Susanne Wollin-Giering[1] & Jochen Gläser[2]

Field-Specific Student Participation in Research Processes

Abstract

Student participation in university research has typically been seen in terms of learning benefits for students; and the relevance of students in research processes has been largely neglected. This study addresses the gap in understanding student participation in research by comparing the link between epistemic properties of research processes and research fields on the timing and prevalence of mechanisms of participation in Modern German Literature and Experimental Condensed Matter Physics.

Keywords

student participation, research processes, teaching-research nexus, epistemic properties, scientific fields

1 Corresponding author; Technische Universität Berlin; susanne.wollin-giering@tu-berlin.de; ORCID 0009-0004-5023-9957

2 Technische Universität Berlin; jochen.glaeser@tu-berlin.de; ORCID 0000-0001-7356-9407

https://doi.org/10.21240/zfhe/19-03/05

Fachgebietsspezifische Partizipation von Studierenden an Forschungsprozessen

Zusammenfassung

Studentische Partizipation an der universitären Forschung wurde bisher meist unter dem Gesichtspunkt des Erkenntnisgewinnes für die Studierenden betrachtet, während die Relevanz von Studierenden in Forschungsprozessen weitgehend vernachlässigt wurde. Diese Studie schließt die Lücke im Verständnis der studentischen Partizipation an der Forschung, indem sie die Verbindung zwischen den epistemischen Eigenschaften von Forschungsprozessen und Forschungsfeldern mit dem Zeitpunkt und dem Auftreten von Mechanismen der Partizipation in der Neueren deutschen Literatur und der experimentellen Festkörperphysik vergleicht.

Schlüsselwörter

Studentische Partizipation, Forschungsprozesse, Lehre-Forschung-Nexus, Integration von Forschung und Lehre, epistemische Eigenschaften, Fachgebiete, Disziplinen

1. Introduction

The active participation of students in teaching and learning has so far been considered mostly from a teaching perspective as a partnership between academics in their teacher role and students in the context of innovative teaching formats (e.g. Børte, Nesje & Lillejord, 2023; Brew & Saunders, 2020). While the importance of research for student active learning is sometimes mentioned in this literature, the participation of students in research is rarely considered as a form of student active learning.

A similar gap can be observed in the literature on the teaching-research nexus (TRN), which predominantly tries to establish the importance of the nexus by either collecting students' and academics' perceptions of the TRN (Neumann, 1992; Robertson & Bond, 2001; Lindsay, Breen & Jenkins, 2002; Prosser et al., 2008) or trying to correlate teaching and research performance, which yields inconclusive evidence (e.g. Feldman, 1987; Braxton, 1996; Hattie & Marsh, 1996; Horta, Dautel & Veloso, 2012). Forms of student participation, the specific roles of students in different forms of participation or role-related contributions by students in research-related teaching formats have not yet found attention.

The variation of student participation in research has been shown to be partly linked to differences between disciplines but the nature of these links is not yet very clear. Case studies of single disciplines (e.g. Jenkins, 2000 and Healey, 2005, of Geography; see Tight, 2016, p. 299 for an overview of single-case studies) contribute little to the exploration of this link. The few conceptual studies (Neumann, Parry & Becher, 2002) and empirical field-comparative studies that attempted the attribution of variations in TRN practices to disciplinary differences used very coarse distinctions of discipline groups like hard vs. soft sciences or humanities vs. the sciences (Jensen, 1988; Colbeck, 1998; Griffiths, 2004; Møller Madsen & Winsløw, 2009; Leišytė, Enders & de Boer, 2009). These dichotomies, which also largely defy empirical operationalisation, cannot support a detailed inquiry of facilitating and hindering conditions for specific forms of student participation in research.

We are thus confronted with a gap in research on student active learning, which underappreciates the participation of students in research, and a gap in research on the TRN, which does not sufficiently recognise the actual roles of students in research processes and underestimates the field-specific nature of this participation. The lack of attention to student participation in research is unfortunate because this perspective can shed light on specific conditions of success for some of the formats that facilitate student active learning.

In this paper, we demonstrate how these two corresponding gaps could be closed by answering the question of how epistemic properties – i.e. properties of research practices and the knowledge of a field – shape student contributions to research and affect the extent to which they occur in different fields in certain phases of the study programme. We utilise findings from a larger study[3] and compare two epistemically highly contrasting fields: Modern German Literature and Experimental Condensed Matter Physics.

2. Theoretical approach

The "conceptual confusion" (Børte, Nesje & Lillejord, 2023, p. 601) concerning "student active learning" (ibid.) complicates the systematic differentiation of forms of student participation in teaching and research. The patterns of student contributions to research we are interested in do not fit into categorisations of how students learn or what they learn (e.g. Healey & Jenkins, 2017). For considering the TRN, it is also important to distinguish between research as a general activity of self-guided knowledge acquisition and research as the production of new contributions to the

3 The study was aimed at identifying the impact of new procedures of research evaluation on the TRN at German universities. The two fields analysed in this paper are cases from this larger research project, which includes 11 fields: Astronomy, Architectural Design, Cardiology, Cell Biology, Communication Technology, Comparative Politics, Criminal Law, Experimental Condensed Matter Physics, German Modern Literature, Theoretical Informatics, and Theoretical Philosophy.

stock of knowledge of a scientific community. Some of the patterns of student participation in research we present in this article can be understood as inquiry-based learning, an educational approach in which students learn through their involvement in entire research processes.[4] The field-specificity of these patterns is the subject of our article.

We start from a definition of student participation in research as a collaboration between university students and academics that leads to a change in the content of the academic's *research*. This definition enables a differentiation of forms of student participation according to its content and according to the different roles students and academics may take in this collaboration and thus a specification of the rather general categories that have so far been discussed in the context of "student active learning". This definition differs from that of "student active learning" because students in a passive audience role may still contribute to changes in research.

For the investigation of student participation in research and the specific contributions they make, we employ a sociology of science perspective on the (collaborative) construction of scientific knowledge. This perspective emerged in the 1980s, when the sociology of science shifted focus to analyse scientific research as a local knowledge production process in a specific context like a laboratory (Knorr-Cetina, 1981; Latour & Woolgar, 1986 [1979]). The application of this perspective to the TRN entails a comparison of students' roles as well as the conditions and processes of their involvement in knowledge production.

Making use of this perspective enables the application of two analytical tools to the investigation of student participation in research. First, we can use the literature on forms of research collaboration as a heuristic tool to search for forms of student participation. Laudel (2001) distinguishes types of collaboration according to the roles

4 In contrast, in research-oriented teaching students are familiarised with the theories, methods and questions of research without necessarily being actively involved in the research process themselves.

of collaborators, namely “collaboration involving a division of labour” (both partners make creative contributions), “service collaboration” (one partner provides routine services to the other), “transmission of know-how” (one partner provides specialist knowledge), “provision of access to research equipment” and “mutual stimulation” (partners discuss their research, which leads to new ideas for one or both of them) (Laudel, 2001, p. 768). We used this typology to identify different forms of student participation in research and to clarify each partner’s role.

Second, we can utilise the sociology of science’s tools for studying conditions of knowledge production to identify facilitating and hindering conditions for the occurrence of particular types of student participation that are produced by the scientific fields in which student participation occurs. For our field-comparative approach, we are particularly interested in epistemic conditions of action (which include affordances and constraints set by field-specific properties of research practices and knowledge). For example, the degree of codification of knowledge “… refers to the consolidation of empirical knowledge into succinct and interdependent theoretical formulations” (Zuckerman & Merton, 1972, p. 303). This includes the organisation of knowledge in unambiguously structured theories and the standardisation of a field’s language. Merton and Zuckerman hypothesised that the degree of codification affects the speed of competency acquisition (Zuckerman & Merton, 1972, p. 303). We therefore expect a high level of codification to correspond to a longer process in which students acquire the language and field-specific concepts they need to participate in research. The levels of expertise necessary for interactions with researchers have been further specified by Collins and Evans (2002), who distinguished between “no expertise”, which prevents meaningful interactions with scientists, “interactional expertise”, which enables competent conversations about the research of a field, and “contributory expertise”, which equips students to execute collaborative roles in research processes. As students proceed in their studies, they develop expertise and may transition through these stages. Consequently, the student participation in research is expected to vary over the course of their studies and depending on the research field.

3. Empirical approach

3.1 Case selection based on field properties

We compared the TRN in fields of research that are taught in university study programmes. The selection of cases for the main study was based on two epistemic properties of fields, namely the mode of obtaining empirical evidence and the degree of codification of knowledge. We expected the mode of obtaining empirical evidence to affect what is taught in study programmes, some of the teaching formats (e.g. practical laboratory courses), and opportunities for students to contribute to research. As outlined in the description of our theoretical approach, we followed Merton and Zuckerman in their assumption that the degree of codification of knowledge affects the time students require to acquire interactive expertise or contributory expertise, which again affects their opportunities to participate in research.

To select fields, we coded abstracts of currently funded projects in the database of the German Research Foundation. We categorised fields based on their approach to obtaining empirical evidence in fields not using empirical evidence, experimental research, observation-based research, and research involving the creation of objects to experiment with or to observe. For the codification of knowledge, we approximated the prevalence of technical terms, chemical or mathematical formulae, or recurring abbreviations.

We present here findings for Experimental Condensed Matter Physics (ECMP) and Modern German Literature (MGL). The two fields differ in both dimensions applied to the case selection. ECMP explores properties of solids and liquids through experimental techniques, which are used to investigate physical phenomena at the atomic and subatomic levels, such as electronic behaviour, magnetic properties, and structural characteristics. Its knowledge is highly codified. MGL analyses German literature from the Baroque era to the present with a focus on genres, themes, influential authors, and literary movements. Its research methods are centred on close reading and interpretation of literature in the light of cultural and social contexts at the time of writing.

To support this research, MGL scholars produce critical editions of literary works based on archival work, the analysis of versions of texts, research on the genesis of texts and on their historical contextualisation. All these methods are observational. The degree of codification of MGL's knowledge is low.

3.2 Methods

We conducted semi-structured interviews with eight professors at German universities in each field. To gather insights into the field's epistemic properties and research practices, we elicited extensive descriptions of research practices including research aims, methods, collaboration, source of project ideas and the epistemic risks involved in their research. Teaching-related questions focused on course content, structure, teaching formats, and the interviewee's freedom to design courses and structures according to their research interests. Questions on the TRN centred on practices of integrating research findings into teaching, the teaching's impact on research, and student involvement in research processes. We only analysed reported actions and conditions of action and excluded attitudes towards the TRN. Interviewee's suggestions for improvement of the TRN were included insofar they reflected on the effectiveness or efficiency of current practices. To prepare the interviews, we made ourselves familiar with the professors' research. Interviews were conducted face-to-face and lasted between 60 and 90 minutes. They were recorded and fully transcribed. We used extractive qualitative content analysis (Gläser & Laudel, 2010) to systematically extract data relevant to the research question from interview transcripts. We organized the data by content of practices (research, teaching and integration of the two) and time (relative to the course of study), and comparatively analysed them across professors within fields and across fields (ECMP and MGL). The analysis focussed on mechanisms of integrating teaching and research and the conditions under which they occurred.

4. Results

In our comparative analysis of the interviews, we identified five distinct mechanisms of student participation in research and compared the situations in which they occurred. In this section, we identify five generic mechanisms of student participation in research (4.1), the prevalence of these mechanisms (4.2), and epistemic conditions facilitating or hindering their operation (4.3)

4.1 Mechanisms of student participation in research

Stimulation of research through teacher engagement

This mechanism resembles Laudel's collaboration type "mutual stimulation" but it is only the academic who has new ideas and these ideas are purely the result of the academic's work. Although it seems counterintuitive to identify this mechanism as student participation, students are necessary in this collaboration because they execute the role of an audience to which the knowledge is presented and for which the knowledge is selected and structured. According to our interviewees, preparing knowledge for presentation to students may lead to new ideas for research. Researchers sometimes develop courses on a subject to deepen their own understanding of the fundamentals of a particular area of research by systematically reviewing them in class. This is particularly helpful when they want to change the topic of their research. In some interviews, hoped-for benefits from presenting such stimulation of research were mentioned as a motivation for offering new courses. This mechanism represents students' participation in research in the most passive role because they must take the audience role but do not actively intervene in the presentation of knowledge.

Stimulation of research through student inputs

This mechanism can also be considered a specific case of mutual stimulation even though it operates purely one way. It represents the canonical example in popular discussions of the benefits of teaching for research (the "naïve" questions by students as triggers of ideas). It changes research by channelling ideas from teaching to research. Students' questions and comments can trigger ideas, can contain ideas themselves, or can point to previously unexplored literature. Again, the benefits of students stimulating research in this manner can occasionally serve as motivation for academics to offer specific courses.

Service collaboration

This mechanism involves collaboration between students and researchers in research processes, where students carry out tasks like literature searches, data cleaning, conducting measurements or analysing data. Outsourcing these non-creative tasks to students saves academics' time. In addition to internships and thesis work, German universities have institutionalised the position of paid student assistants. These assistants typically work up to 20 hours per week, primarily engaging in service collaborations within a research project.

Fusion of teaching and research

The fusion of teaching and research occurs when students conduct actual research in teaching formats, i.e. contribute creative work to produce new scientific knowledge in educational settings. Not all this new knowledge meets the stringent standards of relevance and rigor to merit publication. Instances of this mechanism include research discussed in teaching or research seminars that refine academics' arguments which they later use in publications, and students' thesis projects which might lead to publications.

Recruitment

In contrast to the mechanisms described above, recruitment operates at a different level, as it precedes other forms of student participation that directly impact content. Academics use teaching and learning to recruit students for roles in service collaboration and fusion mechanisms. In addition to recruitment as student assistants or through offering topics for bachelors' or masters' theses, academics also recruit students for subsequent PhD positions. Since the success of research projects in some fields partly depends on the quality of students' contributions, academics usually compete for the best students to recruit.

4.2 Prevalence of mechanisms in the two fields

We will now present the field-specific patterns for two fields studied for each of the five identified participation mechanisms (see Fig. 1).

Stimulation of research through teacher engagement

In ECMP, academics sometimes chose to take over specific basic courses to familiarise themselves with the foundations of a topic they want to work on or develop new courses to obtain an overview of new developments in a field. In the context of this engagement with topics, academics learned and, in some cases, began to question basics of their field. Courses for master students were always based on the specialisations of the researchers.

In MGL, almost all interviewees reported to use teaching formats synergistically to develop partial aspects of their topics, to refresh knowledge on literary works, to catch up on readings, to deal with authors unknown to them, to familiarise themselves with new research approaches, and to practice to independently position themselves. It is common for academics to make their own research the topic of compulsory courses.

Stimulation of research through student inputs

Stimulation of research through student inputs is not very common in ECMP and begins rather late, namely at the end of the bachelor's programme.

In MGL, seminar discussions that include critical questions or hints at specific, not yet discussed aspects of literary works, begin early on, and occur more frequently. Term papers and final theses also contain such inputs and may point academics to literature they had not yet seen. All interviewees reported beneficial situations of this kind, even relatively early in the study programme.

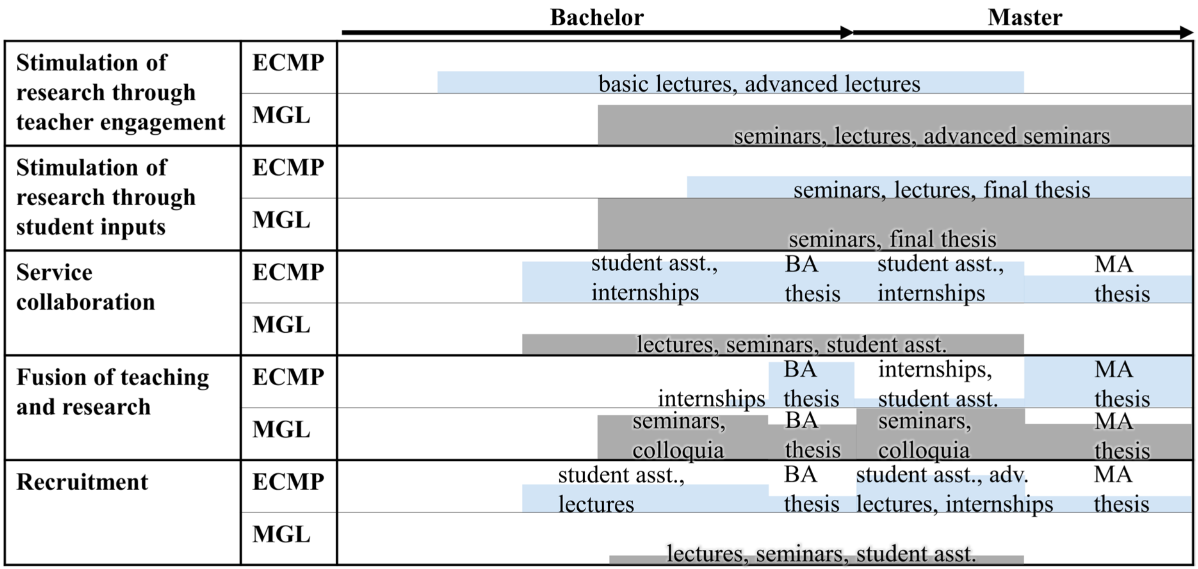

Fig. 1: Student participation patterns in Experimental Condensed Matter Physics and Modern German Literature, structured by time of occurrence in the study programme and teaching format; the width of bars represents the number of professors who have mentioned the mechanism.

Service collaboration

In ECMP, service collaborations typically start after the first year as internships or student assistantships in a research group. Students usually contribute to the building of experimental apparatus, sample preparation and (recurring) measurements, i.e. by executing tasks that do not require theoretical knowledge. Most of the bachelor's theses are also service collaborations. Topics can be assigned again to another student if a student does not meet the standards required for an input into research. Work for the master thesis can be either an extended and more demanding service collaboration or genuine research, in which case it is an instance of fusion (see below).

Service collaborations rarely occur in MGL. Few professors have student assistants at all. Tasks of students mainly consist of literature searches or the transcription of very simple manuscripts in support of editing work. In very rare instances, seminars were used for service collaborations of students, e.g. when seminar participants helped preparing an exhibition.

Fusion of teaching and research

In ECMP, genuine research in teaching formats begins to occur at the end of the bachelor programme with the bachelor's thesis in research groups. From then on, student participation in academics' research processes increasingly turns into fusion, i.e. students make creative contributions by developing measurement procedures, writing analysis software, or analysing data. Bachelor's and master's theses are defended in a research colloquium. A student's work is part of the experimental work of the research group and may include creative contributions that lead to a publication co-authored by the student.

In MGL, much of the fusion happens within seminar discussions. This teaching format is similar to academic discussions in the humanities where researchers' interpretations are discursively tested for validity and developed further. A second instance of fusion are final theses, where students develop own interpretations and views on a specific topic that does not necessarily overlap with the teacher's own research focus. Theses may turn into a contribution to the research of the field that in some cases is worth publishing.

Recruitment

In ECMP, recruitment is a longer process of selecting students for work in the research group. It begins with observing students' performance and interests in undergraduate teaching. Promising students are offered student assistant positions. If their work confirms the first impression, they are often offered topics for bachelor's theses. Good bachelor's degree students are also invited for the master's thesis. These observations continue throughout the study programme, and new 'recruits' are also found in master's courses. In some cases, the process leads to the offer of a PhD position.

MGL has no such sequential recruitment process. Professors are almost exclusively looking for a few student assistants. Generally, the hurdles to getting students interested in academics' research topics are high. As there are only few designated doctoral positions, there is at most a recommendation to do a doctorate somewhere, but no position can be offered to promising students.

4.3 Field-specific conditions facilitating or hindering student participation

The analysis of conditions under which mechanisms of student participation occurred led to the confirmation of the hypothesised impact of the degree of codification of knowledge and of the mode of obtaining empirical evidence. It also returned several additional epistemic properties of fields that affect the frequency and timing of the occurrence of mechanisms. In ECMP, the high degree of codification of knowledge and the experimental approach to obtaining evidence make it possible to disaggregate research processes into steps of variable size that can be carried out by different researchers (the decomposability of research processes is high). Therefore, it is relatively easy for academics to carve out tasks for students that fit both the time they can spend on participating in research and their level of expertise. This opportunity supports both service collaborations and the fusion of teaching and research. These mechanisms occur earlier and more frequently in ECMP than in MGL, which is in turn linked to recruitment for research contributions being much more common in ECMP than in MGL.

The impact of ECMP's high degree of codification of knowledge is ambivalent. On the one hand, the high degree of codification makes some basic theories directly relevant to current research, which is why stimulation of research through teacher engagement may occur quite early, although the prescribed canon of introductory courses leaves little room for adding or replacing courses. On the other hand, students need more time to acquire interactional and contributory expertise and thus are able to stimulate research with their inputs only later in their studies and generally less often than their fellow students in MGL.

This role of epistemic properties is confirmed by the patterns of student participation in MGL, a discipline characterised by a low degree of codification of knowledge, observations as mode of obtaining empirical evidence, and a strong role of personal perspectives in the definition of research problems and in decisions on what counts as empirical evidence. Owing to these properties, research projects in MGL have a low degree of decomposability and are individual rather than group efforts. Research is highly personalised, and few collaborations occur. At the same time, the presentation and discussion of arguments is an important part of the research process.

Under these conditions, the stimulation of research through student inputs can occur earlier because they can acquire interactive and contributory expertise earlier in their studies. Furthermore, the fusion of teaching and research also occurs in seminar discussions where interpretations of literature are presented and discussed. However, the low decomposability of research processes prevents students from being more involved in their teachers' research, especially through service collaborations. Like their professors, students who conduct their own research processes, for example in master's theses, do so independently from others, including from their teachers. The low degree of codification also gives academics in MGL more opportunities to add or replace courses early in the bachelor's programme, which enhances the opportunities for the stimulation of research through teacher engagement.

5. Discussion

We identified several generic mechanisms of student participation in research, the specific forms in which they occur in different disciplines and reasons why prevalence and time of their occurrence are field-specific. Our preliminary results are in accordance with previous observations of field-specific links between research and teaching (e.g. Colbeck, 1998; Møller Madsen & Winsløw, 2009) and, for the first time, provide partial explanations of such differences by linking them to empirically identified epistemic differences between fields of research. We confirmed the hypothesis about the impact of the degree of codification of knowledge formulated by Zuckerman and Merton (1972, p. 303) and our own assumption about the influence of the mode of access to empirical evidence on student participation in research. Our open qualitative approach also let us discover additional epistemic properties that make a difference.

Students participate in a broad range of research practices across the whole research process from taking part in the generation of new ideas up to empirical and publication work. It is also noteworthy that students can participate in research activities at a very early stage of their studies and thus influence them. This early start can also be seen as a long-term socialisation process for the later career of a researcher (Thiry & Laursen, 2011; Feldman, Divoll & Rogan-Klyve, 2013).

The material presented here is limited and supports the shape of our argument rather than a causal account which includes non-epistemic factors. For example, we had to omit the role of institutional conditions, which play an important role in facilitating or promoting student participation (e.g. Leišytė, Enders & de Boer, 2009).

A limitation of the study from which our empirical data are drawn is its empirical focus on interviews with university professors (because these have the highest teaching load). Research and teaching associates may practice the integration of teaching and research differently and may therefore experience different impacts of student participation on their research.

6. Conclusions

Despite the limited scope of our empirical study as presented here, we would like to suggest three tentative conclusions. First, in fields with decomposable research processes students can collaborate with their teachers in the latter's research, which makes the research to some extent dependent on teaching (e.g. as a basis for recruitment). Second, the epistemic properties of fields (the properties of a field's research practices and knowledge) have a strong influence on forms, time, and prevalence of student participation in research. Finally, the observation of a strong dependence of student participation in research on properties of fields suggests that it might be useful to consider the influence of these properties on other forms of student active learning because properties of the knowledge that is taught are likely to affect all situations in which that knowledge is taught and learned.

7. References

Børte, K., Nesje, K., & Lillejord, S. (2023). Barriers to student active learning in higher education. *Teaching in Higher Education, 28*(3), 597–615.

Braxton, J. M. (1996). Contrasting perspectives on the relationship between teaching and research. *New Directions for Institutional Research, 1996*(90), 5–14.

Brew, A., & Saunders, C. (2020). Making sense of research-based learning in teacher education. *Teaching and Teacher Education, 87*, 1–11.

Colbeck, C. L. (1998). Merging in a seamless blend – How faculty integrate teaching and research. *Journal of Higher Education, 69*(6), 647–671.

Collins, H. M., & Evans, R. (2002). The Third Wave of Science Studies: Studies of Expertise and Experience. *Social Studies of Science, 32*(2), 235–296.

Feldman, A., Divoll, K. A., & Rogan-Klyve, A. (2013). Becoming Researchers: The Participation of Undergraduate and Graduate Students in Scientific Research Groups. *Science Education, 97*(2), 218–243.

Feldman, K. (1987). Research productivity and scholarly accomplishment of college teachers as related to their instructional effectiveness: A review and exploration. *Research in Higher Education, 26*(3), 227–298.

Gläser, J., & Laudel, G. (2010). *Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen* (4. Edition). VS Verlag.

Griffiths, R. (2004). Knowledge production and the research-teaching nexus: The case of the built environment disciplines. *Studies in Higher Education, 29*(6), 709–726.

Hattie, J., & Marsh, H. W. (1996). The relationship between research and teaching: A meta-analysis. *Review of Educational Research, 66*(4), 507–542.

Healey, M. (2005). Linking research and teaching to benefit student learning. *Journal of Geography in Higher Education, 29*(2), 183–201.

Healey, M., & Jenkins, A. (2017). The role of academic developers in embedding high-impact undergraduate research and inquiry in mainstream higher education: twenty years' reflection. *International Journal for Academic Development, 23*(1), 52–64.

Horta, H., Dautel, V., & Veloso, F. M. (2012). An output perspective on the teaching-research nexus: An analysis focusing on the United States higher education system. *Studies in Higher Education, 37*(2), 171–187.

Jenkins, A. (2000). The relationship between teaching and research: Where does geography stand and deliver? *Journal of Geography in Higher Education, 24*(3), 325–351.

Jensen, J. J. (1988). Research and teaching in the universities of Denmark: Does such an interplay really exist? *Higher Education, 17*(1), 17–26.

Knorr-Cetina, K. (1981). The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science. Elsevier Science & Technology Books.

Latour, B., & Woolgar, S. (1986). *Laboratory Life: The Construction of Scientific Facts*. Princeton University Press.

Laudel, G. (2001). Collaboration, creativity and rewards: Why and how scientists collaborate. *International Journal of Technology Management, 22*(7/8), 762–781.

Leišytė, L., Enders, J., & de Boer, H. (2009). The balance between teaching and research in Dutch and English universities in the context of university governance reforms. *Higher Education, 58*(5), 619–635.

Lindsay, R., Breen, R., & Jenkins, A. (2002). Academic research and teaching quality: The views of undergraduate and postgraduate students. *Studies in Higher Education, 27*(3), 309–327.

Møller Madsen, L. M., & Winsløw, C. (2009). Relations between Teaching and Research in Physical Geography and Mathematics at Reseach-Intensive Universities. *International Journal of Science and Mathematics Education, 7*(4), 741–763.

Neumann, R. (1992). Perceptions of the teaching-research nexus: A framework for analysis. *Higher Education, 23*(2), 159–171.

Neumann, R., Parry, S., & Becher, T. (2002). Teaching and Learning in their Disciplinary Contexts: A conceptual analysis. *Studies in Higher Education, 27*(4), 405–417.

Prosser, M., Martin, E., Trigwell, K., Ramsden, P., & Middleton, H. (2008). University academics' experience of research and its relationship to their experience of teaching. *Instructional Science, 36*(1), 3–16.

Robertson, J., & Bond, C. H. (2001). Experiences of the Relation between Teaching and Research: What do academics value? *Higher Education Research & Development, 20*(1), 5–19.

Thiry, H., & Laursen, S. L. (2011). The Role of Student-Advisor Interactions in Apprenticing Undergraduate Researchers into a Scientific Community of Practice. *Journal of Science Education and Technology, 20*(6), 771–784.

Tight, M. (2016). Examining the research/teaching nexus. *European Journal of Higher Education, 6*(4), 293–311.

Zuckerman, H., & Merton, R. K. (1972). Age, aging, and age structure in science. In M. White Riley, M. Johnson & A. Foner (Eds.), *A theory of age stratification* (Vol. 3, 292–356). Russell Sage Foundation.