at the level of global development and in a national context. The quantitative approach (bibliometrics), on the other hand, has its limitations more between the micro and meso levels, i.e. at the level of individual people or publications.

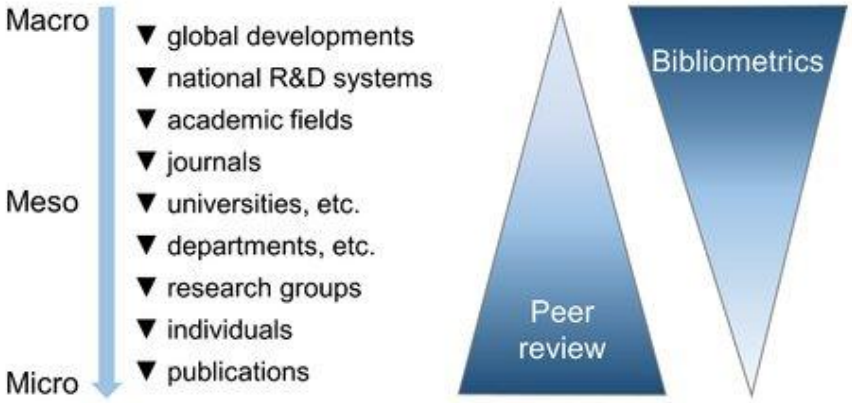

Figure 9. peer review vs. bibliometrics (Tong et al. 2023; Hinze 2014).

The two most obvious limitations of the quantitative operationalisation of HETP (OER Statistics) are the exclusive representation of teaching/learning materials (without consideration of interactions without material or documentation) and the need for openness of these materials. This means that it is not possible to represent the output of higher education teaching in its comprehensive totality. The teaching material represents only a part of higher education teaching, not teaching in its entirety, as conversations, discussions or consultations, for example, are not recorded in the form of material. In addition, this teaching material can only be scientifically recorded if it is open and available without access restrictions. It should be emphasized that the OER Statistics do not directly record performance, but only open teaching material. I thus follow the limitation described at the beginning, namely that operationalisations of academic performance are always only a representation and never the performance itself. This limitation is not restricted to the field of HETP but also applies to scientometric procedures in research. Another limitation is that OER Statistics consider very diverse and hardly comparable artefacts and documents of teaching/learning materials. This is due to the underlying definition of OER (chapter 5.3.1). This stipulates that the OER Statistics only take into account material that is of sufficient quality and level of creation. We must assume that the respective storage locations of the OER ensure this. A manual check of the quality and level of creation of the OER could be carried out, which would establish a link to the qualitative approach and is desirable if time and human resources are available. With regard to the OER to be considered, it should also be pointed out that these open teaching/learning materials can appear in very different forms and formats. Research publications often appear as articles, books or proceedings. OER, on the other hand, can be published in a much wider variety of forms. They can be PowerPoint presentations, videos, text documents, figures, exercise sheets, curricula or other formats. These are more difficult to compare, as small figures are of course different to entire online courses with a certificate of completion. Another limitation of OER Statistics is that there are no common quality assurance procedures in the OER landscape. A fundamental principle of the OER movement is that teaching and learning materials are shared with other educators and learners, even if they are not of the highest quality. A low threshold for publication is desired and required. However, this means that we must assume very different qualities for OER. This is somewhat different for research output, as a peer review process usually exists in this area and ensures quality to a certain extent. This assurance is not absolute either, as the peer review process is not flawless,

and the quality of research or teaching cannot be assessed objectively. The rise of predatory publishers also raises questions about the extent to which the quality of research is actually verified. Nevertheless, at this point I see a difference between the use of scientometric methods in research and in teaching, which must be considered in the use and interpretation of these analyses. Other aspects that complicate the handling of OER in the context of scientometric assessments are the handling of versioning and a lack of everyday practice in the citation of OER. Different versions of the same OER are established practice and lead to a lively approach to OER. These are not rigid entities but materials that should be further processed. This poses a challenge for the quantitative operationalisation of teaching material (like different versions of the same preprint in the research area). It is also a challenge that although OER must always be cited (if only because of the license), however, these citations follow less standardized practices than the citation of research material.

These scientometric limitations are not new. They are known from application in research and must be addressed with good scientometric practice in teaching and research. This includes sufficient metrics literacy among the creators and users of scientometric analyses. All decisions made must be considered and named both during planning and implementation. Users must know that OER Statistics do not measure quality or performance but rather count and quantitatively record OER. In addition, all scientometric surveys must adhere to good-practice-guidelines such as the Leiden Manifesto (Hicks et al. 2015). These guidelines have been in place for several years and must be part of everyday practice. Finally, it should be noted that the most important answer to all limitations and difficulties lies in clear and transparent documentation of data preparation and analysis. When it is understandable which decisions were made, for example, when dealing with versioning and recording citations. It must be clear which citation window has been chosen and how the sufficient level of creativity and quality of the OER is justified. The GLOBAL reporting guideline is currently being developed as a guideline for documentation of the scientometric analyses (Ng et al. 2024). This suggests what should be documented so that all decisions are understandable. This is necessary to counter scientometric limitations.

5.3. Relevance and outlook

The aim of this thesis is to operationalise HETP for the academic RRS. The relevance of this operationalisation lies in the contribution that my thesis makes to the discourse on the representation and thus the appreciation of university teaching in the academic RRS. University teaching and the education of the next generation is of extraordinary importance not only for students but also for society. Education influences social change and plays a crucial role in the development and fulfilment of social potential. Building on this responsibility, it is appropriate to value those who do the work. Following this line of reasoning, HETP must be included in the academic RRS. My work provides a theoretical model for this.

The movement toward open scholarship is laying the foundation for incorporating HETP into the quantitative RRS. When teaching and learning materials are published as OER, scientometric methods can be applied to teaching performance in a manner similar to the use of quantitative indicators in research. However, implementing my conceptual model for operationalising HETP requires a cultural shift toward greater openness in sharing teaching practices. In this context, Nosek

(2019) illustrates key elements for fostering such a cultural change toward Open Science and Open Scholarship in the form of a pyramid (Figure 10).

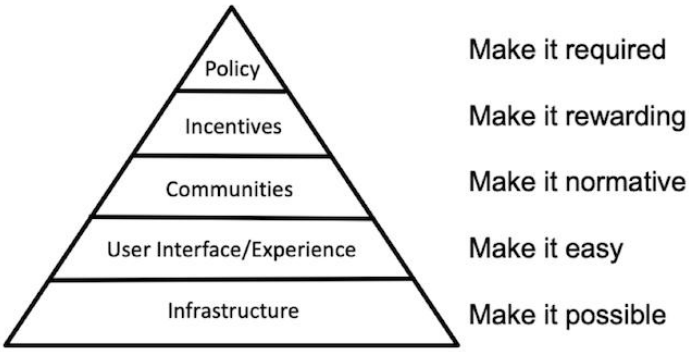

Figure 10. strategy for culture change (Nosek 2019).

The pyramid consists of five interconnected levels, each building upon the previous one. In order for one level to be fully realized, it is necessary to ensure that the level below makes it possible. An open science infrastructure is needed to enable cultural change (first level). Certain user interfaces and experiences should make these practices easy (second level), communities need to make open science practices normative (third level), incentives need to be created for a change in the culture so that open science practices are rewarding (fourth level), and policies provide the top of the pyramid that ensures these practices are required (fifth level). My thesis is positioned at the fourth level (*incentives – making it rewarding*). The operationalisation of HETP serves as a foundation for establishing incentives to promote the creation and use of OER.

Follow-up research should start at all levels of the pyramid of Open Science cultural change. At the infrastructure level, further research is needed into how the OER ecosystem should best be set up with regard to the inclusion of HETP in the academic RRS. Currently, there are many different infrastructures for OER and not all academics have options to publish their OER in high-quality infrastructures. Thus, we need more research on how an infrastructural ecosystem for OER can be best established to make using and sharing OER easily possible. At the user interface/experience level, the experiences of academics with open teaching and the appreciation of these practices should continue to be studied. Sharing and citing OER are complex as we do not have proper infrastructures and standards like metadata. Here, we need more efforts and research to facilitate the adaptation of OER activities like sharing and citing OER. At the community level, the connection between scientists needs to be further normalized and investigated. This specifically includes sharing and citing OER as a form of connection and exchange. Conferences, training courses and workshops are another form of community building. These can also be drivers of an open science culture change and must be examined in their function as an exchange platform.

When these three levels are investigated, they build a strong basis to implement the theoretical concept of my thesis. Regarding the top level of policies, I hope that the results and outcomes of my thesis will be considered. Policies should be established to ensure that the desired practices are mandatory (make it required). These desired practices include the implementation of university teaching as well as the implementation of open practices and the design of OER. Policies that address good scientific practice and scientific careers should take university teaching into account and recognize both research and university teaching as parts of science.

One example of such a policy is the *Coalition for Advancing Research Assessment* (CoARA 2022). The agreement is a European initiative to reform research assessment. Three aspects of this policy coincide with the main line of argument of my thesis. Firstly, in the first commitment of the agreement, CoARA supports my idea that HETP should be considered in the RRS: “Recognize the diversity of contributions to, and careers in, research in accordance with the needs and nature of the research […] activities including teaching, leadership, supervision, training and mentoring.“ (CoARA 2022, 4-5). Secondly, the first commitment also calls for openness to be valued and promoted: ”practices that contribute to robustness, openness, transparency, and the inclusiveness of research” (CoARA 2022, 5). Thirdly, in the second commitment, CoARA emphasizes the importance of the interplay between qualitative and quantitative approaches in the RRS: “Base research assessment primarily on qualitative evaluation for which peer review is central, supported by responsible use of quantitative indicators” (CoARA 2022, 5). As we can see, my doctoral thesis is a contribution to an already existing discourse. The journey toward greater recognition of university teaching within academia is already underway.

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Declaration & Research Data

My thesis consists of five scientific c that have already been published:

(1) Weimer, Verena; Heck, Tamara; van Leeuwen, Thed; Rittberger, Marc (2023): The quantification of open scholarship—a mapping review. In *Quantitative Science Studies*; 4(3): 650-670. license: CC BY 4.0. doi: https://doi.org/10.1162/qss_a_00266

(2) Weimer, Verena; Kullmann, Sylvia (2023): Teaching as part of open scholarship – Scientometric indicators for open educational resources. In *Proceedings of ISSI 2023 – the 19th International Conference of the International Society for Scientometrics and Informetrics*, 1, 667–683. license: CC BY 4.0. doi: https://doi.org/10.5281/zenodo.8246995

(3) Weimer, Verena; Kullmann, Sylvia (2024): Teaching as part of open scholarship – Developing a scientometric framework for open educational resources. In *Scientometrics*. license: CC BY 4.0. doi: https://doi.org/10.1007/s11192-024-05007-1

(4) Weimer, Verena; Alt, Rebecca; Hiebl, Johannes (2024): Wissenschaftswettbewerb = Wettbewerb in Forschung und Lehre? In: Webler, Wolff-Dietrich (Editor): Überzogener und überhitzter Wettbewerb in der Wissenschaft (Band II). Herausforderungen bei der Ausgestaltung von Wettbewerb – Theoretische und analytische Perspektiven. Reihe Hochschulwesen: Wissenschaft und Praxis. CC BY SA 4.0. doi: 10.53183/9783946017394. URL: https://www.universitaetsverlagwebler.de/webler-2024b

(5) Weimer, Verena; Kullmann, Sylvia (2025): *OER Statistics Framework:* Recognizing and rewarding Open Educational Resources in Academic Evaluation, *Information. Wissenschaft & Praxis*; doi: https://doi.org/10.1515/iwp-2025-2051

The first three publications are empirical and are accompanied by published research data. Publications (4) and (5) are theoretical in nature and therefore have no research data.

- **research data (1):** Weimer, Verena; Heck, Tamara; van Leeuwen, Thed; Rittberger, Marc (2023): The quantification of open scholarship - A mapping review [Data set]. Zenodo. Doi: https://doi.org/10.5281/zenodo.8128130

- **research data (2)** are anonymized and prepared for transfer to the *Research Data Centre for Higher Education Research and Science Studies* (FDZ-DZHW). The handover is expected to take place under the DAP-id oerindicator. The research data can be requested from me until then.
  The personal research data from the study are stored in the DIPF data archive under the project name 'OER Statistics' and will be kept there for 10 years in line with the Code of Conduct for Safeguarding Good Research Practice of the German Research Foundation[5]. This data includes the audio files of the interview recordings, the interview participants' declarations of consent, the confidentiality declarations of the project participants and the vote of the DIPF Ethics Committee.

[5] Guidelines for Safeguarding Good Research Practice. Code of Conduct: https://doi.org/10.5281/zenodo.6472827 [retrieved: 01/12/2025]

- **research data (3):** Weimer, Verena; Kullmann, Sylvia (2023): Replication Data for "Teaching as part of Open Scholarship", DANS Data Station Social Sciences and Humanities, V1. https://doi.org/10.17026/SS/W8MDOI
  The personal research data from the study are stored in the DIPF data archive under the project name 'OER Statistics' and will be kept there for 10 years in line with the Code of Conduct for Safeguarding Good Research Practice of the German Research Foundation. This data includes the audio files of the interview recordings, the interview participants' declarations of consent, the confidentiality declarations of the project participants, the vote of the DIPF Ethics Committee and the documentation of the consent of the participants who agreed to be named in the acknowledgements.

Curriculum Vitae

Verena Weimer was born in Karlsruhe, Germany, in 1991 and grew up in Dortmund. She attended school there from 1998 to 2011, graduating with her Abitur (Max Planck Gymnasium). From 2012 to 2015, Verena pursued a Bachelor's degree in *Pedagogy: Development and Inclusion* at the University of Siegen, graduating with distinction (final grade: 1.6). She went on to complete a Master's degree in *Gender Studies* at Humboldt University of Berlin between 2016 and 2018, achieving an excellent final grade of 1.1.

Since 2019, Verena has been a research assistant at the DIPF | Leibniz Institute for Research and Information in Education in Frankfurt am Main. Her work is situated at the intersection of educational science, information management, and scientometrics, with a particular focus on Open Science (OS) and Open Educational Resources (OER). Currently, she is jointly responsible for two projects: one investigating the impact of Open Science, and another dedicated to generating open citation data in the field of educational research.

In addition to her research activities, Verena has been teaching at Darmstadt University of Applied Sciences since 2021, where she offers the seminar *Introduction to Scientometrics* within the Information Science program.

In 2022, she began her doctoral studies as an external PhD candidate at the Centre for Science and Technology Studies (CWTS) at Leiden University, the Netherlands. Her dissertation is supervised by Prof. Dr. Thed van Leeuwen, Prof. Dr. Marc Rittberger, and Dr. Tamara Heck. During her PhD studies, she completed numerous further education courses as part of the training programme. These included a research integrity course at Leiden University and a university teaching certificate course at Goethe University in Frankfurt am Main.

Verena has also gained valuable international experience throughout her academic journey. In addition to her doctoral work in the Netherlands, she spent a semester abroad at UNICAMP in Campinas, Brazil, during her undergraduate studies, and completed a research stay at the Georgia Institute of Technology in Atlanta, USA.

Acknowledgments

This compilation not only summarises a cumulative doctoral thesis consisting of five treatises but also draws a line under several years of designing and implementing research. Under big visions and ideas. Under a lot of disillusionment. Under dreams and hopes, worries and fears.

I would like to thank Tamara Heck. For giving feedback without mercy or restraint. For your tireless support and backing. For everything you believed I could do and everything you pulled me back on. Thank you for making open science the most normal thing in the world for me. Thank you for the guidance I couldn't have wished for better.

I would like to thank Thed van Leeuwen. Thank you for opening the door to scientometrics and the associated community for me. Thank you for introducing me to a world I previously had no access to. Thank you for your feedback, which has always been constructive. Thank you for insisting on optimisation in one situation and appropriate pragmatism in another. Thank you for teaching me how to distinguish between the two.

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Thank you to my parents, Sabine and Uwe. Thank you for your loving support and guidance, for your care and backing. Thank you for always trusting that I would find my way. Thank you for everything you have given me. Thank you to my brother Tobias for always being there – in the past and in the future. Thank you to my partner Matthias and my friends. Thank you, Mama, Papa, Tobias, Matthias and friends - for being the most important people in my life and for always reminding me what really matters in life.