The relationship between research and education: typologies and indicators

A literature review

Mari Elken and Sabine Wollscheid

Report 2016:8

NIFU

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Preface

The relationship between research and education has been a subject for debate in higher education research, with ambiguous and sometimes contradictory empirical results. The report presents some of the key arguments in existing studies by exploring various types of linkages between education and research.

NOKUT and the Research Council of Norway are collaborating to develop an evaluation model ("Integrated Academic Evaluations") for academic research, education, and the interplay between the two in Norwegian higher education. The literature review conducted has been the basis for suggesting possible indicators for carrying out such an evaluation.

The report is funded by NOKUT and has been conducted at NIFU. The project team consists of Mari Elken (project leader) and Sabine Wollscheid who have written the report, and Svein Kyvik who has acted as a key expert in the project team. Bjørn Stensaker and Per Olaf Aamodt have been closely involved as resource persons for the project – both for the literature review and in the process of developing indicators.

Oslo, 15.04.2016

Sveinung Skule
Director of NIFU

Nicoline Frølich
Head of Research

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Summary

This report examines international state-of-the-art literature on the relationship between research and education. NOKUT and the Research Council of Norway are collaborating to develop an evaluation model ("Integrated Academic Evaluations") for academic research, education, and the interplay between the two in Norwegian higher education. To inform this work by international state-of the-art research, NOKUT has commissioned a literature review about the relationship between research and education, and the development of a set of indicators that could be used for this purpose.

The review uncovered that literature in this area is inconclusive. The positive relationship between research and education in the tradition of Humboldt is supported by academic staff, but also taken for granted. At the same time, multiple studies show no relationship. However, the literature broadly does suggest that engaging students in student-active learning forms has positive effects on student learning outcomes.

Overall, the evidence reveals a highly complex and multidimensional picture on the research-education relationship at different levels such as national, organisational/institutional, curriculum and individual. This complexity and multidimensionality and the lack of unambiguous definitions of the two core terms, research and education, make it challenging to define a clear set of measurable indicators to measure the impact of the research-education relationship on study quality. We thus argue that it is important to distinguish between and combine three types of indicators, i.e., input, process and output indicators, highlighting the importance of student-active learning forms.

Typologies to systematize links

In general, the literature review shows that the research-education link can take various forms and directions, and might vary according to disciplines and program levels. Typologies identified in the literature show that these links can be analysed from various perspectives and with different units of analysis. One possibility is to distinguish between a *research-teaching* link with staff as unit of analyses and a *research-learning* link with students as unit of analysis. The most prominent model for this was developed by Healey, distinguishing between focus on students vs staff, and focus on content vs process.

The research-teaching relationship: contradictory evidence

For the research-teaching link the evidence can be characterised as ambiguous. While a substantial part of the literature points to positive and synergetic links, closely related to the traditional academic ideal, other literature does not reveal any links. First, definitions of the two terms have an implication on its relationship. For example studies drawing on a wider conception of research more often find a positive or synergetic relationship between the two concepts. Second, both direction and strength of

the research-teaching link appear to be associated with a number of context factors at different levels, such as discipline, the degree of academic orientation of the program and student sub-population under study. While one should be cautious to transfer results from one context to another, there are indications that higher involvement in research is positively associated with their likelihood of using research in teaching activities as well.

The research-learning relationship: student-active learning forms

This set of literature builds on the notion of inquiry-based learning, and the term undergraduate research has gained world-wide attention. However, there are multiple practices related to it – in terms of organisation, participation and methods. This includes students' involvement in faculty research and/or conducting own empirical research, but can also take other forms, such as doing literature reviews or presenting such research in symposia. There seem to be distinct national, institutional and disciplinary variations of these practices. While the evidence is also not conclusive, most of the literature indicates that experiences with research have a positive effect on student learning outcomes. Engaging in processes of inquiry is productive for developing critical thinking and understanding of research. As there are also likely substantial disciplinary differences on the definition of research, we emphasize the notion of inquiry in our development of indicators as a means to represent this way of activating students.

Research-based curriculum

While curriculum in itself would not fully determine what will take place in a classroom (i.e. notions of hidden curriculum), it provides an important frame for how one conceptualises the primary processes, and the sequence and coherence of various elements in the programme. Thus, curriculum itself should also be based on research-based knowledge. While student active learning forms are considered beneficiary, a research-based approach to curriculum would emphasize that one needs to employ various approaches to teaching and learning processes.

Contextually embedded nature of the research-education linkage

The literature shows rather consistently that disciplinary differences matter, for the ways in which teaching and research are defined, and how the link has been conceptualised in various studies. We have not identified studies that explicitly include multiple levels of education and systematically compare the *effects* of research-based education on student outcomes on various levels. However, it is rather obvious that the level of education is an important element. While most of the literature we have identified in the research-learning section focuses on undergraduate education, existing literature shows that in general this relationship is strongest at the PhD level and weakest at the bachelor level.

While many studies indicate positive views from staff regarding the positive relationship, a number of authors highlight that current national and organisational frameworks can in fact push towards the somewhat normative stance that education and research *should be* linked closer together. The rationale can be found in the uneven emphasis on teaching and research, due to resource constraints, status and time allocation. Higher education institutions have multiple tasks and engage with the society in various ways and the independence or interdependence of the main functions of universities has been an enduring debate in modern universities. As higher education institutions evolve, their increased complexity has also led them to have several layers of organization where the patterns for organising education and research might differ from each other.

Furthermore, recent changes in the higher education landscape can alter the underlying premises for whether and under what conditions such a link exists. Internationally, there is both a trend towards higher concentration of research (for instance, the spread of research excellence initiatives), and withering out of institutional categories (i.e. abolishing earlier binary structures). This can mean both concentration of research activities, or in fact widening them to new institutions and actors. National and international policies can facilitate the enhancement of such a link, or alternatively emphasize the

tensions. There are important cultural factors that frame how the link plays out. One can argue that such systemic aspects can be at least as important as disciplinary differences.

Indicators to examine the link between education and research

Drawing on the literature review, we argue that indicators to measure the research-education relationships and its quality on higher education in Norway should be seen as "quasi-indicators" rather than full-scale performance indicators, due to the ambiguous nature of the link. Such indicators should use multiple sources of data, and employ both qualitative and quantitative measures. We have proposed three sets of indicators: input, process and output indicators. We argue that this distinction is important, as indicators that give information about the framework conditions would not necessarily be good indicators for the educational process.

Input indicators concern the framework conditions for educational practices. We have identified three input indicators: organizational conditions; academic staff R&D orientation; and curriculum research integration. *Process indicators* focus on educational processes. In general, quality of educational process has been notoriously difficult to measure in indicators, leading to various proxy measures being used in rankings (i.e. student-staff ratios etc). We emphasize three process indicators: the use of student-active learning forms, variation of teaching and learning methods, and involvement in staff research. *Output indicators* refer to assessment.

An important consideration here is that a number of these indicators allow for comparisons within the disciplinary fields, but comparisons across fields by the use of single indicators (in particular indicators about research orientation and research productivity) should be conducted with caution, having in mind that academic work varies substantially across fields.

1 Introduction

1.1 The purpose of this report

NOKUT and the Research Council of Norway are collaborating to develop an evaluation model ("Integrated Academic Evaluations") for academic research, education, and the interplay between the two in Norwegian higher education. As a supplement to this process, NOKUT has commissioned a literature review about the interplay between research and education. To examine these issues, NOKUT outlined three main questions:

1. How can one examine the effects the interplay between research and education has on the quality of education, and students' learning outcomes? What methods and data can one use to examine the interplay between research and education? For the last question, a typology of different types of interplay between research and education will be useful.

2. Are there disciplinary differences? Are there disciplines or subjects where a productive interplay of research and teaching is harder to achieve and/or less likely to have a positive effect on the quality of education and research?

3. Even though it is most common to think that research affects education, we also want to map how different aspects of education can affect the quality or content of research. In other words, what interactions between education and research can potentially benefit research?

The aim of the review is to provide possible indicators for studying the interplay between research and education.

1.2 Methods

The study has been conducted in two stages. First, a literature review was conducted, inspired by systematic review methods. Second, the report suggests a set of indicators.

1.2.1 Literature review

Inspired by methods applied in systematic reviews, the process underlying the literature review at hand consisted of several pre-defined steps. This includes the definition of a search strategy, the process of screening and selecting relevant studies, and the process of synthesizing the studies that were included.

Search strategy

The process of defining an appropriate search strategy for this literature review was inspired by a systematic review approach[1], and consisted of several steps, rather iterative than linear. Our point of departure for the literature search were existing newer review studies on the broader field, including their reference lists (see, for instance, Kyvik & Vågan, 2014; Trowler & Wareham, 2007). Additionally, we conducted a scoping search in single databases (e.g., Google Scholar) to identify existing (systematic) literature reviews and core publications on the topic.

Informed by our findings from the scoping search, we further defined inclusion and exclusion criteria, and key search terms for two databases, Google Scholar and ERIC, in assistance with our research librarian at NIFU[2]. Taking the references retrieved by searches in Google Scholar as a point of departure, we applied a snowball method, by screening reference lists (e.g. a bibliography on the topic by Healey, 2015) of reviews (e.g. Trowler & Wareham, 2007) to identify relevant primary studies for further analyses. In addition, we applied an electronic search in a sample of highly relevant journals, such as Higher Education, Studies in Higher Education and Teaching in Higher Education. To reduce selection bias and to include grey literature as research reports, we also conducted a search on websites of relevant institutions such as the Higher Education Academy.

Given limitations in time and resources as well as the broad scope of our research questions, we have thus combined a systematic literature search in Google Scholar with selected literature from a sample of journals and websites of relevant institutions, and literature found in reference lists of core publications (snowball method).

Screening and selection of relevant studies

To identify and select relevant literature for further analyses, we first screened titles and abstracts of approximately 200 references obtained from the broad literature search to get an overview over the literature if they were matching the following inclusion criteria:

- source of publication: research report or published in peer-reviewed journal;
- published after 2000 (review studies after 2005);
- either analytical or empirical study on the research-teaching link;
- deal with research-teaching link on bachelor and/or master level.

If eligible, we retrieved full-text articles, which were included for further analyses if they matched one of the following criteria: focus on different aspects of the research-teaching link according to specification, direction, strength, measurement of strength; address quality impacts of the link and/or identify indicators of links.

After selecting relevant studies based on these criteria, snowballing method and searches in selected journals provided additional literature for further analysis. Core publications (mainly review articles) were read by two researchers, while single studies were read by one researcher. To address the research questions leading our review, we narratively synthesized a sample of both existing literature reviews and primary studies (qualitative and quantitative) based on the principle of 'conceptual saturation' (Thomas & Harden, 2008).

One should not view this review as comprehensive and covering all possible sources that have discussed the relationship between research and education. However, we believe that the selected

1 In general, a systematic literature review is a method that comprehensively retrieves, appraises and synthesizes the literature on a previously defined research question (Petticrew & Roberts, 2006).

2The literature search resulted in approximately 2,200 hits in ERIC and 135 hits in Google Scholar. The search in ERIC did result in very few potentially relevant hits; on the other side, the search in Google Scholar, which was more specific, lead to fewer hits in total, but more relevant references.

literature has been sufficient to highlight both the key trends as well as complexities presented in existing research.

1.2.2 Development of indicators

The indicators were developed in collaboration by the research team and the resource group. The literature review provided a starting point. However, a large amount of existing literature on the topic comes from countries such as USA, UK and Australia. Having in mind that there are some substantial differences between these systems and the Norwegian higher education system, we have critically discussed the main conclusions of the review *vis à vis* the Norwegian system in the process of developing indicators. Important elements here include: basic system structure (i.e. whether all or some higher education institutions conduct research); governance of the higher education system (who decides regarding particular issues); degree structure (what bachelor and master degrees across various fields of studies are expected to contain); level of standardisation (uniformity of requirements); and broader aspects related to academic culture in the country.

After considering the review results against these considerations, a set of preliminary indicators was developed by the research team. This preliminary set was then discussed with the resource group. In the second round, the indicators were refined and condensed. A draft version was sent to NOKUT for comments and clarifications. Finally, the report also went through internal quality assessment procedures at NIFU.

1.3 Organisation of report

This introductory chapter has provided information about the review and the methods employed. In chapter 2, we present the literature review. The chapter starts with outlining the main concepts in this review – research and education. After this, various typologies are presented, followed by two review sections that examine the link between research and education from the view of a) academic staff and b) students. These review sections take a starting point in these typologies and examine how the link has been studied empirically in research literature; and whether, and under what conditions, positive effects of student learning or research have been identified. In addition, the chapter includes reflections on issues related to curriculum, organisational aspects, as well as a section examining the role of different levels of education. We follow this with some reflections regarding the Norwegian context. The chapter concludes with summarising some good practice examples of a productive link between research and education that have emerged from the literature.

Chapter 3 presents the indicators developed in this study. We first present some dimensions and indicators that have previously been used in Norway. After a discussion of these in light of the empirical articles examined in this report, we present the rationale for the proposed indicators, as well as some possible sources for measurement. In Chapter 4, we summarise the main conclusions in light of the research questions that were proposed in section 1.1.

2 Research and education: typologies and links

"The coupling of research with teaching and learning is a basic feature of modern higher education" (Clark, 1993, p. xv)

Despite research and education being widely considered as the primary processes of modern higher education, the link[3] between research and education in higher education has been subject to an ongoing and controversial debate on the nature of the relationship according to program level, discipline, its strength and directions (e.g. Hattie & Marsh, 1996; Kyvik & Vågan, 2014; Palmer, Hunt, Neal, & Wuetherick, 2015; Trowler & Wareham, 2007; uz Zaman, 2004; Zubrick, Reid, & Rossiter, 2001). There is a strand of literature on the research and education relationship which views the two as interlinked or symbiotic (Brew, 1999, 2013; Brew & Jewell, 2012; Halliwell, 2008). Others would instead view the research-education links as conditional, dependent on the subject area and organizational context (Barnett, 2005), or level of education (Kyvik & Aamodt, 2015; Kyvik & Vågan, 2014; Thune et al., 2012). Yet others would argue that the overall evidence based on correlational studies suggests that the relationship between research and teaching is rather weak, ranging from no or zero relationship (Hattie & Marsh, 1996) to a modest positive relationship at undergraduate and graduate level (Kyvik & Aamodt, 2015; uz Zaman, 2004).

Overall, the relationship between research and education in higher education appears to be dependent on a variety of factors including program level, discipline and the underlying definitions used (i.e. broad vs. narrow conception of research). To further understand the mechanisms underlying the relationship between research and education, we will first start with a definition of the two core terms used in the literature. We then discuss various typologies for the links between research and education. After this, we focus on how the identified types of links have been studied empirically, and under which conditions a positive link has been identified. We have also identified some good practice examples in the literature. Then, we focus on the various aspects that can have an effect on how this link plays out: level of education, curriculum and organisational framework. The chapter concludes with a reflection regarding the Norwegian context, discussing relevant recent trends in Norwegian higher education.

[3] We use the terms relationship, relation and link interchangeable throughout the text. We use the terms nexus, mechanism and interplay, which are suggesting an existing relationship, when referring to a particular study using these terms.

2.1 The notions of research and education

The relationship between research and education is highly dependent on the *definitions* of research and education (Healey, 2005b). These are terms that are broadly used, but with quite different meanings dependent on the context where they are used.

2.1.1 Research

The term of research is generally ambiguous regarding how it is used in the scholarly literature, in policy documents and in everyday life. The OECD definition, which is used for producing R&D statistics, distinguishes between basic and applied research and experimental development (OECD, 2002). The latter category includes activities that are considered separate from research, that are obviously strongly related to applied research.

Research is commonly used not only as a denominator for basic research, applied research, and experimental development (R&D), but further for a variety of other activities performed by academics like scholarly thinking and scholarly writing, curriculum development, consulting etc. The definition of the OECD for example has proven to be too narrow to capture the entire spectrum of knowledge production taking place in practical oriented subjects and programs (Brew, 2006). Further, the notion of the term research differs between different countries and languages. The English term "research" has for example a broader meaning than the Norwegian term "*forskning",* even though the latter is used for a wider range of activities than the more narrow term "science" (Kyvik & Vågan, 2014).

Furthermore, a distinction has been made between "Mode 1 research" and "Mode 2 research" (e.g. Gibbons et al., 1994). Mode 1 research is defined as "unfettered pursuit of knowledge […] [with] no apparent commercial effect" (Huff & Huff, 2001, p. 51), more narrowly understood as science or basic research, while Mode 2 research is defined as "goal and activity centered" (Huff & Huff, 2001, p. 51) and "carried out in a context of application" (Gibbons et al., 1994, p. 3) with emphasis on solutions in different practice contexts (Prøitz, 2015, p. 13).

The disciplinary differences of research are well established in existing literature, being labelled as different "tribes" and "territories" in the book by Becher and Trowler (2001), that builds on Biglan's (1973) classification of disciplines as hard/soft and pure/applied[4]. Furthermore, within a single disciplinary category, it is also possible to find various orientations to research. For instance, a study by Visser-Wijnveen, Van Driel, Van der Rijst, Verloop, and Visser (2009) showed that there are important individual variations in how academic staff conceptualise knowledge and research as activities. Kyvik (2015) presented results from a survey to permanent academic staff at Norwegian universities in 2008, and found that 68 percent of the staff in the humanities characterized their research as mainly basic, while 14 percent defined it as mainly applied (Gulbrandsen & Kyvik, 2010; Kyvik, 2015).Recent research has also suggested that the conceptions of research can vary according to research productivity (Brew, Boud, Namgung, Lucas, & Crawford, 2015).

In the following, we thus employ a broader definition of research for several reasons. First, adopting a broad perspective is advocated in existing research, as this enables more teachers and students to see the connection between research and education (e.g. M. J. Prince & Felder, 2006). Second, disciplines vary in their definition of research ranging from a more narrow understanding in hard and pure disciplines to a wider definition in soft and applied disciplines (Becher & Trowler, 2001). Third, as highlighted earlier, academic staff have different conceptions of research. For instance, many teachers in professional programs use a wide definition themselves (Kyvik & Vågan, 2014).

[4] Biglan originally also had the life-nonlife dimension, but the pure/hard and soft/applied distinction has been used more widely in literature about higher education and academic work.

2.1.2 Education

Etymologically, the verb *to educate* has its origins in the Latin word *educatus* (past participle of *educare*), in the sense of to train and to educate someone.[5] The term education is twofold and distinguishes between *teaching* with focus on the academic teacher's activity on the one hand, and *learning* with focus on the student's activity on the other hand.

Although the two activities are closely intertwined, we have chosen to use this distinction between two main dimensions as a way to organize the literature in the review. This choice is primarily based on the models of how the relationship between research, teaching and learning can be measured (see section 2.2.).

Within educational research, there is a wide array of research on conceptions like inquiry-based, problem-based and project based learning. These will be briefly discussed (see section 2.4) as one possible conceptualization of creating links between research and learning. However, it should also be noted that a more detailed pedagogical discussion of various approaches to learning and their impact on learning is out of the scope of this review.

2.2 Typologies of links between research and education

In the literature on relations between research and education, one can find a wide range of models to describe different relations or mechanisms between research, teaching and learning (e.g. Griffiths, 2004; Healey, 2005a; Jenkins, Breen, & Lindsay, 2007; Trowler & Wareham, 2007). Jenkins et al. (2007, p. 61) for example suggest that linking research and education from the perspective of students is achieved when 1) students learn how research within their disciplines leads to knowledge creation, 2) students are introduced to current research in their disciplines, 3) students learn the methods used to carry out research in their disciplines, 4) students are motivated to learn through knowledge of and direct involvement in research, 5) students carry out research, 6) students participate in research conducted by their lecturers, 7) students learn and are assessed by methods resembling research procedures in their disciplines, 8) students learn how research is organized and funded, 9) students become members of a school or department and university culture within which learning, research and scholarship are integrated, and 10) students' learning is supported by systems and structures at departmental, institutional, and national level that facilitate staff scholarship and research in the pedagogy of the disciplines as well as disciplinary scholarship and research.

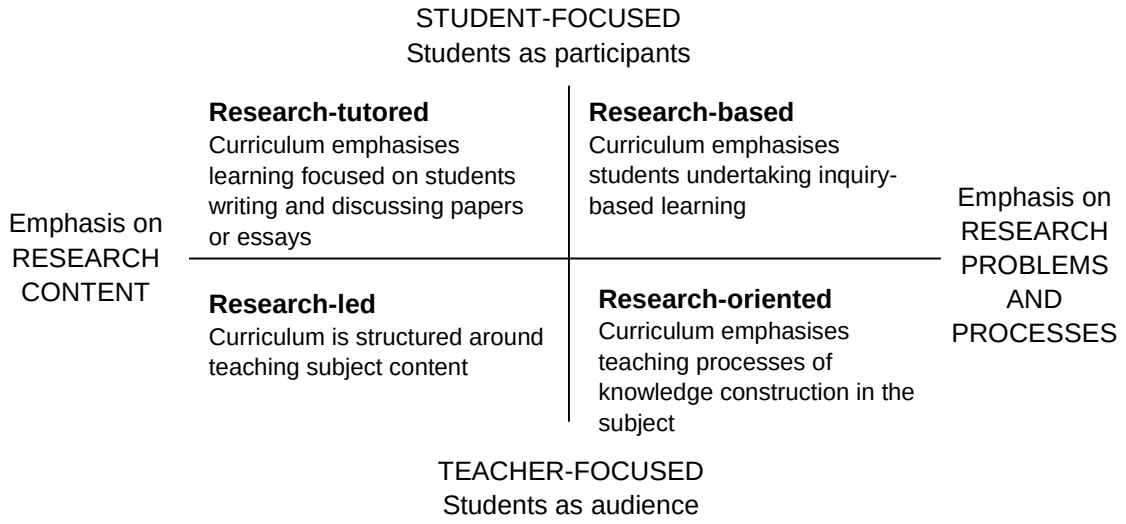
Various attempts have been made to systematize these various links. The most prominent model is that of Healey (2005a) who distinguishes between four different types of relations between research and education, and different ways of how these relations should be organized, namely *research-tutored*, *research-based*, *research-led* and *research-oriented education.* The four categorisations build on the work by Griffiths (2004). To date, the model remains highly cited in articles that deal with the relationship on research and education[6]. In our review, we have not been able to identify an alternative typology that would represent a substantial divergence from this model. At the same time, specifications of Healey's model have been provided, for instance for various ways in which students can be participants.

In the Healey model[7], these relationships can be conceptualised according to two axis. The first axis of that model distinguishes between the focus of education from being *student-focused* based on the assumption that students are active learners to being *teacher-focused* based on the assumption that students are passive recipients of learning content. The second axis distinguishes between an

[5] http://www.etymonline.com/
[6] The model was also used as a basis in the 2010 UHR report on research-based education.
[7] The model has been used in multiple publications by Healey, also in collaboration with Jenkins in their 2009 publication.

emphasis on *research content* and on research processes and problems. In his model, Healey has introduced the curriculum design as a third dimension, dependent on the combination of the core dimensions student-/teacher focus and emphasis on research process/content. Thus, Figure 1 describes the fourfold typology and the corresponding curriculum design.

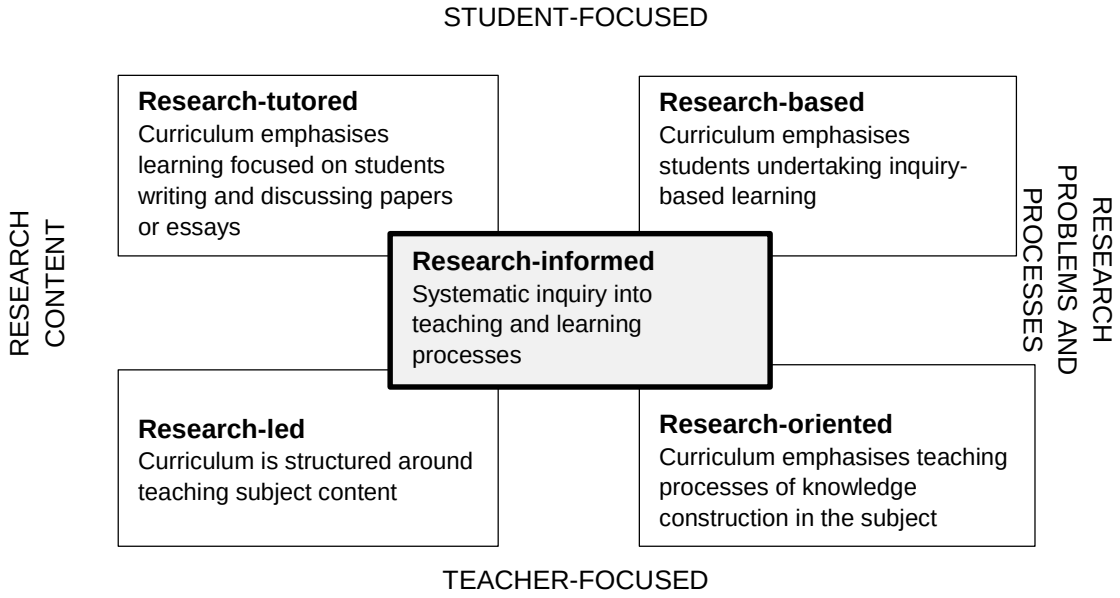
Figure 1 - Research-education relationships and curriculum design



Source: Healey (2005a, p. 70)

In her modification of the model, Ozay (2012) proposed to emphasize “research informed” as a central element of the whole model. She argues that this represents a scholarly approach to teaching processes in general and should as such be linked to all of the possible practices. In a sense, this also builds on the notion of a research-based curriculum, and an idea that teaching as academic work and organisation of studies in the form of curriculum should in essence be based on existing knowledge about learning.

Figure 2 - Modified framework for research in undergraduate learning



Source: Ozay (2012), building on Healey (2005a) and Healey and Jenkins (2009).

From a more discipline-specific perspective, D. Bennett, Wright, and Blom (2010) suggest adding the ART-nexus including arts practice to research and teaching. They also build on the model by Griffiths (2004) and Healey (2005a), arguing that it is necessary to also incorporate artistic practice to this nexus, as traditional modes of research are not adequate for artistic practice.

Visser-Wijnveen, Van Driel, Van der Rijst, Verloop, and Visser (2010) aimed at providing an empirical foundation for typologies by Griffiths (2004) and Healey (2005a) by capturing the variety of different relationships between research and teaching from the perspective of individual academics. Thirty academics at the Faculty of Humanities at Leiden University were interviewed in a semi-structured format by the means of a "mental visualisation assignment", by asking to describe "what the linkage between research and teaching would look like in the ideal situations" (Visser-Wijnveen et al., 2010, p. 199). Drawing from rich descriptions of ideal linkages, the authors revealed five profiles of the research-teaching nexus, namely

1. teach research results (research-led);
2. make research known (research-led);
3. show what it means to be a researcher (research-oriented);
4. help to conduct research (research-based);
5. provide research experience (research-based).

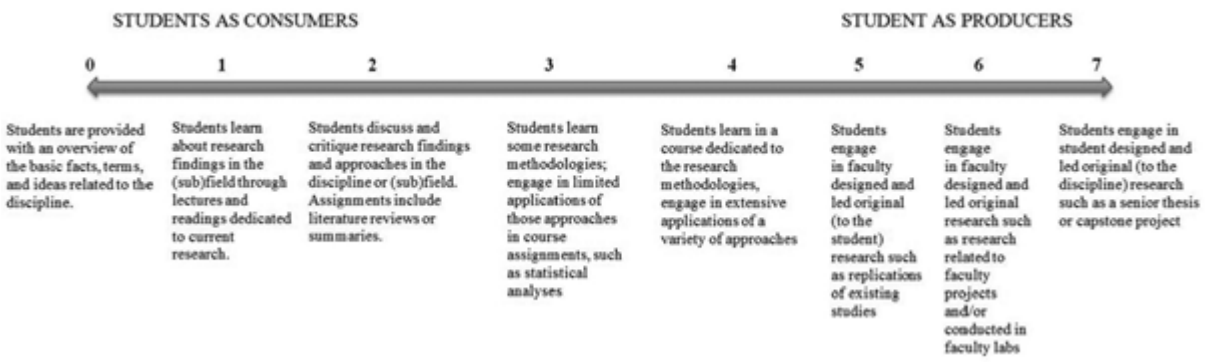
The results are largely in line with the typology of the research-teaching nexus by Healey (2005), while research-tutored was the one definition that was not clearly identified. For each of the five profiles the study found different teacher roles as expert, motivator, role model, tutor and guide. Additionally, they argue that essential themes for each of the five profiles were the following:

1. orientation of the linkage (being either one- or bidirectional)
2. approach according to learning (focus either on learning about research or on participation in research)
3. curriculum, i.e., emphasis on either disciplinary research or teachers' own research, whether attention should be on research content or process.

Having this in mind, Visser-Wijnveen et al. (2010) suggest to consider six dimensions when discussing the link between research and teaching: intangible vs. tangible; disciplinary vs research-teacher's own research; research in general vs. current research; research content vs. research process; learning about research vs. participation in research; and unidirectional vs. bidirectional.

Studies that have examined the role of students have further nuanced the various forms of student participation in research processes. Hensley (2015) viewed students' interaction with knowledge as a key dimension, and developed a continuum between in the one end students as consumers of existing knowledge, and in the other, students as producers of new knowledge.

Figure 3 – Student engagement with knowledge



Source: Hensley (2015, p. 721)

Trowler and Wareham (2007) criticize the literature on the “teaching-research nexus” on several aspects. First, much of the literature seems to be conceptually and theoretically weak neglecting to elaborate complex phenomena at different levels, such as discipline, university and department level. Second, much of the literature seems to take a one-sided, normative position which undermines the possibly negative aspects of research-teaching interactions, neglecting that the possibility to separate research and teaching functions might have benefits for both. Third, there is a tendency in the literature to use an unspecified terminology to describe the connections. Fourth, the literature lacks a development of causal theories, i.e., the modelling of precise mechanisms of influence, strength of influence and the influence of different factors on others appear to be underexplored.

Additionally, Trowler and Wareham (2007) conclude that the findings from the literature are ambiguous, pointing to a positive relationship in some cases and not in others, and that there is evidence to suggest that students both appreciate and do not appreciate their staff being involved in research activities. Finally, they highlight the need to examine how policies on institutional and national level can facilitate this link.

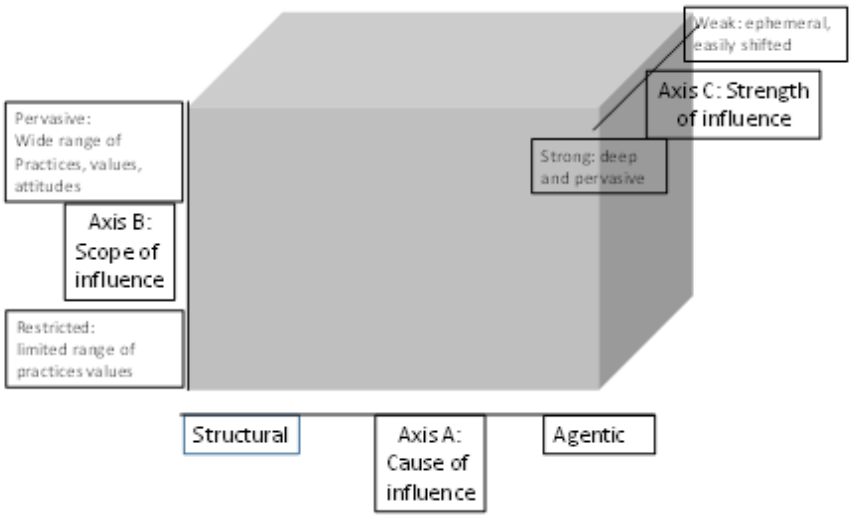
2.2.1 The role of academic disciplines

Building on a review of the literature, Trowler and Wareham (2007, p. 2), aim to provide an overview of concepts and approaches used to define the teaching-research link. Their conceptual framework distinguishes between *cause*, *scope* and *strength* of influence of the teaching-research link, as three dimensions to model the influence of discipline on academic practices and attitudes. Figure 4 illustrates that framework. It provides three axes to distinguish: different conceptions on the relationship between disciplines (e.g., hard pure sciences, soft applied sciences) as well as research and teaching as academic practices.

Axis A addresses the question about factors *causing* any link between disciplines and academic practices (research and teaching) and attitudes, factors which might be placed along a continuum from structural to agentic. The term *structural* means causal mechanisms which might enforce regularities and predictability on academic practices, values and attitudes on research and/or teaching. The epistemological character of a discipline and the nature of knowledge structure serve as an example of a structural factor. In contrary, the term *agentic* means causal influences reflecting individual choices. Here, self-selection by a particular type of people into certain disciplinary fields is an example of an agentic factor. Between these two extremes, however, there are causal explanations with a combination of structure and agency; for example those explanations which regard disciplines as conditioning practices and attitudes, but not totally determining them, providing some flexibility for individual agency.

Axis B addresses the question about the degree of *pervasiveness* related to the link between disciplines, and practices and attitudes, ranging from a very extensive linkage, going beyond simple classroom practices, into the ways of perceiving students (pervasive), to a very *restricted* linkage. For the latter the limited set of academic practices occurs only in particular places, based on certain attitudes for which relevance and scope is restricted to those contexts.

Figure 4 - A framework of the relationships between disciplines and teaching, disciplines and research.



Source: Trowler and Wareham (2007: 4).

Axis C addresses the question about the *strength* of the linkage between disciplines, and academic practices and attitudes, on a continuum from being strong to weak. At the *stronger* end of the continuum this linkage is relatively immune to the influence of factors such as for example institutional context and department culture. At the *weaker* end of the continuum the linkage can be easier displaced by other factors. This means that one might find many exceptions to a hypothesized relationship between disciplines on the one side, and academic practices, values and attitudes on the other.

By including the axis on scope and influence in the model, Trowler and Wareham (2007) argue for addressing the need for defining the level of specificity in terms of the extent and significance of causal effects. They criticize the literature on the research-teaching link to be vague, using a variety of terms such as 'interaction', 'interconnection', or 'integration' between research and teaching on the one side, or just an 'influence' or impact on the other (Neumann, 1996, cited in Trowler and Wareham 2007).

2.2.2 Direction of links and causal claims

Most of the literature deals with the impact of research *on* teaching (see, e.g. Griffiths, 2004; Healey, 2005a; Jenkins, 2004), while relatively few single studies have explored the opposite direction, the impact of teaching *on* research (see, e.g. Becker & Kennedy, 2005; Newby, 1999). Reviewing the literature on the relationship between research and teaching, Becker and Kennedy (2005, p. 1) claimed that it is "all in terms of research enhancing teaching, ignoring any possible causality in the other direction." Addressing this gap, Becker and Kennedy surveyed a wide range of economists, known as productive researchers, on how their teaching enhanced their research. They identified 13 categories of this relationship among them *honing understanding*, i.e., that teaching provided a further understanding with a positive impact on research, *learning through teaching*, to uncovering new ideas and initiating thinking about new ideas, *preparing for class* which involves an update of the literature, looking at data for an illustration for the lecture or finding out something that not has been noticed before during that process and *discussion with students* which might lead to new ideas for further investigation. Newby (1999) distinguishes between three mechanisms on how teaching might benefit from research: first, direct stimulation and challenges of critical thinking as a result of contact with students, second, research outputs generated by students during projects and course work and third,

the mechanisms of programs with the explicit aim to recruit future researchers among students (Newby 1999, cited in Halliwell, 2008, p. 22).

Trowler and Wareham (2007) suggest a model of the directions of the relationships between research and teaching. Building on the work of Coate, Barnett, and Williams (2001, p. 165) who distinguish between an *integrated*, a *positive*, a *negative* and an *independent relationship*, Trowler and Wareham (2007) have added two additional *mixed relations*, i.e. the possibility that teaching positively influences research, while research negatively impacts teaching and vice versa. They assume that certain manifestations of relationships will exist only for particular cases, for example in terms of disciplines, institutional contexts, course level and subject matters.

Table 1 - Typology of relationships between research and teaching

Integrated relationship (1) Research and teaching are not distinct, considerable overlap (if not identical)	
Positive relationship (2)	
Research has a positive influence on teaching	Teaching has a positive influence on research
Independent relationship (3) Research and teaching are independent of each other (neutral relationship)	
Negative relationship (4)	
Research has a negative impact on teaching	Teaching has a negative impact on research
Mixed relationship	
Teaching positively influences research, research negatively influences teaching (5)	
Teaching negatively influences research, research positively influences teaching (6)	

Source: Trowler and Wareham (2007: 3).

More recently, Cadez, Dimovski and Zaman Groff (2015) have noticed, however, that most current studies on the research-teaching relationship do *not* deal with causality. In contrast to their claim, Malcolm (2014: 297) acknowledges the progress in the field by concluding that "[r]ecent research has produced a more granular and situated understanding of the research-teaching nexus."

In sum, these typologies show that the link can take various forms and that there likely is variation across disciplines in how the link between research and education plays out. At the same time, these typologies also show that this link can be analysed from various perspectives and with different units of analysis. Taking this as a point of departure, we organize the remaining of the review in two sections: the relation between research and teaching (staff as unit of analysis), and the relation between research and learning (students as unit of analysis). This distinction has also been made elsewhere in relevant literature (Healey & Jenkins, 2009; Kyvik & Vågan, 2014).

In the review sections we examine *how the link has been studied empirically in research literature*, and whether and under what conditions positive links to student learning or research have been identified. These review sections along with these typologies also form a basis for the proposed indicators in the next chapter.

2.3 Link between research and teaching

"Academics are the strongest exponents of the argument that research and teaching are central to their work and its value." (Henkel, 2004, p. 21).

In the following, we provide an overview over the literature on the link between research and teaching taking the academic staff as a unit of analysis. Broadly, one can distinguish between a strand of literature (see also McLean & Barker, 2004), which consists of mainly qualitative studies dealing with an integrated and synergetic relationship, a strand of literature revealing the myth of an existing nexus, and a strand of literature addressing more complex relationships, by adding further conceptions, and thus, showing a more nuanced picture.

2.3.1 An integrated and synergetic relationship between research and teaching

In general, a substantial part of the literature on the link between research and teaching can be described as normatively biased, supporting either the argument of an integrated, synergetic relationship between research and teaching, or the argument of a positive relationship between the two. In this literature, the existence and intrinsic value of such positive link is largely assumed, and focus is primarily put on how to further improve the link. However, a positive link has also been uncovered in the studies that empirically examine the views of the academic staff.

In studies that take this positive view, the relationship is labelled as a "nexus" (Elsen, Visser-Wijnveen, Van der Rijst, & Van Driel, 2009; Henkel, 2004; Neumann, 1994; Visser-Wijnveen et al., 2010; Zubrick et al., 2001), a "positive link" (Elton, 2001) or a "useful link" (Badley, 2002), notions which connote a synergetic link between the two, or as "scholarship" (Brew, 1999, 2003), research and teaching being two sides of the same phenomenon – learning. The idea of "scholarship" dating back to Humboldt and the ideal that researchers and students are united "in the common pursuit of knowledge" (Coate et al., 2001, p. 159), has been widely discussed. To provide one of the most prominent examples, Boyer (1990) distinguishes between four activities of scholarships, the scholarship of discovery, i.e. basic research, the scholarship of integration, the scholarship of application and the scholarship of teaching. Building on these conceptions of scholarship, Brew (2003) argues for a new model of "academic communities of practice" where the activities of academics and students are not seen as separate activities. In this model "research and teaching are both viewed as activities where individuals and groups negotiate meaning, building knowledge within a social context" (Brew, 2003, p. 12).

Reviewing the previous literature on the link between research and teaching from the perspective of the academic staff (e.g. Neumann, 1992; Rowland, 1996; Smeby, 1998), Robertson and Bond (2001, p. 7) conclude that nearly all staff members interviewed in the studies reviewed "expressed a preference for integrating teaching and research as opposed to focusing exclusively on one or the other." In one of the studies reviewed, Neumann (1992) found support for a strong belief in a "symbiotic nexus" between teaching and research among academic staff based on a qualitative, in-depth study with 33 informants across four different fields. Neumann (1992) distinguishes between three levels of that nexus: first, a *tangible* nexus related to the transmission of advanced knowledge; second, an *intangible* nexus in connection to the student development in terms of building an idea of and attitude towards knowledge and at the same time creating a stimulating environment for academic staff; and third, a *global* nexus relating to the interaction between research and teaching on the department level.

Positive results have also been obtained in the CAP study. CAP was a large cross-national survey-based study on the academic profession, carried out in 19 countries (Teichler, Arimoto, & Cummings, 2013). A large majority of the academic staff in all of those 19 countries (including Norway) were described as "in favour of a nexus between teaching and research" (Teichler et al., 2013, p. 119). However, there are both disciplinary and country specific variations in the extent to which it is possible to identify a dominant research orientation among the academic staff. In general, about three quarters of the staff in the whole survey agree that "research reinforces teaching" (83% in Norway). In average,

about 23% agree that “teaching and research are hardly compatible” (14% in Norway), but this score varied from 6% to 52% among the countries included in the study. The authors conclude that while there are obvious tensions reported, most academics report positive views on the relationship. An interesting finding is that overall, there does not seem to be substantial disciplinary differences regarding staff views on the compatibility between teaching and research (Teichler et al., 2013).

In their study, Robertson and Bond (2001) pay attention to the *meaning* of research and teaching and their possible inter-relationships. Lead by a phenomenological approach they interviewed nine academics on their own experience of the link between research and teaching after these had been confronted with the results by Hattie and Marsh (1996) on a zero relationship. Painting a more complex picture, Robertson and Bond (2001) end up with the five different experiences of the relationship between the two activities. This includes the experience of teaching and research as symbiotic activities in a learning community between academics and students, supported for example by Brew (1999, 2003); the experience of teaching being a means of transmitting new research findings (*research-led teaching*); and the experience that teachers demonstrate and facilitate inquiry-based learning (*research-based teaching*). In contrast, they further reveal some less visible experiences by academics in contradiction to the prominent ideal: the experience that research and teaching are mutually incompatible, and the experience of no or little connection between research and teaching at undergraduate level, earlier reported in meta-analyses by Hattie and Marsh (1996) and uz Zaman (2004).

Examining student perspectives on the link, Hajdarpasic, Brew, and Popenici (2015) have investigated the views of 200 undergraduate students at a large and research-intensive university in Australia. The study aim was to understand the way students thought they would benefit from being taught by researchers instead of non-researching staff. In this way, they aim to explore the particular value of academics’ research for teaching. The core conclusion supported findings from earlier studies that found a positive relationship. Their results indicate that staff research engagement was crucial for students’ understanding of content, had an impact on their enthusiasm for learning and teaching, encouraged postgraduate study, had an important role in undergraduate research and had an impact on developing employment related skills. Similar results have also been shown elsewhere. For instance, Healey and Jenkins (2011) summarised existing research and found that students report positive impacts of staff research involvement.

One can expect that these benefits would be even more pronounced on the graduate level. In a recent study, Horta, Dautel, and Veloso (2012) examine the positive link on graduate level, where teaching can also have a positive effect on research production. They construct a model where both staff and students are conceptualised as learners, and use this model to reprocess a number of existing empirical evidence. They use large scale cross-sectional data from the US to examine faculty output in terms of four indicators for publication (dependent variable), and explanatory variables related to the teaching function (teaching assistant, number of students, percentage of time on research, and time allocated for research with students). Their results indicate that traditional teaching activities show weak linkage to research outputs. However, having a teaching assistant has a positive effect on research production. Furthermore, a positive effect on research production was found when engaging with research activities with both undergraduate and graduate students, emphasizing teaching approaches where students are actively engaged in the research process. The study shows how the teaching-research relationship is dependent on teaching methods (Horta et al., 2012). Similar results regarding publications have also been reported earlier for the PhD level education in the Norwegian context, where it has been highlighted that this can have a positive effect on publication patterns (Kyvik & Smeby, 1994).

Own course evaluations: University teachers do research on own teaching

Giacaman and Sinnen (2014) report on their own experience by applying a research-infused teaching approach in an undergraduate course in software engineering by combining *research-based*, *research-led* with *research-tutored* teaching with a particular emphasis on research-based and

research-led components. Examining students' course evaluations, they conclude that students appear to appreciate a research-infused approach, and that students were inclined to choose to continue their work with an affiliated research group. Furthermore, students contribute to research by assisting postgraduate students in their work.

In the context of two undergraduate university courses in business in Australia, Jiang and Roberts (2011) evaluated the impact of two approaches of *research-led* and *research-based* teaching on student learning and understanding of research. The first approach dealt with the lecturer using his own research as the foundation for a case-study design (*research-led*), in the second approach, students were asked to conduct their own research project (*research-based*) in the form of a literature review. Based on findings from student questionnaire data the study authors concluded that students' understanding of research was most strengthened by the *research-based* learning project presented to them as an experience of doing research. At the same time the authors raise the issue of a lack of students' understanding of research. Providing practical implications for curriculum design the authors suggest to more clearly inform students about the *purpose* of the research-based learning project to increase their understanding and interest in research (see also Lightfoot & Piotukh, 2015).

It should be noted that these studies are single case studies, conducted by academics who are involved in the evaluation. Thus, one can expect that it is more likely that positive results are reported. Furthermore, such studies allow limited conclusions on the impact of students' learning outcomes as they lack a comparable "control group".

A study of a larger scale that goes beyond some of these issues is that by Mägi and Beerkens (2015) in Estonia. They address the impact of research-active staff members' involvement in teaching on students' learning experiences, in other words "of how, and whether at all, a research-intensive environment offers a better learning experience for students" (Mägi & Beerkens, 2015, p. 1). Drawing on national survey data from academic staff (N=679) it was shown that teachers who were active researchers were more inclined to integrate research outcomes into teaching, to engage students in research groups and co-publish with students. In addition to the teacher's research-intensity it was her or his intrinsic interest in both activities teaching and research that did matter mostly for the use of these practices. Furthermore, the study showed that this engagement also had discipline- and institution-specific characteristics (i.e. higher rates of inclusion in projects and co-publication with students in natural sciences, incorporation of research into teaching in humanities and social sciences). A limitation of their data set is that it does not specify whether the responses are based on undergraduate or graduate teaching experience, thus the study does not address the potential variation across levels of education.

In general, with some exceptions the strand of literature on a positive or synergetic link between research and teaching can often be described as rather conceptual. The empirical studies contain primarily qualitative and phenomenological studies that explore academic staff perceptions, beliefs, values and personal attitudes of the relationship between research and teaching, and their personal conception of being an academic. Thus, these studies are embedded in the existing cultural norms about what higher education is, and should be.

2.3.2 Revealing the "myth" of a simple (positive) relationship

Addressing the critics of the literature taking a starting point in the existence of a positive link, the following section will briefly review a sample of empirical studies going beyond the ideal in the tradition of Humboldt, nuancing the myth of a simple positive or synergetic relationship.

Coate et al. (2001, p. 159) made the critical point that the literature on the relationship between research and teaching is rather "strong on rhetoric and light on the empirical nature". Several meta-analytical reviews and subsequent single studies thus have come to opposite conclusions than the studies reviewed above. For the individual academic and department level several meta-analyses (e.g. Hattie & Marsh, 1996; uz Zaman, 2004) and single studies (Marsh & Hattie, 2002) have shown a zero

or weakly positive relationship, including at the postgraduate level (uz Zaman, 2004) across different conceptions of teaching and learning. However, it should be noted that Hattie and Marsh (2004) explain that part of the explanation for this near zero relationship by the in average low publication frequency across different institutions. Thus, if there is low research intensiveness in particular institutions in the system, this can lead to a negative link in average. Furthermore, it has also been highlighted that there is no evidence of the opposite – that separation of teaching and research would lead to better teaching (McLean & Barker, 2004, p. 408).

Addressing the overall question on whether funding policies impact academic activities such as research and teaching, Coate et al. (2001) aimed to provide evidence from the perspective of academic staff and students by applying focus group interviews, across different higher education institutions and subjects in the United Kingdom. Distinguishing between *volumes* of teaching and research in terms of time and resources, and *values* underlying each of the two activities, they focused on the management of staff *time* as a crucial factor to shape the relationship between research and teaching. Of importance for this review is the point to challenge the general belief of research enhancing teaching, showing that the two activities can exist in a variety of relationships which are shaped by value-orientations of academics and by the management of the resources available. While the idea of a synergetic relationship coexists on an intellectual level, this idea however, sometimes appears to be challenged at the department level where research and teaching can be treated as distinct activities competing for resources (i.e. time and funding). As such, a mismatch between incentives for research and education can have a negative impact on the relationship (Geschwind & Broström, 2015).

Elton (2001) stresses that a positive link between research and teaching only exists under certain conditions. He argues that such a link is mainly grounded in the *process* of research-based teaching, rather than in the *outcomes* related to teaching and research. Further, he argues that more traditional teaching methods (*research-led* in Healey's and Jenkins' model) might facilitate a positive link only for the most able and intrinsically motivated students, who might become the academics of the future. Thus, having in mind this ideal student while constructing a positive link between research and teaching, academics appear to exclude the majority of students who are not striving to become an academic:

> "Academic teachers think of students in terms of their own student experience and rarely if ever verify how typical it is from the point of view of their own students. Since only a very small proportion of students ever become academics, it is, of course, the very opposite of typical; yet it is the experience which for a long time has been dominant in the minds of academics." (Elton, 2001, p. 52).

The link between students' perception of lecturers' research and student motivation was investigated by Breen and Lindsay (1999). Studying final-year undergraduate students at Oxford University, they found that lecturers' course competence and students' intrinsic motivation appear to be the main factors for students' positive perceptions of faculty research activities, while negative perceptions of research appear to be associated with students who have an extrinsic motivation for learning (good grades) and regard research as a distracting activity.

A study by Shin (2011) is another example addressing the question of how the research-teaching link actually varies by contextual factors, including career stage and academic ability of staff, disciplines and patterns of research publication (book, domestic journal and international journal). Drawing on survey data from a research-university of South Korea, the study revealed evidence that the research-teaching link was not consistent according to different measures of research productivity, and varied across faculty career stage and discipline, thus, providing support for arguments of a positive as well as a negative link. The link was shown to be positive when research performance was measured by book and domestic journal publications, and negative when measured by international journal publications. This would suggest that it is not only the number of publications, but also the type of publication that can be relevant to examine. Cadez, Dimovski, and Zaman Groff (2015) investigated

the relationship between research performance and teaching quality by distinguishing between quality and quantity indicators (productivity) of research and teaching. While research quantity (productivity) was measured by publication counts, research quality was assessed at the share of papers published in high-quality journals. Drawing on cross-disciplinary data of a sample of academics in a research-oriented university in Slovenia they found that research productivity measured for example by numbers of publications was not related to teaching quality, consistent with prior evidence (e.g. Hattie & Marsh, 1996). On the other hand, research quality was positively related to teaching quality measured by student evaluations. While coming to somewhat different conclusions, the studies also show that quantitative measurement of only publication outputs would not be sufficient.

2.3.3 Complexity of the research-teaching link

Reviewing the literature on individual disciplines, we find different patterns related to the teaching-research link, ranging from being more focused on teacher participation and content-oriented to being more focused on student participation and process-orientation. While this overview is not exhaustive, it gives an insight into some of the discipline-specific dilemmas and the complexity of research-based teaching.

In STEM fields, Blomster, Venn, and Virtanen (2014) investigated if teachers and researchers in the area of biosciences at a research-intensive university had consistent ideas about research-based teaching and the teaching of research methods. Using qualitative content analyses of a sample of 58 teacher surveys, the study authors found three different categories of ideas; either focusing on the teacher (*teacher-centred*), on the student (*student-centred*) or on the pedagogical research. Second, the authors ended up with five categories related to the way teachers regarded student involvement in research. The study showed a positive relationship for teachers with a more student-centred view on teaching, who would more likely involve students in research.

In social sciences, the debate on the link is sometimes also related to a larger international debate about evidence-based practice in professions. Drawing on qualitative data from a case study, Deem and Lucas (2006) explored students' experience with teaching of research methods (research-oriented) in a master program in education at a research-intensive university in the UK. The students had a background as education practitioners with full-time experience of at least one year. They show that all students know about the transmission model of teaching research methods (*research-oriented/-led*) and most students also had an idea of cultural and learning models of teaching research methods; some students recognized a symbiosis between teaching and research (*research-based teaching*). The authors argue that teaching of research methods to educational practitioners has practical implications for the development of connections between the two forms of teaching - at school and in higher education - and research, and further to engage students in joint learning experiences with tutors. Thus, this contributes directly to the development of a research-based teacher profession.

The report of the British Educational Research Association (BERA) and the Action and Research Centre (RSA) addressed the teaching-research link in the teacher profession. The BERA-report reviews the evidence by asking whether research might improve the quality of both the teacher profession and the quality of teacher students' learning experiences. Drawing on a broader definition of research comprising enquiry-based learning, engagement with research, and research literacy, the review identified four strategies in which research might contribute to the quality of teacher education: first, grounding teacher education programs on research-led knowledge from a range of disciplines; second, the use of research to inform structure and design of teacher education programs; third, to equip teachers and teacher educators to engage with research and becoming users of research; fourth, help teachers and teacher educators to conduct their own research supporting the idea of teachers as researchers. Thus, based on the review of the evidence, the report strongly argues for the positive impact of a teacher profession grounded on research literacy and engagement and its effect on learner outcomes. This, in turn enhances quality through empowerment of practitioners (BERA-RSA, 2014).

An example that challenges traditional conceptions of the research-teaching nexus from the view of academics, deals with education of professionals within the area of accounting at two universities in South Africa (Lubbe, 2015). The study highlights a different kind of attitude to research, as new knowledge in the field of accounting (applied science) is assumed to be constructed and renewed primarily more outside than inside the university. The findings indicate tensions of an existing difficulty in combining two 'contradicting' logics, that of the university requiring to be active researchers, and that of the accounting profession. In contrary to academics of other disciplines, accounting academics appear to spend "most of their time and energy on teaching and the development of pedagogy, instead of research. Time […] on research is also not viewed to inform teaching, but rather for its own benefits, such as the promotion of further studies." (Lubbe, 2015, p. 1104). Criticising the traditional thought of a dichotomy of research and teaching, the author suggests the idea of thinking of academics in professional programs in their role of "knowledge agents" with a concern about academics' and students' learning and possibilities in which the learning of one group can inform the other. Thus, she suggests the possibility to engage in the "scholarship of integration, application and teaching" to enhance the "understanding of new and existing knowledge, its transformation and transmission into pedagogy" (Lubbe, 2015, p. 1104) to highlight the idea of the complex role of the academic in the profession.

The ART-nexus highlighted in section 2.2. is another example of disciplines-specific dimensions for the link between research and teaching. D. Bennett et al. (2010) have explored the thinking and action of academics in arts (e.g., music, media, visual art, theatre and ceramics), drawing on interview data of 14 arts practitioners, who were all active teachers and researchers, the authors make the point that such an ART-nexus might address limitations of traditional modes of research by unpacking innovative processes, as traditional modes of research do not seem to provide an adequate model for all kinds of research, and in particular artistic practice.

2.3.4 Summary and implications

In sum, our review of the literature on the research-teaching link by taking the academic staff as a unit of analysis, led to inconclusive findings. Even though a large part of the literature, mainly consisting of qualitative studies, and exploring views and perspectives of the academic staff of research-teaching, rather points to the existence of positive and synergetic links, closely related to the academic ideal, the picture is more complex. The direction of the research-teaching link and the strength between the two concepts appear to be associated with a number of factors, such as discipline, the degree of academic orientation of the program and student sub-population. Further, definitions and conceptualizations of the terms research and teaching applied appear to have implications for the result. Studies drawing on a wider conception of research more often find a positive or synergetic relationship between the two. Thus, the broader the definition of research, the higher the probability to discover a positive and integrated relationship; as research and teaching no longer are regarded as two separate activities, but interrelated activities, namely scholarship. Following this, the indicators developed would need to take a starting point in a broad conceptualisation of research activities to allow for variety of possible relationships.

The complexity of different research-teaching links according to discipline, student populations and definitions has implications for further studies, which to a higher extent might build on more clearly predefined definitions of what research and teaching actually means, and might account for different sub-populations of students in different study programs and different higher education institutions. With few exceptions, the studies under review, stem from other countries than Norway or other Scandinavian countries, mostly from Anglo-Saxon countries. Thus, one has to be careful in generalizing the findings from the literature review to the Norwegian context, with a different system of higher education, different student populations and different study programs than those in the countries where these studies have been carried out.

However, there are indications that higher involvement in research is positively associated with their likelihood of using research in teaching activities as well (see study by e.g. Mägi and Beerkens

(2015)), suggesting that examination of research intensiveness can be one means to measure the link, in particular as one would also distinguish between different kinds of publications (Cadez et al., 2015; Shin, 2011). Furthermore, the study by Horta et al. (2012) is of relevance here in that it also distinguishes between various teaching methods, finding a more positive link when more student-active methods are being employed (see also Blomster et al., 2014).

2.4 Link between research and learning

In this section, we examine ways in which students engage in research-like activities, putting students' learning as the main unit of analysis. That is, to what extent and how can research be integrated into learning processes? As Healey, Blumhof, and Thomas (2003) argue, while the literature on the relationship between quality in research and teaching has been ambiguous and suggestive of a weak link, it has become increasingly commonplace that students are engaged in research. A term that is widely used in this context is "undergraduate research", according to Brew (2013, p. 604) a "student-focused way of bringing research and teaching together". Consequently, a substantial part of the literature presented in this section builds on literature on undergraduate research. While there are aspects of this literature that are unique to undergraduate level education, one should note that this literature builds on an underlying principle that learning is based on inquiry, and is thus equally relevant for both bachelor and master level education in the Norwegian context.

Over time, the literature on undergraduate research has become rather substantial. However, it includes a number of single case studies of local practices, often published in subject-specific journals or journals published by organisations advocating for undergraduate research. A smaller amount of the literature has been published in general journals on teaching and learning in higher education, or on higher education. The studies are frequently descriptive and oriented towards sharing good practice. There is considerable geographical bias in terms of available literature. Furthermore, there is also some imbalance in terms of the subject areas covered (a number of rather small disciplinary fields are overrepresented in the overall literature), to some extent due to the principal subject areas of the most productive scholars in this area. Similar to the literature on teaching and research, some of this literature has a normative assumption of value added, rather than deconstructing the mechanisms through which such value is added (Adedokun & Burgess, 2011, p. 12). There is also a considerable amount of grey literature in this area, linked to good practices and principles.

2.4.1 Student-active learning forms and inquiry based learning as a starting point

The basic idea of undergraduate research builds on the notion of inquiry-based learning (IBL). IBL has been argued to be a productive means to assure the link between research and education (Spronken-Smith & Walker, 2010). The view of learning as an inquiry-based process puts emphasis on activating the students and engaging them in knowledge construction, problem solving, inquiry and project-based learning. It has been argued that on higher levels of education, IBL is very close to actual research processes (Hutchings, 2007).

However, IBL is not a very clearly defined approach, with multiple concepts that are partially overlapping (i.e. use of inquiry and enquiry). There are various forms of student-active learning (M. Prince, 2004), and IBL has been categorised as one form of such student-active learning, along with problem-based learning, case-based learning, project-based learning as distinct pedagogical approaches (Damşa et al., 2015). While these are concepts used in the literature, there is also considerable overlap between the terms, and IBL is a rather wide category that includes a range of activities (for an overview on IBL, see also Aditomo, Goodyear, Bliuc, & Ellis, 2013; Damşa et al., 2015; Furtak, Seidel, Iverson, & Briggs, 2012; Spronken-Smith, Walker, Batchelor, O'Steen, & Angelo, 2011). Furthermore, there is also some disciplinary traditions for the specific terms that are used, i.e. PBL is more used in medical education (see, e.g. Brew, 2013, p. 610).

In this review, we use the term *inquiry-based learning* as a wide category that emphasises learning as "open-ended, student-directed inquiry or research" (Damşa et al., 2015, p. 43). This view of learning emphasises the *research-based* approach in the model by Healey (Healey, 2005a; Healey & Jenkins, 2009), outlined in section 2.2.

Cheesman (2015, p 51) has summarized what distinguished inquiry based approaches from traditional classrooms, highlighting some of the key differences. It should be cautioned that this represents a rather broad categorization and a somewhat narrow version of "traditional" classroom. However, the categorisation can be seen as a way to contrast some of the key differences.

Table 2 - Inquiry based classroom vs traditional classroom

	Traditional classroom	Inquiry based classroom
Characteristics	• Teacher centered • Passive learner • Emphasis on right answers • Rhetoric of conclusions • Lots of memorization • Students are empty vessels that need to be filled • Students work as individuals	• Student centered • Active learner • Alternative hypotheses are elicited • Conceptual and process oriented • Student has prior experiences that can be built upon • Group work/peer teaching are the norm
Implications for teaching and learning	• Curriculum begins with the parts of the whole. Emphasizes basic skills. • Strict adherence to a fixed curriculum is highly valued. • Materials are primarily textbooks and workbooks. • Learning is based on repetition. • Teachers disseminate information to students; students are recipients of knowledge. • Teacher's role is directive, rooted in authority. • Assessment is through testing, correct answers. • Knowledge is seen as inert. • Students work primarily alone.	• Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts. • Pursuit of student questions and interests is valued. • Materials include primary sources of material and manipulative materials. • Learning is interactive, building on what the student already knows. • Teachers have a dialogue with students, helping students construct their own knowledge. • Teacher's role is interactive, rooted in negotiation. • Assessment includes student works, observations, and points of view, as well as tests. Process is as important as product. • Knowledge is seen as dynamic, ever changing with our experiences. • Students work primarily in groups.

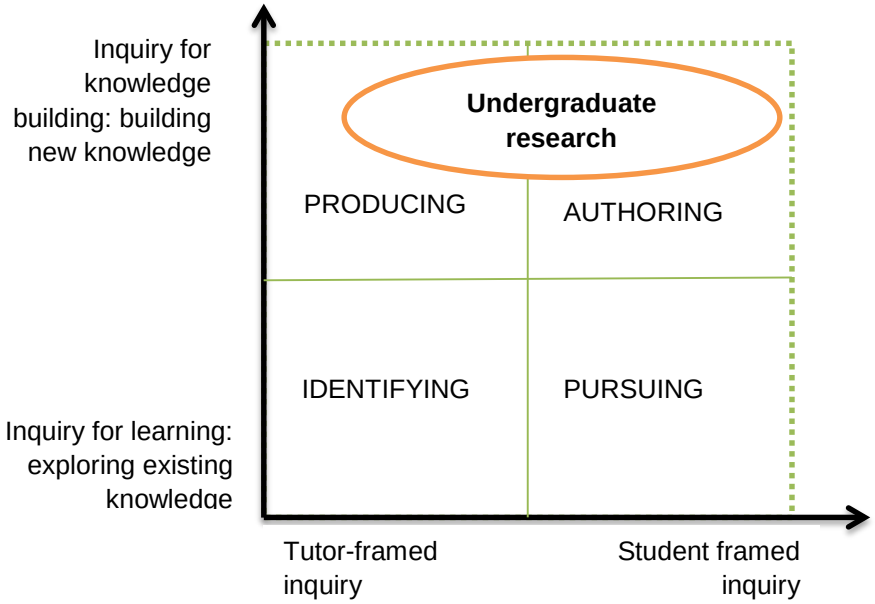
Source: (Cheesman, 2015, pp. 51,54)

In a recent comprehensive review on quality in higher education, Damşa et al. (2015) identified that such student-active learning forms have several commonalities in that they all aim to activate the student, involving the student in the learning process. Thus, students engage in "sharing, understanding and constructing new knowledge" (Damşa et al., 2015, p. 41). Thus, students do not learn *about* new knowledge, but *how knowledge is made* (Boughey, 2012). In the model by Hensley (2015) that was presented in section 2.2., this represents the situation where students are not only consumers of knowledge, but also become producers of knowledge.

Looking into variations *within* inquiry-based approaches, a study by Levy and Petrulis (2012) distinguished two axis – a) whether the inquiry is directed by student or tutors and b) whether it is about acquiring existing knowledge or developing new knowledge. Following these two axis, they have developed four possible ways to think about the process – producing; authoring; identifying; and

pursuing knowledge. Undergraduate research here crosses both producing and authoring in that while focus is on producing knowledge, undergraduate research can be both tutor and student-framed.

Figure 5 - Types of inquiry-based learning and undergraduate research



Source: based on Levy and Petrulis 2012.

While there is considerable support in literature for IBL having positive effects on student learning, some studies on IBL have also shown that this effect is not as clear for low-achieving students (see, e.g. Wilson, Taylor, Kowalski, & Carlson, 2010). Thus, the positive benefits of IBL cannot be assumed, and design of such courses requires careful attention (Damşa et al., 2015, p. 43). Among other things, this suggests a systematic approach to skills development where students gradually increase their autonomy towards "open inquiry" where they are able to operate within self-determined guidelines (see, e.g. Coady & Nelson, 2013; Willison & O'Regan, 2007).

Building on the Healey and Jenkins model regarding research-teaching relationships, and Levy's work (see figure 5, and Levy & Petrulis, 2012) on the continuum between information or discovery, Spronken-Smith and Walker (2010) examined the potential of IBL as a means to strengthen links between teaching and research. They examined three different cases and found that an open, discovery-oriented inquiry-based learning can facilitate tighter links. In such an open approach, students were expected to develop their own research questions and teachers become co-learners, both part of the academic "community of practice". For those teachers with less experience in the pedagogy of inquiry-based learning, the authors suggest a more *structured* approach of inquiry-based learning, even though this approach allows less potential to strengthen the nexus between teaching and research. Overall, they suggest that a mix of structures and open approaches is necessary.

Overall, the principles of undergraduate research build on the notion of inquiry-based learning, but undergraduate research is also presumed to have wider implications for career choices, and general skills development (Adedokun & Burgess, 2011, p. 12). Thus, the aims and implications of undergraduate research are assumed to go beyond the actual learning process itself. The emergence, spread and implications of undergraduate research will be discussed in the next sections.

2.4.2 Origins and variations of undergraduate research

The term undergraduate research has particularly gained attention in USA and Australia in recent decades. Much of the articulated rationale for the need to engage students in research processes is viewed due to the changing society that sets new demands for knowledge production and acquisition (Brew, 2013). Involving students in research builds on the Humboldtian ideals and has been an element in higher education throughout the 20th century, and some would argue that the undergraduate research approach is a means to maintain this ideal (Jenkins & Healey, 2010, p. 41). However, its position in American higher education significantly changed after the Boyer Commissions report in 1998 (Boyer Commission, 1998). The report primarily targeted research universities and was built on an assumption of the benefits of creating a positive link. While the initial format of undergraduate research emphasized selected students that engaged in research activities, more recently calls have been made in the literature to mainstream this research-based approach (Healey & Jenkins, 2009).

More recently, it has gained attention worldwide and become an "international movement" (Jenkins & Healey, 2010). In recent years experiences with undergraduate research have been shared from Australia (see, e.g. Brew, 2010 for overview) and UK (see, e.g. John & Creighton, 2011). Furthermore, a fledging set of empirical studies are also emerging in other countries, for instance in Ireland (Hanratty, Higgs, & Tan, 2010), Scotland (Land, 2013) Netherlands (van der Rijst & Visser-Wijnveen, 2011) and Germany (Deicke, Gess, & Ruess, 2014), as well as Norway (Kyvik & Aamodt, 2015) to name a few.

There are a multitude of different practices related to the term (Walkington, 2015). Brew (2010, p. 38) has highlighted that there is a range of definitional aspects that condition the decisions about undergraduate research. While Beckman and Hensel (2009) also argue that there is no single definition or one-size-fits-all approach, they refer to one definition that has been frequently used:

> "*[An] inquiry or investigation or a research-based activity conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline and/or to understanding*." (the so-called "CUR definition", cited in Beckman & Hensel, 2009)

In essence, these approaches are built around various forms of "*students as researchers*" thinking (Walkington, 2015), the "*research-based*" quadrant of the Healey model. One could view the variety according to various dimensions – an organisational and curricular aspect (how courses are organised and whether undergraduate research is integrated to curriculum), a participation aspect (for all or selected students) and a field aspect (different conceptions of how to define education and research across disciplinary areas) (see Beckman & Hensel, 2009, for more possible dimensions of variation). This diversity can also be found across disciplines within single institutions (Bastiaens & Nijhuis, 2012). From an organizational and participational aspect, the key difference is whether undergraduate research is individualized (selected student assistants, extra courses for selected students) (see, e.g. Garde-Hansen & Calvert, 2007), or whether it is integrated into the curriculum as an element of the learning process for all students. Course based undergraduate research experience (CURE) is a term used to represent undergraduate research that is fully integrated to curriculum and offered to all students of the course.

Where participation is not mandatory for all, studies suggest that there is self-selection among students in that it attracts motivated and high performing students (Berkes, 2008; Gardner, Ferzli, Jeffrey, & Shea, 2015). Fewer studies exist on the decisions by faculty on engaging with undergraduate research. Eagan Jr, Sharkness, Hurtado, Mosqueda, and Chang (2011) present one of the few studies that takes a large dataset (HERI survey to academic staff, N=4832) to examine staff involvement in UR in STEM fields. Their analysis shows that the type of institution is an important predictor for staff behaviour. Furthermore, their data showed that faculty demographics did not have an effect on decisions to engage in undergraduate research, but their commitment to undergraduate education as a whole had a considerable effect. Among the STEM fields, life sciences stand out as a

field where it was particularly widespread to include students in research. In general, the more active the faculty researchers were, the more likely they were to include students in research (Eagan Jr et al., 2011).

There is also variation when these courses are offered in the study programme. For instance, final year "capstone projects" are typical in North America and Australasia (Healey, 2014). Such final year research projects can be found in various formats in many European countries, including Norway, where the notion of a bachelor thesis is becoming increasingly commonplace, after long experience with such thesis on Master level[8]. While sometimes not conceptualised as a part of research-based teaching, a bachelor thesis is in principle an expression of undergraduate research. A comparative study examining degree requirements in Australia, Canada, Finland, the Netherlands, Norway, Spain, Sweden and the US showed that there are country-specific expectations and traditions for research work. There was more variation between countries than disciplines with respect to the requirement of a research project as a part of a degree (Parker, 2012).

2.4.3 Conditions for value added from undergraduate research

Undergraduate research has been positively linked to enhancements in student learning, career choices and skills developments (Adedokun & Burgess, 2011, p. 12; Cheesman, 2015; Cuthbert, Arunachalam, & Licina, 2012; Fechheimer, Webber, & Kleiber, 2011; Hathaway, Nagda, & Gregerman, 2002). It has been argued that introducing undergraduate research as an element of curriculum can be a means to facilitate participation in research activities by underrepresented groups (Bangera & Brownell, 2014). Furthermore, reduced retention has been highlighted (Gardner et al., 2015). There seems to be considerable enthusiasm around the developments, and Adams notes also that undergraduate research experiences can often have a "real 'wow' factor" (Adams, 2009). Overall, one can argue that various forms for undergraduate research increase *research literacy* of students.

Despite these positive reports, less is known about the causal links and mechanisms that lead to these positive results, in particular as several authors have raised concerns about self-selection issues. In the following, we examine some of the common arguments regarding positive outcomes and how this has been studied empirically.

Preparation for research work later

One important aim of undergraduate research has been recruitment to graduate studies and future research careers. Different kinds of methods have been used in such studies. Allin (2010) studied student experiences with a vocationally oriented evaluation research project as an undergraduate research experience, and highlighted that undergraduate research experience provides a basis for further thesis work. A study by Hathaway et al. (2002) examined future career choices of 291 surveyed graduates and found that undergraduate research experience had a significant relationship to likelihood of a research career. Similar results have also been highlighted in STEM areas (see, e.g.Cheesman, 2015; Deonandan, Gomes, Lavigne, Dinh, & Blanchard, 2013; Hunter, Laursen, & Seymour, 2007).

Seymour, Hunter, Laursen, and DeAntoni (2004) and Hunter et al. (2007) reported on a qualitative longitudinal study of 76 students in liberal arts colleges, reporting on a range of benefits and in particular the process of identity construction and "becoming a scientist" process in undergraduate research courses in physics, chemistry and biology. Interviews were conducted in the beginning of their studies, and then when they graduated as well as with academic staff and faculty advisors. The study identified a positive effect, as both students and staff viewed this as being socialized into a community of practice (Hunter et al., 2007).

Elsewhere, self-selection has been identified as an issue (Hvenegaard, Link, Moore, & Wesselius, 2013). In cases where undergraduate research experience is offered to a selected group of students,

[8] *hovedfag* before the introduction of 3+2 system

self-selection bias can occur as students who choose undergraduate research are often also those likely to proceed to research careers (Gardner et al., 2015, p. 38). Berkes (2008) examined this self-selection bias empirically by studying the background variables of students who participated in undergraduate research, and argued that students who engage in undergraduate research are often high achieving students, thus challenging the causal link often made between participation in undergraduate research and choice of research career (Berkes, 2008). At the same time, the Hathaway et al. (2002) study was randomized in that it did include variety of performance levels, and still indicated that there is a positive effect.

Complexity and contradicting results are also visible in this area. While several American studies seem to suggest a positive link for future career choices and views about research (see also Hill, Blackler, Chellew, Ha, & Lendrum, 2013), a recent German study that measured motivation and interest before and after undergraduate research experience found no effects on research orientation (Deicke et al., 2014). However, a qualitative small-scale study from Japan again reports the opposite results, where shifts in conceptions were identified (Imafuku, Saiki, Kawakami, & Suzuki, 2015). In UK, a survey (N=1226) indicated also positive results for both STEM and non-STEM students (John & Creighton, 2011).

One possible explanation to these varying results can be found in the multiple practices related to undergraduate research, as well as potential country-, institution- and discipline-specific characteristics. As many of these studies are based on specific institutions and cohorts, there could be institutionally anchored variables that these students share. Thus, even in a single country context, an indicator based on share of students continuing to research work would likely be challenging due to such discipline- and institution-specific elements.

Increases in students' academic performance

A number of studies have also been conducted on participation in undergraduate research and grade point average (GPA). While the studies seem to indicate that there is a positive relationship, there is varying evidence for the strength of this relationship.

Fechheimer et al. (2011) found a positive link, while acknowledging the limitations of GPA as a measurement of student success and the challenges of establishing a causal link beyond the existence of this positive link. Furthermore, they argue that if a student takes a *single* undergraduate research course, then if controlled against SAT, the GPA increases are in fact not significant. Their recommendation is that there should be multiple research-based courses to facilitate increases in academic performance.

In cases when undergraduate research courses are extra-curricular, they tend to attract selected high performing students. Thus, many existing studies also examine this student group. Haave and Audet (2013) took a different view and examined the undergraduate research experiences of those students who are not among the top achievers. In their study, they examined two core questions – whether students with lower GPA gained benefits from undergraduate research experiences, and whether those benefits were long lasting. They examined results from 201 students on various fields of study in their campus who had obtained an undergraduate research experience. Contrary to the studies on IBL (see section 2.4.1.) that emphasize positive effects primarily for high-performing students, they found that lower performing students in fact have a stronger increase between prior GPA and final grade of the undergraduate research course than the students who have been high achieving throughout. Furthermore, these effects were lasting. Their conclusions thus question whether undergraduate research should be earmarked for the highest performing students, as they argue that: "admission to UREs based only on prior GPA thus appears to be counter-productive by denying access to high impact educational experiences from students who would most benefit from it" (Haave & Audet, 2013, p. 108). As the results also appear to be lasting (increases in performance remain), they suggest that undergraduate research experiences should be introduced early during the degree programme, and not only in senior years. The suggestion to provide undergraduate research courses to first year

students is also shared by other scholars (Fechheimer et al., 2011; Hathaway et al., 2002; Stanford, Rocheleau, Smith, & Mohan, 2015; Walkington, 2015).

One of the studies that has also included a control group was by J. S. Bennett and Bauer (2003). In their survey, they found significant effects of undergraduate research, also on students' cognitive and personal skills and abilities. They also found a strong relationship between undergraduate research experience and pursuit of graduate study. However, the study was limited to self-reported gains, and selected students who were engaged in faculty research projects, thus there can be selection bias among students participating.

Overall, it would appear that there seems to be reasonable level of agreement that student involvement in research activities has positive effects on student learning. Thus, to identify productive links between research and education with positive effects on student learning, student involvement in research processes appears to be a possible indicator. However, this indicator is prone to self-selection bias among students, if such opportunities are only offered to select few high performing students.

Value of UR to academic staff

Studies that explicitly examine the impact of undergraduate learning on research are rather rare. One of the few studies identified in this review is the one by Dolan and Johnson (2010) that examines how undergraduate research experience influences postgraduates and academic staff. The study is a qualitative interview-based case study and has examined relationships in one research group in molecular life science at a large public research university in the US. Overall, what emerged was that undergraduate research had an impact on perceived group structure (hierarchy, ties), for socialization processes, and for developing mentoring skills among postgraduates (Dolan & Johnson 2010). As this is one single case study and limited to a very specific aspect of the dynamic, it provides limited arguments for more general indicators in this area.

Evaluation

The key question is how such value added or enhancement of student learning is measured, as research results are ambiguous (Brownell & Kloser, 2015, p. 526), in terms of being able to have clear indicators. It has also been emphasized that also local course evaluations of such courses have not always been substantial, and with limited robust evidence on value added (i.e. comparing pre-post course measurements, or comparing outcomes with students who have not taken the course) (Adhikari & Nolan, 2002). Even when students are asked about how research has been integrated into the course it is not given that it is very clear to students what this link means, or that they are aware what this means for their learning environment and process. In another study, it has been highlighted that developing this understanding is to some extent a "discontinuous realisation" process (Zamorski, 2002).

Overall the research results present somewhat mixed evidence and add some ambiguity to the assumed *direct* positive value added – in some cases there seems to be positive relationship, in other cases this applies to some groups more than others, and sometimes there appears to be no relationship. There is also reason to believe that in some cases the relationship could also be caused by other variables and that more evidence is needed to control for student demographic background. However, there seems to be a reasonable degree of agreement in literature that undergraduate research has a positive effect on student outcomes.

2.4.4 Complexity of the research-learning link

The complexity of undergraduate learning is no less complex as the research-teaching link, not least as the notion of what can be considered as "research" activity can vary substantially. For a share of natural sciences fields, research would mean laboratory work. In other fields, the research component can be representing work in archives, or collecting in empirical data from various kinds of respondents.

Traditional work patterns within the particular subject fields (i.e. individual vs. team, hierarchies, etc.) have also implications for how undergraduate research is organised.

Existing empirical evidence suggests substantial disciplinary variation with respect to participation in undergraduate research (Fechheimer et al., 2011). This means that examining the literature of student participation in research as one way of integrating research and education requires nuances and clarifications and cannot be adopted in a one-size-fits-all manner. Thus, we aim to cover some existing empirical studies in larger groups in the following sections.

The role of undergraduate research as one means to integrate research and education has been particularly emphasized in STEM fields. A review on undergraduate research in biosciences education indicated a variety of inquiry-based approaches that had been employed (Adams, 2009). A number of these are based on various ways to include students in experiments and laboratory work, thus these also require a specific skillset for experimental techniques that are obtained prior to research work. For this reason, undergraduate research also requires more coherent curriculum thinking to assure consolidation of knowledge (Adams, 2009). A laboratory setting provides a rather intuitive link to undergraduate research (Hughes, Brown, & Calvert, 2008). However, not all undergraduate research in natural sciences is based in laboratories, it can also include approaches such as systematic reviews and presentation of such reviews at symposia (Deonandan et al., 2013).

Geography, earth and environmental studies provide an interesting group of subjects in that they are argued to be in the "intersection of natural and physical sciences, the social sciences and the arts" (Healey et al., 2003, p. 2). A study by Healey et al. (2003) examined the linkages between teaching and research in the area of geography, earth and environmental studies (GEES) in multiple case studies. They argue that this link is complex and contested, with contradictory evidence. At the same time, they highlight existing positive evidence for using student-centred teaching methods with active engagement of students.

Another notion relevant for studying undergraduate research is the notion of fieldwork. Fuller, Brook, and Holt (2010) have investigated the teaching-research link in the undergraduate program in physical geography. They found that research and education were closest related in research-based papers in the third year, with a strong fieldwork element. However, this was also a selected group of students and thus potentially experiencing issues with self-selection, as authors highlight. In another study, Fuller, Mellor, and Entwistle (2014) address the teaching-research link by evaluating the perceptions according to the mix of staff research activity and student fieldwork. The study authors conclude that engagement in research activity in the field, where student fieldwork is combined with staff research, is viewed positively by students to study for a degree, to promote interest in the subject and to improve the understanding of the methodologies used. An important contribution in how to improve the teaching-research link is the point to combine research-based fieldwork (conducted by students) with teachers' own on-going research projects.

Literature on undergraduate research has had main emphasis on STEM fields, with comparatively less focus on humanities, arts and social sciences[9]. Cuthbert et al. (2012, p. 130) highlight that only 2 of 24 publications by the Council of Undergraduate Research[10] were on fields outside STEM. This highlights the disciplinary differences in engaging students in research activities. It has been argued that domains of knowledge with high demands for conceptual and factual knowledge make the threshold to engage in high-level inquiry higher (Coady & Nelson, 2013). However, some single studies can be found. Cuthbert et al. (2012) reported on a sociology class where students reported very positive experiences of finally *doing* some research rather than reading about it, thus the *authenticity* of the research experience was appreciated by the students. The authors argue that this also leads to development of *research literacy*. In humanities, Harding (2002) reported about an initiative in a

[9] This applies to studies on undergraduate research identified in this sample, not studies on inquiry-based learning as a whole

[10] Council of Undergraduate Research (CUR) is a non-profit educational organisation in the US that composes of educational institutions. CUR has worked on promoting undergraduate research since the 1970s.

course in oral history with intensive fieldwork, highlighting the benefits for reflexivity and understanding of research methods. Elsewhere, it has been highlighted that students need to become engaged as practitioners of that particular discipline, that can be seen as more productive than acquiring transferable skills (McLean & Barker, 2004). These studies highlight that these experiences can provide students with a means to understand and become engaged with the knowledge and methodology of the field.

In general, studies with reports on experiences from single courses tend to be positive, in particular as students appreciate authenticity and relevance of such research experience. At the same time, studies have also shown that when research is experienced early in the programme, learning gains for STEM and non-STEM students are similar (Stanford et al., 2015).

For study areas that are more vocationally and professionally oriented, research can be labelled as "relevant vocational research" (Allin, 2010), this kind of research is usually applied, with a clear vocational dimension and can be considered research only in the wider definition. This kind of research is also frequently closely tied to professional practice.

DeVore and Munk (2015) have examined undergraduate research experiences in teacher education and recognize that literature in this area is "emerging", but highlight the positive effects on developing a reflective approach to practice in teacher education. In nursing, similarly positive experiences have been reported on integrating education, research and practice – where students carry out research projects during their practice periods (Fawcett, Aber, & Weiss, 2003). This view has particularly become emphasized in teacher education, as research engagement and development work have become more important among teacher educators (Cochran-Smith, 2005). Finland has often been used as an example due to their research-based approach to teacher education. One example is that a research thesis has been an element of teacher education in Finland (Westbury, Hansén, Kansanen, & Björkvist, 2005), in effect being an example of students becoming knowledge producers.

Different disciplinary models for undergraduate research?

Aiming to account for some of this complexity and variation in a comparative manner, Zimbardi and Myatt (2014) constructed a typology for various forms of undergraduate research after having examined 68 research undergraduate research programmes in 26 discipline based schools in Australia. They proposed five distinct typologies: *apprenticeship*, where students work under direct supervision of an academic on a project close to the interests of that person; *industry project*, where students focus on a complex problem from "real life" professional practice; *inquiry project,* where students construct the whole research project to both learn about content and construct new knowledge; *methods course,* where students only focus on elements of the research process relevant in the discipline; and *mixed models,* where two or more of others have been combined. They also examined these various models for undergraduate research in light of the hard-pure, soft-applied categorisation, and found that in general, the various types are applied across various disciplinary categorisations, with the exception of industry-based type that was not used in pure disciplines. This suggests that a possible indicator examining student involvement in research needs to be sufficiently broad to take into account these variations.

2.4.5 Summary and implications

Literature on research and learning is dominated by a large segment of literature on undergraduate research. However, one could argue that the results would be relevant for both Bachelor and Master level studies in the Norwegian context.

The term undergraduate research has gained world-wide attention and there are multiple practices related to it – in terms of organisation, participation and methods. Furthermore, there appears to be distinct national, institutional and disciplinary variations of these practices. However, they share a view on learning that emphasizes student-active learning forms. This includes students' involvement in faculty research and conducting own empirical research, but can also take other forms, such as doing

literature reviews or presenting such research in symposia. At the same time, the studies also highlight that this requires careful curriculum planning to assure the development of necessary knowledge and skills first (i.e. skills needed for laboratory work, or for working with complex concepts in humanities and social sciences).

While the evidence appears to be somewhat contradictory, there appears to be agreement regarding positive effects on student outcomes. The studies have both employed quantitative and qualitative measures – from interview and observation studies, reports on own practice, to surveys and wider analysis of GPA and demographics. There is no single canon in the literature for how to study the value added, and the data appears to be rather multifaceted.

Furthermore, one can further problematize the notion of undergraduate research and whether it can in all cases that have been described be considered *research* or whether it would be more appropriate to be considered an inquiry process. Engaging in processes of inquiry is productive for developing critical thinking and understanding of research (see e.g. Cuthbert et al 2011). However, there are also likely substantial disciplinary differences whether such activities can be considered *research*. For this reason, we instead emphasize the notion of inquiry in our development of indicators as a means to represent this way of activating students (students as active participants in Healey model).

2.5 Research-based curriculum organisation

The model by Healey (Healey, 2005a; Healey & Jenkins, 2009) is also frequently used as a starting point for analysing the relationships of teaching and research in curricula. Elsen et al. (2009) took a starting point in the work of Healey and examined curriculum in research intensive universities. Their analysis showed that it was not always easy to categorize curricula in Healey's scheme, suggesting that such ideal models become adapted in practice situations. This suggests that such models should be seen as ideal forms rather than empirical descriptions, as one is likely to find hybrid practices. Thus, indicators used need to be broad enough to capture variations and hybridity.

Overall, studies on curriculum have emphasized the benefits of student-active learning forms as a basis for the link between research and education (see, e.g. Brew, 2003; Healey et al., 2003). The development of "research culture" in curriculum has been emphasized, among other things through involvement of students in research projects (Garde-Hansen & Calvert, 2007), echoing the calls made in literature about undergraduate research. However, while there has been increasing emphasis on introducing more student-active forms of learning to the curriculum, it has also been argued that it is important to maintain variation (Healey & Jenkins, 2009). Elsen et al. (2009) highlight that to cover a variety of learning objectives found in most curricula, curriculum needs to consist of courses that are designed with different underlying principles. They emphasize the importance of including a variety of approaches to teaching and learning, in order to strengthen the research-education link in the curriculum.

Brew aimed to develop a comprehensive model that could account for these aspects. She argues that curriculum decisions are not only pedagogical, being frequently taken outside the domain of the specific course (Brew, 2013, p. 608), thus, how teaching, learning and research are integrated reflects strategies within the organisation and rules for who has the authority to decide about the curriculum. Brew (2013) has highlighted that the integration is a wider debate about how curriculum is constructed and how various approaches are weighed. She proposes an alternative model to think about curriculum development, in particular in the context of inquiry-based approaches. In her earlier work, Brew (2006) presented scholarly communities of knowledge-building as a way to construct these bridges and focus on engaging students in scholarly activities. Applying this to a curriculum context, she argues for a *research-based curricula* as a model, which she argues is able to take into account the complexity of teaching and learning processes in an inquiry-based context. This echoes the model

proposed by Ozay (2012) (see section 2.2.), where research-informed thinking is also the main principle to think about academic work.

Brew (2013) provides an instrument for academics to think about curriculum development. In the model there are three main components: *students* are placed to the centre of the model as they represent the main focus. The students are always located in a specific *context*. Context here denotes a wide variety of contexts, including organisational/institutional, external societal as well as the discipline. As Brew argues, these affect curriculum choices and who has the authority to make such choices. *Learning outcomes* in Brew's model are the output of the process, dependent both on students themselves, but decisions on learning outcomes are also dependent on institutional priorities that are set for specific study programmes. Overall, the model identifies the embedded nature of these decisions. An important element of such embedded view is to consider the notion of authority regarding decisions about curriculum and the extent to which these are research-based. A study that examined teacher education in Finland found that students showed positive views regarding a research-based approach to curriculum (Jyrhämä et al., 2008).

One can argue that the curriculum is the formalised document where pedagogical decisions meet the various institutional and organisational demands. While curriculum in itself would not fully determine what will take place in the classroom (i.e. notions of hidden curriculum), it provides an important frame for how one conceptualises the primary processes, and the sequence and coherence of various elements in the programme. Thus, in order to provide a frame for a productive relationship between research and education, this needs to be embedded in curriculum choices. However, studies on inquiry based learning and undergraduate research emphasize that these curriculum choices need to be carefully planned. There is evidence to suggest that student-active learning forms are beneficiary (even if this can have some contextual variation, see section 2.4.3 and 2.4.1), but studies in this section suggest that it is also important to maintain variation in the approaches used.

2.6 Levels of education

In this review, we have focused on education on bachelor and master level. However, as much of the literature comes from an Anglo-Saxon perspective, it is more common to see use of terms such as undergraduate and graduate, broadly equivalent to the division between bachelor and master degrees. At the same time, one should keep in mind that there are substantial differences between the American and UK systems of higher education and that of Norway (i.e. availability, necessity and affordability of master and PhD level education, among other things). For instance, in the US and UK it is under certain conditions possible to go directly from bachelor degree to PhD studies. Thus, this can skew some of the conclusions from American studies on undergraduate research having impact on career choices to become a researcher.

We have not identified studies that explicitly include multiple levels of education and systematically compare the *effects* of research-based education on student outcomes on various levels. However, it is rather obvious that the level of education is an important element. While most of the literature we have identified in the research-learning section focuses on undergraduate education, existing literature shows that this relationship is strongest at the PhD level and weakest at the bachelor level (Kyvik & Aamodt, 2015; uz Zaman, 2004). This is not surprising, having in mind that PhD education in most cases incorporates an independent research project. PhD dissertations are considered as independent research contributions, the master thesis can be seen as a research contribution in some cases, whereas the bachelor thesis are usually more representative of a learning process for the student (Kyvik & Aamodt, 2015; Smeby, 2000). These expectations have also been formalised in the learning outcome definitions, in particular on PhD level, in both national and international qualifications frameworks.

The discussion of levels also has a disciplinary dimension that can be linked to two considerations. First, this concerns the structure of study programmes and what are typical trajectories for students in higher education. This has an important national dimension and varies from country to country. In Norway, some professionally oriented fields (i.e. a number of welfare professions), the pathway through higher education usually means obtaining a bachelor degree. In certain disciplinary fields with a clearer research orientation, a larger proportion of the students continue to master level studies. In some fields (i.e. medicine, law, engineering, etc.), students have integrated master level studies. This also creates different dynamics for how the link between research and education is operationalised. Thus, national regulation can have an important effect on the organisation of study programmes. The national embeddedness of these regulations makes cross-national comparisons rather complicated. Even when the structure of educational degrees has to some extent become more similar in Europe after the Bologna Process, there is also considerable national variation in how the research component is included into degree requirements (see, e.g. Parker, 2012).

Second, the disciplinary scope is linked to the status of knowledge in these fields. The relationship between research and education appears to be stronger in the so-called “hard sciences”, such as natural sciences, medicine and technology than in the “soft sciences”, social sciences and the humanities (see Becher & Trowler, 2001 for an review of the disciplinary categorisation). In the natural sciences, medicine and technology, research can be described as “cumulative” and “paradigmatic” (Kuhn, 1962), and new research often builds on the latest findings in very specialized areas of research. This might explain why researchers (and students) to a higher degree collaborate within research projects, and, therefore have a more established tradition for joint publications compared to the social sciences and humanities, traditionally described as “pre-paradigmatic” (Kuhn, 1962), with a weaker tradition for collaboration between researchers (and students) and collaborative work on publications (e.g. Kyvik & Smeby, 1994).

While the relationship between research and education at graduate level, i.e. master and PhD level, is strongest in the natural sciences, medicine and technology, at the bachelor level, however, the Norwegian case has shown that it can be at least as strong in short professional programs traditionally provided by state colleges as in the disciplinary university programs, such as teacher education (at preschool, primary and lower secondary level), nursing science, social work and applied engineering (Kyvik & Vågan, 2014). At the same time, reviewing the literature, Kyvik and Vågan (2014) show that terms of research and education are ambiguous, multidimensional and vary in their definition in different countries, disciplines and education programs. To provide an example, the broader the definition of research, the stronger the relationship between research and education appears to be. This is the case for professional programs in Norway that apply a rather broad definition of research, in contrast to the hard sciences with a more narrow definition of research (science). However, in the conclusions of their study, Kyvik and Vågan also highlight that the link is nationally embedded.

2.7 The role of organisation and policy

As highlighted earlier in this review, while there are indications for the positive link to exist under certain conditions, a definite answer has been elusive. As a result, a number of studies have taken a normative stance that teaching, learning and research *should be* brought closer together. A number of authors highlight that current national and organisational frameworks can in fact push towards this stance.

In recent years, there have been frequent debates regarding reward systems and the status of teaching and research, in particular as one can identify increased use of performance indicators. For both institutions and individual academic staff this creates a skewed incentive system. A study by Geschwind and Broström (2015) addressed the dilemma between the ideal of a research-teaching nexus and the reality of an increased division of labour between teaching- and research-oriented staff

facilitated by institutions. By investigating the implementation of the research-teaching nexus at three research-oriented universities in Sweden, the study authors reveal a perceived mismatch between the incentives provided to individual academic staff members and the need for more research-informed teaching. A main conclusion is that research quality seems to be more rigorously evaluated than teaching quality which leads to discourage junior researchers from engaging too much in teaching-related activities. For senior researchers teaching competes with other scholarly activities such as supervising postgraduate students, administrative work and contributing to the international scientific community.

Various explanations have been provided. It has been argued that research tends to be viewed as having higher status (Rowland, 1996), and academics would thus focus on research activities (Douglas, 2013). One issue with many indicators that have traditionally been used is that outcomes of excellent research are often quantified (publications, grants, etc.), whereas outcomes of excellent teaching and learning are not as easily captured by quantifiable measurements. In this line of argument, the need for better reward systems for teaching has been highlighted in the literature (Brew, 2003, p. 16; Hattie & Marsh, 1996; Horta et al., 2012, p. 173), as current skewed rewards systems create a tension between resource-intensive teaching practices and research, as academic staff operates in the era of publish and perish (Laursen, Seymour, & Hunter, 2012, p. 37) (see also section 2.3.2 for more examples). Despite attempts to increase the status of teaching, this has in some cases had an effect of lowering the status of teaching even further (Macfarlane, 2011).

At the same time, an Australian study on those who have obtained awards for excellent teaching showed that they are also usually active researchers, thus pointing towards the need to examine this also on an individual level (Halse, Deane, Hobson, & Jones, 2007). Furthermore, as highlighted earlier, CAP data showed that most academics observe a positive link between the two, with some observed tensions (Teichler et al., 2013). However, one could question whether the fact that people engage in both teaching and research as two separate tasks would imply that the practices themselves are interlinked or mutually reinforcing. While CAP data showed positive responses from academic staff, the research we have reviewed shows that the possible forms of such links can be rather complex.

At the same time, the tension between coherence and fragmentation has been an enduring characteristic of universities as organisations. Higher education institutions are commonly conceptualised as having multiple tasks and functions, the term “multiversity” was already proposed in the 1960s (Kerr, 1963). This denotes that higher education institutions have multiple tasks and engage with the society in various ways. From an organisational aspect, the independence or interdependence of the main functions of universities has thus been an enduring debate. As higher education institutions evolve, their increased complexity has also led them to have several layers of organization where the patterns for organising education and research might differ from each other. At the same time, departments, faculties and organisations as a whole remain important actors in creating the premises for the link to exist (Jenkins & Healey, 2015).

Lifting the vantage point further, one can argue that the existence of the link can also be linked to the policy priorities that have been formulated, both nationally and internationally. Thus, while the debate on the tasks of the university has been enduring, recent (sometimes substantial) changes in higher education landscape can alter the underlying premises for whether and under what conditions such link exists. Internationally, there is both a trend towards higher concentration of research (for instance, the spread of research excellence initiatives), and withering out of institutional categories (i.e. abolishing earlier binary structures). Thus, if recent changes provide a threat to the link (i.e. concentration of resources to fewer institutions), this can emphasize the (to some extent normative) stance that research and education *should* remain linked. Brew (2003, p. 4), for instance, highlights that higher education institutions have an interest in creating and maintaining a positive link due to current funding models that reward teaching and research separately.

At the same time, an almost contradictory trend can be identified. Changes in knowledge production and institutional landscape (see also section 2.1.1.) can also lead to an increased expectation of research emphasis in institutions where this has not been the case earlier. This can for instance be seen as one possible explanation for strong emphasis on research-education integration in Norwegian university colleges (Kyvik & Aamodt, 2015). This means that a much wider set of organisations and academic staff now has research competence and is engaged in research processes.

National policy can also play a more direct role. The case of Ireland has shown that national priorities and funding schemes can provide an important incentive for widening undergraduate research in higher education (Hanratty et al., 2010), in other cases a less productive role has been identified. An example of the latter can be found in one Chinese study, where it is reported that national policies have in fact further emphasized existing tensions between education and research (Lai, Du, & Li, 2014). What these two brief examples show is that the link between education and research can also be facilitated by external and more systemic conditions beyond the single organisation, and such external conditions can also create an unproductive environment for the link between education and research.

Research-based education has also received attention in various inter- and transnational coordination processes, in the Bologna Process and initiatives taken by the OECD and the EU, not least as emphasis on the "knowledge triangle" has come to focus in recent years. Maintaining the link was also emphasized in the *Magna Charta Universitatum* that was signed in 1988. An OECD report in 1998 proposed student engagement in research on bachelor level (Wagner, 1998). However, for instance in the case of EU this emphasis is not very clear cut, as the knowledge triangle thinking incorporates various policy logics (Maassen & Stensaker, 2011). While multiple interpretations and preferences also emerge internationally, such initiatives can influence national preferences and how the research-education link is operationalised. An example that can be used here is Germany, where the Bologna Process provided a push towards student-centred learning, thus bringing student-active learning forms to focus (Deicke et al., 2014).

Overall, one can argue that there are important cultural factors that frame how the link plays out. For instance, the link would look inherently different in countries with a large component of teaching-only institutions. One can argue that such systemic aspects can be at least as important as disciplinary differences.

2.8 Examples of good practice

In the following sections, we briefly outline some identified good practices cases of how to integrate research and education. The examples have been selected during the literature review among articles where specific institutions have been identified as possible cases for good practice. It should be noted that these examples should not be seen as an exhaustive overview of possible ways to create such linkages, but can instead serve as illustrations of a positive link in specific organisational contexts.

Maastricht University

The activities in Maastricht University were described in an article by Bastiaens and Nijhuis (2012), a study that forms a basis for this overview. Maastricht University has had focus on problem based learning since its establishment in 1976. Problem based learning is used in *all* programs at the university, and it is considered a core of their "educational format", characterised by "a new kind of graduate, one able to work across disciplines, work in teams, exercise self-discipline, and undertake lifelong learning" (Bastiaens & Nijhuis, 2012, p. 38). Student groups usually consist of between 10-13 students, and they work on both actual and simulated problems, under staff supervision. Bastiaens and Nijhuis describe the process as following:

> "The problems are processed during two sessions. In the first session, prior knowledge is activated by brainstorming about possible problem statements. As a conclusion, the learning goals are formulated. After this session, students study literature on their own with the aim of meeting the learning goals. Ideally, no specific chapters of reading are assigned, and students are required to find literature by themselves. In the second session, students report on their responses to the learning problems and check that the learning goals have been met. If necessary, new learning goals are formulated. (…) The supervisor monitors the process and provides feedback on the learning process, but the students themselves are responsible for their own learning process, for formulating their own learning goals, and for chairing the sessions" (Bastiaens & Nijhuis, 2012, p. 39).

The authors also highlight that these experiences have now been widened to a more substantial undergraduate research focus at the university, supported by the Dutch Sirius programme[11] for excellence in education. This initiative uses the research-skills development framework (see also section 2.4.1) as a basis for the Maastricht Research Based Learning Programme. Bastiaens and Nijhuis highlight three key elements:

- Students are supervised by renowned scholars in small groups for a period of five months, learning to collaborate and think independently
- A multi-disciplinary approach is encouraged
- The approach involves businesses and partners from society

The formats vary across faculties and disciplines. The selection for the programme is competitive and students need to show particular standards to be eligible, as well as submit a proposal or letter of interest (Bastiaens & Nijhuis, 2012).

Research based learning at Humboldt University

This example of good practice is based on the review provided by Deicke et al. (2014). Humboldt University received funding from the so-called Quality Pact for Teaching (*Begleitungsforschung zum Qualitätspakt Lehre*). The funding programme has funded over 250 projects in Germany[12] with an aim to improve the quality of teaching and learning. The comprehensive project "Transitions" (Übergänge)[13] received funding to facilitate transitions from school to university, between different learning approaches, and from university to further studies or employment. One of the initiatives that the large project proposed was the "bologna.lab" initiative, emphasizing the role of the Bologna Process in promoting student-centered learning approaches in Germany. A key element of the initiative is the "Q programme", where Q stands for "a creative space and the opportunity to ask their own questions (question), doubting apparent certainties (query) to seek their own solutions (quest) and to make new experiences and to acquire skills (qualification)."[14]

Among other things, students are engaged in research during their bachelor and master level studies. Four different projects are currently being run:

1. Students lecture students (Q tutorial) – students bid for funding to be employed as tutors and lead a team of students.

[11] The Sirius Programme was launched in 2008 by the ministry in Netherlands, as a way to facilitate programmes on institutional level that can motivate top performing students. Separate budgets exist for bachelor and master level initiatives, and institutions have to provide co-funding for the projects. The description of the program highlights its trust-based nature in that institutional applications are evaluated based on goals, and not the way in which institutions plan to achieve them. Read more about the Sirius Programme here: https://www.siriusprogramma.nl/english

[12] See more here: http://www.qualitaetspakt-lehre.de/en/3013.php
[13] http://www.qualitaetspakt-lehre.de/en/1334.php
[14] https://www.hu-berlin.de/de/einrichtungen-organisation/verwaltung/bolognalab/projekte-des-bologna.labs/q-programm

2. A subproject to an existing research project (Q team) – students create own subprojects, usually result in a BA and MA dissertation work. Junior academic research staff can bid for funding for supplementary teaching contracts.
3. Self-study (Q module) – provides opportunities for advanced students to engage in research and not attend regular classes.
4. Learning through research (Q college) - students collaborate internationally with other students on research projects without spending a whole semester abroad (including visits, technology-enhanced meetings, online learning platforms, etc.)

The study showed that research-based learning in itself did not increase students' interest in research. What mattered was that there was a positive relationship between the number of research activities students engaged in, and their interest in research. Furthermore, the effect was evident for activities such as reading research literature, developing a research design or undertaking empirical research (Deicke et al., 2014, p. 32). These results also emphasise that engagement with the processual aspects of research work can have positive effects on student learning.

Reading and writing scientific reports at Leicester University

This example has been selected from the wide range of brief case descriptions provided by Healey and Jenkins (2007), further elaborated in the case overview by Willmott, Clark, and Harrison (2003).

In this initiative, attention is particularly put to how students can learn to read research papers that are often full of academic jargon and complex writing. Thus, Willmott et al. (2003) discuss when and how students should be introduced to "real" research literature, and the skills and tools necessary for them to evaluate how evidence is constructed. Two different kinds of activities were conducted. First of all, to engage with research literature, students work in "journal club" style, where they engage in discussions of research papers.

The other element is learning to produce research reports. The overall set-up is based on a sequence of activities defined for the exercise. In session one, students engage in buzz groups to discuss what sections one might find in a research report. This is summarised and then systematized by the tutor who also provides a presentation of the function of various sections. In this session, the students also discuss the role of the "abstract" in an article, by discussing three versions of an abstract for one fictional paper. In between the sessions, student work with research articles based on a structured set of questions. In session 2, students move from reviewing to writing. As a task, students need to write an "abstract". Then, a planning section follows where students need to consider how to plan an experiment that would hypothetically use an existing data set. Here, students have to design a study around the dataset in a collaborative manner. After this, students write up the possible analysis and research report. Students also receive one-to-one feedback from the tutor. After feedback on first report, students then write another research report on a data set (Willmott et al., 2003).

This study can be seen as an example of thinking cumulatively how students can be engaged with research literature. Further examples of this kind of research engagement can be found in the list of cases by Healey and Jenkins (2007).

Summing up

While illustrating vastly different practices, these three cases also show that initiatives to link research and education have multiple sources. They can be the result of a long-standing institutional emphasis on particular teaching approaches, a result of national initiatives that facilitate excellence, a result of specific institution wide programmes, or they can also be facilitated in the frame of a single course. For this reason, one can argue that maintaining educational innovation is essential. While certain incentives can be provided through policy and strategy on national and institutional level, there are also multiple ways to engage with the link on study programme and subject level.

3 Indicators for the research-education link

In this chapter, we first highlight some of the contextual aspects of the Norwegian case. Then, we outline some existing indicators/dimensions used in the Norwegian context. We then summarise these experiences, and link them to the key results from the literature review. After this, we propose the three main principles that have been used to develop indicators to examine the relationship between research and education. In the final section of this chapter, we outline these indicators in three distinct groups – focused on input, output and process.

3.1 The (sometimes unclear) notion of research-based education in Norway

Research-based education (here denoting *forskningsbasert utdanning*) is a well-established term in the Norwegian higher education system, and grounded in existing law that states that education has to be based on the cutting edge in research, development work, and artistic practice.

However, what exactly this research-based nature entails is frequently argued to be unclear, implying multiple meanings (Hyllseth, 2001; Kyvik & Vågan, 2014; UHR, 2010). Some might argue that education should be based on the cutting-edge of knowledge in the respective field. Others argue that education has to be linked to an active research environment in the institution. Another view is that those teaching the course should be active researchers, and in some cases this has been interpreted that academic staff should report on their own research. Yet another interpretation is that students should be engaged in research projects (in particular on Master level). This idea of including students in staff research projects (in particular on bachelor level) is an expectation and practice that has emerged more recently (Kyvik & Aamodt, 2015). In their book discussing research-based education in professional education, Kyvik and Vågan (2014) and Kyvik, Vågan, Prøitz, and Aamodt (2015) suggested interpretations of research-based education in Norway:

- Education is linked to a research environment
- Education is conducted by staff who also do research
- Education builds on existing research of the field
- Education provides knowledge about philosophy of science and research methods
- Students learn how research is conducted and produces new knowledge
- Students participate in research projects of the academic staff
- Students conduct own research as a part of their studies

One can see how these can be interlinked to the categories presented earlier, *research-tutored, research-led, research-based, research-tutored* and *research-oriented* (see section 2.1.), categories also used in the UHR report.

The notion that education has to be research-based is established in law, and emphasized in a number of key policy documents for higher education. Its ambiguity, however, creates challenges for how the law should be enacted (UHR, 2010). This is particularly the case as various policy documents emphasize different interpretations and provide contradictory logics. A report by UHR outlined the key documents for higher education in Norway. They argue that the Quality Reform (*Kvalitetsreformen)* could be seen as a reform that has weakened this relationship by strongly emphasizing education. In the national qualifications framework (*NKR)*, it is the methodological component that is emphasized as well as being based on new research knowledge on the frontier of the field. In the report by *Dannelsesutvalget* emphasis was instead on critical thinking (UHR, 2010). In the latest White Paper on research (Meld.St.18 (2012-2013)), student-active research has a separate section (Kyvik & Aamodt, 2015). Overall, it is clear that while the term itself is rather institutionalised in Norwegian policy context, it also retains a high level of ambiguity, despite frequent calls for clarification.

More recent policy developments in Norway can add further perspectives, in particular as a result of the new structural reform. The reform emphasizes larger and more robust organisations, with an aim to assure higher quality. As a side-effect, the reform also has further weakened the traditional division between universities and university colleges (as several university colleges have merged with universities), to the extent that it has been questioned by some within the system whether these institutional categories are meaningful in this context. What this means for the link between education and research is not yet clear. Current processes can strengthen the notion of academic staff as researchers, in cases where mergers create more robust institutions with larger research environments and more robust study programmes. However, this can also weaken the overall links in cases where there would be concentration of research and education on Master and PhD level to a particular campus over time, thus making the bachelor-only campus less attractive for research-active staff. In this instance, current processes can also undermine particular kinds of links between education and research in some instances.

3.2 Building further on existing indicators and dimensions proposed and/or used in Norway

As the notion of research-based education has been established in law, there has also been attention to the topic in Norwegian higher education. In the following sections, we briefly outline indicators that were proposed in a report by UHR, and summarise experiences from existing NOKUT evaluations, and outline possible measurements discussed in studies by Kyvik and Aamodt (2015) as well as Kyvik and Vågan (2014).

3.2.1 UHR report

In 2010, UHR established a working group to examine the link between education and research, with a starting point that establishing and maintaining this link is a “comparative advantage” (UHR, 2010, p. 7). Thus their focus was not so much on whether there is a link, but how to assure that the link is *good enough.* In the report they also propose particular dimensions to examine this:

- Whether the study programme is taught by active researchers
- Percentage of staff who engages in teaching and research equally much
- Share of staff with PhD who engages in bachelor level teaching
- Share of teaching by staff with PhD education
- Educational content draws on the research interests of staff
- Use of PhD candidates in education

- Staff gets training in research-based education
- Educational content is based on research where relevant research results are integrated into teaching
- Education includes a component of scientific method
- Students engage in analysis of research reports and articles
- Students are aware of research in their own higher education institution
- Student participates in research or research-like activities
- Student contributes to scientific publications
- Study programme has various teaching methods
- Assessment emphasizes independent critical thinking

These indicators were developed primarily for internal quality enhancement activities. Thus, one could argue that as a *whole* these would not be suitable for an external evaluation, due to the level of detail required and issues with measurement. Instead, this whole list can function as a checklist for individual academic staff or the leadership in the organisation for their internal work on facilitating the link. An issue with the list is that it is somewhat imbalanced towards staff qualifications, and thus input factors. At the same time, some of these are relevant also in our discussion, as will be highlighted later in this chapter.

3.2.2 Building on Norwegian experiences

NOKUT has conducted three evaluations where research-based education has also been an element of the evaluation – teacher education (2006), engineering (2008) and preschool teacher education 2010). The methodology employed in the evaluations was based on self-evaluations with both quantitative and qualitative questions regarding research-based education – where the following indicators were used (Lid, 2012).

Table 3 - Indicators used in the NOKUT evaluations

Quantitative indicators	- Size of academic environments (measured in FTE) - Share of staff with PhD level qualification (*førstestillingskompetanse)* (FTE) - Share of teaching staff with PhD level qualification (FTE) - Share of full-time equivalents (FTE) used for R&D
Qualitative indicators	- Research profile and scope - Definition of research-based education - Research-based teaching practice - How students are informed about staff research - Student participation in staff research - Positive outcomes of student involvement in staff research - Strengths, weaknesses and opportunities for development - Recruitment and competence development of staff

Source: (Lid, 2012)

Responses varied to these indicators. The analysis of the NOKUT evaluation data showed that neither size nor time allocated had a considerable effect on the perceived quality of research-based education, and the only input factor that showed some relationship was share of staff with PhD level competence (Lid, 2012). However, one could argue that this is well in line with international literature that has also found positive relationships between staff who are active researchers and their engagement in research-based education. The analysis in the NOKUT evaluations also indicated that there did not seem to be a clear correlation between publication patterns and the outcomes of the evaluations provided by the evaluation committees. While there is some ambiguity in international research literature in this area, a number of studies highlight positive relationships between teaching practice and publication patterns (Eagan Jr et al., 2011; Halse et al., 2007; Horta et al., 2012). However, it can also be the case that it is the quality and not the quantity of publication that matters (Cadez et al., 2015). Furthermore, this view is also shared by students (Hajdarpasic et al., 2015).

Examining research-based education in short-cycle professional programmes in Norway, Kyvik and Vågan (2014) have examined various dimensions for measurement. Three relevant dimensions in the book include research practices of academic staff, involving research in teaching practice, involving students in research projects. Regarding research orientation of staff, they adopt a broad perspective on R&D. Taking this as a starting point, they find that a large majority of staff in professional programmes reports that they are involved in some sort of R&D activities. At the same time, they highlight that if this is seen in context of publication patterns, one can find more variation.

Regarding the introduction of research into teaching, they have examined various skills related to research literacy, including training in research methods, ability to read research texts and developing an understanding of the research process. Furthermore, they examined whether staff uses examples from their own research in teaching. One could argue that all of these can be seen as relevant aspects in developing *research literacy,* an element that has also been highlighted in international research literature (see section 2.4.4). However, what international literature also shows is that there is considerable disciplinary variation across disciplines. Thus, an indicator encompassing such activities should emphasize how students are introduced to the *approaches and methodology of that particular knowledge area*. Thus, it is to be expected that the kinds of research skills needed would differ substantially between engineering, history and medicine.

In their study on involving students in research projects, Kyvik and Aamodt (2015) have examined current practices in Norway. In particular, they examine the extent to which involving students in research contributes to quality enhancement, with particular emphasis on bachelor level education. The analysis uses data from a survey to academic staff that was conducted in 2013. Their analysis shows that on the PhD level, the involvement of students in staff research projects ("to a high degree") varies across disciplines, from about 40% in humanities to over 80% in technology fields. On the master level, students are to a much lower degree involved in research projects by academic staff, with just over 40% of staff in mathematics and natural sciences, and about 15% in humanities reporting that they frequently involve students in their research projects. These disciplinary differences reflect in general the research traditions in these fields (Becher & Trowler, 2001).

However, Kyvik and Aamodt also show that the picture is dramatically different on the bachelor level, where all Norwegian data indicates that such involvement is rather low. The survey data from 2013 indicates that 2-7% of staff indicate that they "to a high degree" involve students in research projects. Involving students is more common in university colleges (with lower research intensity) than the traditional research universities. This is in line with the NOKUT evaluation results, of the 59 study programmes in total that were evaluated in the three evaluations, only two indicated that they had a systematic approach to involving students in research on bachelor level (Lid, 2012).

At the same time, the survey showed that a much larger share of staff agreed (to some/high degree) that bachelor level students *should be* involved in research projects, a result that the authors argue is difficult to interpret (Kyvik & Aamodt, 2015) (i.e. what is student involvement , and what is "some degree"). Other studies (Kyvik & Vågan, 2014) have also shown that the staff has a positive view on involving students. Overall, one can sum up that the study by Kyvik and Aamodt showed that involvement of students in staff research projects is rather commonplace on PhD level, occurs on master level, and is still rather uncommon on bachelor level at this point (Kyvik & Aamodt, 2015).

A recent analysis of humanities education in Norway uncovered that when it comes to staff presenting their research to students, the majority of academic staff presents some of their research to students, with small differences in terms of publication productivity and staff rank (Kyvik, 2015). Furthermore, Kyvik (2015) shows how the humanities are rather different from other research fields, as the field has traditionally not involved large research groups.

The question then becomes whether low involvement of students in staff research on bachelor level can be seen as a problem. On the one hand, it has been formulated as a policy aim. At the same time, existing research has also questioned whether it is a reasonable aim and to what extent it would have

a positive effect on student learning (Kyvik & Vågan, 2014). While existing research on undergraduate education shows positive effects, there are important distinctions between research experience offered a) to selected students who engage in specialized courses or staff research projects; or b) as a part of the curriculum for all students, in which case research activities do not always mean involvement in actual staff research projects. The latter can include a variety of research-like activities for students. For this reason, we argue that examining students' involvement in research should instead focus on how inquiry-based learning elements are introduced to curriculum.

3.3 Building on international research literature

Based on the literature review and reflections on curriculum, organisation, and policy dimension, one can argue that existing knowledge is ambiguous regarding the link, and that the link has different dimensions on various levels of analysis.

- First, the link can be studied on system and organisational level. This concerns both how the higher education system is organised nationally, and the specific priorities on organisational level (see section 2.7.). This concerns aspects of system structure (whether some or all institutions do research), and organizational strategy (whether all units within an institution do research).

- Second, this link can be studied on curriculum level. A study programme can be research-based in various ways. The model by Ozay (2012) that builds on Healey (Healey & Jenkins, 2009) (see section 2.2) emphasizes five possible dimensions (see section 2.2). According to Healey and Jenkins, quality is achieved by not *only* employing student-active learning forms, but using a *variety of approaches* to address different kinds of learning outcomes.

- Third, the link can also be studied on the level of the individual academic or student. For instance, how individual academics use research in their teaching activities, and what benefits do students gain from engaging in research-like activities (see sections 2.3 and 2.4.).

The link can vary across countries, institutions, organizational units, disciplines and levels of study (i.e. bachelor, master). For example, if it is possible to identify a high level of integration between research and education in a bachelor programme for physics, it is not given that this integration on study programme level would be a result of specific institutional priorities, or that a bachelor programme in history in the same institution would have a similar degree of integration. Different disciplinary practices mean that one cannot assume that a similar link would be found in a different department in the same institution; different organizational settings mean that one cannot assume that a similar link would be found in a physics department at a different institution.

This comes down to principal organizational factors in higher education institutions. First, despite the push towards universities becoming more "complete" organizations (Seeber et al., 2015), individual base units in higher education institutions can be rather autonomous and decoupled from other similar units within the organization. Second, while disciplines share important commonalities across various institutions (Becher & Trowler, 2001; Clark, 1983), academic practice is situated in a specific organizational context and thus also embedded in the organizational culture of that particular organization (Stensaker, Välimaa, & Sarrico, 2012). Thus, the link will always have a situated and contextually embedded nature. Beckman and Hensel (2009) even suggest that for instance for undergraduate research experiences, no single definition can be found, as any definition would be institutionally embedded. This requires the indicators to enable local translations in order to avoid too rigid measurements.

Some reviews have provided some possible indicators. Healey and Jenkins (2011) for instance outline possible measurements for student awareness, experiences and perceptions of research. They

suggest a substantial set of dimensions on awareness (i.e. seminars, books, notice boards of research opportunities, research posters, etc.), experience (i.e. research seminar, dissertation writing, reading research papers, involvement in fieldwork, etc.) and perceived positive impact. However, a number of these dimensions are very detailed with respect to the data required (detailed survey data from students) and likely more appropriate for research purposes than for evaluative work. In another article, Jenkins et al. (2007) (see section 2.2.) highlighted ten dimensions for how the research-education link is operationalised – from students being informed about current research to carrying out research. Overall, these can be placed under various typologies of student involvement (the Healey model).

While much of the literature does not identify specific indicators for measurement, the empirical studies we have examined provide a basis for the indicators proposed here. In particular, we have taken a starting point in aspects where a positive link has been identified in literature. While there are contradictory results for most of the dimensions, some aspects have shown to have obtained more positive support. What is evident in existing typologies is that research-based education is a multi-faceted phenomenon. Thus, indicators have to take into account various dimensions of the relationship and the various possible units of analysis.

3.4 The principles and limitations of proposed indicators

Indicators and measurement are a key element of current steering mechanisms, where the relationship between higher education and the state has been transformed from control to steering at a distance. This means that there is also emerging empirical evidence on the role of indicators and how the use of indicators can influence existing practices. When developing any new set of indicators one has to keep in mind the importance to minimize perverse, “unintended effects” (Boudon, 1982). In the following, we outline three main principles we have used for the development of the indicators in this report.

First, not everything in higher education is nor can be measured in quantities. There are a number of intangible aspects of quality that are difficult to capture in the form of indicators. A similar claim can be made of the quantification of the relationship between education and research, two terms that even on their own can be difficult to define and quantify. As there is no robust and agreed upon conceptualisation regarding the specific causal mechanisms in the research-education link, there is a danger that some aspects would not be measured in self-reported gains and evaluations due to diverging conceptualisations of how the respondent understands the link. This does not mean that such self-reported data are per definition invalid. There is for instance ample evidence of student evaluations being a good indication of quality. However, it can be the case that students would not be conscious about what aspects of their course are research based (for instance, see section 2.4.3 for discussion about students prejudices on how they perceive research), especially as the notion of research can have a rather broad definition. For this reason, the development of indicators also need to include varied data sources.

Second, building on this first argument, indicators that address complex processes of education and research are rarely able to encompass all aspects of the academic practice. Thus, too narrow indicators can become too rigid and fail to take into account the broader context of academic work. Having in mind that research and education are dynamic activities with new conceptualisations and interpretations emerging over time, we argue that the indicators have to be broad enough to incorporate institutional innovation and local quality enhancement initiatives as dynamic processes.

Third, indicators have to balance costs and benefits. This means that a very long list of detailed indicators would not be cost-effective for an evaluation. As a consequence, a too large set of

indicators might undermine the quality of data obtained by the institution and require substantial additional resources for compiling the data.

For this reason, we argue that indicators to measure the research-education relationships and its quality on higher education should be seen as “quasi-indicators” rather than full-scale performance indicators. Such indicators should use multiple sources of data, and employ both qualitative and quantitative measures. Furthermore, we argue that it is important that indicators would, when possible, use existing data sources and measurements.

3.5 Indicators

Having these three principles in mind, we propose three sets of indicators. The first set concerns directly with the framework conditions for educational practices. Broadly speaking, these can be seen as input indicators. The second set of indicators emphasizes process of education. In general, the quality of the educational process has been notoriously difficult to measure in indicators, leading to various proxy measures being used in rankings (i.e. student-staff ratios etc). Third, we focus on output, in the form of assessment. We argue that this distinction is important, as indicators that give information about the framework conditions would not necessarily be good indicators for the educational process.

An important consideration here is that a number of these indicators allow for comparisons within the disciplinary fields, but comparisons across fields on single indicators (in particular indicators about research orientation and research productivity) should be conducted with caution, having in mind that academic work varies substantially across fields (see section 2.2.1).

Having in mind the principles outlined in the previous section, we intentionally propose broad indicators to avoid that performing well on the indicator would hamper educational innovation. At the same time, the combination of indicators has to be sufficiently specific to say something meaningful about the relationship between education and research.

3.5.1 Input indicators

While the literature examined suggests that one important aspect is national culture and tradition for research integration into education, we have not included specific indicators on national level, as the proposed indicators will be used in a single country context. However, if cross-national comparisons would be considered, national regulations for qualifications and general policy context is a dimension that should be included in the analysis.

Thus, our input indicators primarily focus on the specific aspects on organizational and study programme level that can be used as a means to examine the link on the local level.

Organizational conditions

Literature in our review has highlighted that creating institutional incentives can have an important effect in facilitating or weakening the link between education and research (see section 2.7.). In particular, this concerns the extent to which there are explicit and direct incentives for emphasizing research and/or education, and whether these incentives are balanced. For instance, if there are strong institutional incentives for increasing quality of research, whereas no such incentives exist for excellent teaching, this can create an unbalanced emphasis among staff.

Possible sources for measurements are necessarily qualitative, and include an overview of existing institutional and faculty strategies for achieving excellence in education and research, the extent to which specific incentives and programmes have been introduced, and the outcomes of such

incentives. A realistic source for such information is either self-reports or qualitative analysis of existing document data from institutions.

Academic staff research and development orientation

In the three NOKUT evaluations conducted, staff qualification was the only input indicator that showed some relationship to quality. Furthermore, existing research has pointed towards a link between staff research activity, productivity and their engagement with research-based education (see section 3.1.2 for a summary from the review). As a key element of research literacy is to learn the methodology of that particular knowledge field, staff acquaintance with research and development can be seen as a basis for transferring such knowledge to students. However, this indicator should be seen as a compound indicator, where staff qualifications, publications and other development work would all be taken into account.

It should be noted that this indicator is particularly discipline-dependent, and that it should not be used as a single indicator or a proxy for measurement of the overall relationship. For instance, the study by Kyvik and Vågan (2014) on short cycle professional programmes showed that staff in university colleges was less active researchers, but at the same time showed a high engagement for research-based education. Furthermore, existing research in Norway shows high stratification in publication patterns, for instance, in the area of humanities (Kyvik, 2015). However, we nevertheless argue that an overall compound indicator that can capture "staff research and development orientation" is relevant when discussing the relationship between education and research.

In Norwegian context, use of research in teaching is sometimes translated as teaching about *own* research. The law indicates that education should be based on the cutting edge of knowledge on the field. While staff research can provide useful examples to learn the methodology of the knowledge field in a detailed manner (staff having first-hand knowledge about the process), it is not given that it would in all cases be equally relevant to the learning outcomes of the students in that particular subject. Thus, we argue that teaching about own research can be a very useful way of introducing students to the methodology of the knowledge field; however, staff who engages in research and development can productively use cutting edge research in teaching without necessarily using examples from own research in all cases. This is to a large extent dependent on the research interests and specialization of staff, and the expected learning outcomes of students in that particular subject. Therefore, while it is positive that staff uses own research in their teaching practice, this would not be a good indicator on its own.

Possible sources for measurements. We argue that such an indicator should not only examine the share of staff with PhD level competence, but also take into account publication patterns – not only quantitatively, but also qualitatively. To assure that this indicator would also adopt a sufficiently broad definition to research, this should be complemented with self-reported data on developmental work and other research-related activities that would not be expressed through traditional publication patterns. The rationale for this more open add-on to the indicator stems from the literature review, where in some fields (accounting was an example highlighted in the review), the notion of research can be rather different.

Research-based curriculum

One important result from the literature review is that introducing research to education requires coherence in curriculum planning. This has been emphasized both in literature on curriculum (see section 2.6.), literature that has specified various kinds of links (see section 2.2.), as well as literature on inquiry-based learning (2.4.1.). What these arguments share is that to assure research skill development, curriculum itself needs to be research-based. Rather than the curriculum being a set of rather independent modules or courses, this means that there is a need for systematic thinking about how students will obtain the necessary skills to engage with research – whether it is reading research reports, or engaging with research projects themselves. This concerns, for instance, the organisation and placement of research methods courses, and the scope and format of bachelor and master thesis.

In a more principal level, this concerns how theory and research activities are being coupled in the curriculum. Here, sensitivity towards disciplinary practices needs to be shown, having in mind the differences in academic work, and the variation that Kyvik and Vågan (2014) identified with respect to research methods across professional fields.

Possible sources for measurements here include the scope and placement of bachelor and master thesis in the study programme, as well as organisation of research methods courses. Are such methods courses provided and where are they located in the study plan? Data sources for such information would be self-evaluation from study programmes. Another possible source for such data could be student feedback.

3.5.2 Process indicators

For process indicators, we take a starting point in the notion of inquiry based learning as a key element of introducing students to the methodology of the knowledge field. This perspective emphasizes sensitivity towards the various practices, and allows for local translations of the concept.

Use of student-active learning forms

A substantial conclusion from the review is that inquiry-based learning and student-active learning forms appear to have a positive effect on student learning. This has been substantiated in existing literature reviews (Damşa et al., 2015), as well as in literature about undergraduate research (see section 2.4.3 on value added by undergraduate research). As one example, Spronken-Smith and Walker (2010) examined the potential of IBL as a means to strengthen links between teaching and research. They examined three different cases and found that an open, discovery-oriented inquiry-based learning can facilitate tighter links. Furthermore, Healey (2005b) has made a strong argument for undergraduate research.

However, an important argument here is that inquiry-based learning does not *only* mean inclusion of students to staff research projects. Instead, we advocate for a broad and open interpretation of inquiry-based learning approaches. This definition can sufficiently take into account disciplinary differences. For instance, inquiry-based learning then means that the students obtain research literacy in their specific field by gaining insights to the methodology of that particular knowledge field. This can mean ability to conduct literature reviews, working in an archive or being able to read complex technical reports. Furthermore, this includes the ability to engage in peer review processes, and provide feedback in a constructive manner. In essence, this concerns the way in which students are activated to engage with knowledge on the field.

Furthermore, this focus emphasizes the research-based nature of learning outcomes. That is, not only the knowledge, but also the skills and general competencies should be research-based. Thus, an inquiry based approach emphasizes the development of research literacy, and thus contributes to skills and competencies emphasized in the qualifications framework – related to analytical skills, critical thinking, communication and awareness of ethical issues.

Possible measurements: to obtain data about the scope of using student-active learning forms, it is likely that multiple data sources are needed. This can include data from *Studiebarometeret*, as well as self-evaluation reports and staff surveys. Furthermore, it is important that it is clearly exemplified what is meant by student-active learning forms and that these should be translated to local disciplinary context.

Variation of teaching and learning methods

While student-active and inquiry-based learning is emphasized in literature, another key conclusion from the review is that it is important to assure variety of teaching and learning methods. The shift towards student-centred learning does not mean that all learning should *only* be inquiry-based. Instead, productive learning requires a combination. This indicator is closely linked to the curriculum research integration indicator. While the former emphasizes the sequence and scope of including

research elements, this indicator emphasizes the process aspect, that is, how different courses are carried out.

This variation is particularly important to assure a broad set of skills related to research. For instance. Norwegian bachelor level graduates are expected to be able to apply academic knowledge, reflect over own practice, find and evaluate to scholarly information. One could argue that these three skills require different kinds of learning methods. Thus, variety of teaching and learning methods emphasizes the research-based nature of the skills and competencies expressed in learning outcome formulations.

Possible measurements: The combination and variety of teaching and learning methods employed in the study programme. Data sources for such information would be self-evaluation from study programmes. Another possible source for such data could be student feedback or staff questionnaires.

Involvement in staff research

Involvement in staff research projects is frequently examined as one dimension of research-based education in Norway. However, taking into account the results from (Kyvik & Aamodt, 2015; Kyvik & Vågan, 2014) and the previous NOKUT evaluations, we argue that it does not seem to be meaningful to use this indicator on bachelor level in a broad scale. Literature on undergraduate research highlights that in fields with more complex basic threshold concepts, it is complicated to involve students in research projects. Furthermore, this involvement is typically limited for a small number of students in each cohort and is highly linked to the size of cohorts and other external aspects.

This does not mean that bachelor students should not be engaged in inquiry-based activities. Rather the opposite, we argue that engagement with inquiry-based learning forms is one of the key aspects of research-based education, but this should take the form of student-active learning forms, combined with a careful introduction to the methodology of the field of knowledge.

However, one can argue that this can be seen as a relevant indicator on master level studies, as a number of master thesis can be seen as an (independent) research contribution.

Possible measurements: Share of students involved in staff research.

3.5.3 Outcome indicators

In some sense, the key outcome indicator are the learning outcomes of the study programme, and the extent to which these emphasized research literacy. However, one could argue that this would not be a meaningful indicator on its own as learning outcomes need to be aligned with the National Qualifications Framework. However, a key aspect here is assessment practice and the extent to which assessment practices are appropriate to facilitate student-active learning.

Assessment

Aligned with the process indicators emphasizing the use of student-active learning, and the use of varied teaching and learning approaches, assessment needs to be appropriate to facilitate such learning. Literature on assessment practices emphasizes the necessity for alignment and coherence (Damşa et al., 2015).

Possible measurements: Quantifiable data from curriculum regarding share of various assessment methods.

Table 4 - Summary of indicators and possible measurements

Type	Indicators	Possible measurement
Input	Organizational conditions	Qualitative overview of existing institutional and faculty strategies for achieving excellence in education and research, the extent to which specific incentives and programmes have been introduced, and the outcomes of such incentives. A realistic source for such information is either self-reports or qualitative analysis of existing document data from institutions.
	Academic staff R&D orientation	Composite indicator, including staff with PhD level competence, as well as number and quality of publications, complemented with self-reported data on developmental work and other research-related activities that would not be expressed through traditional publication patterns.
	Research based curriculum	Qualitative overview of organisation of study programmes structure. For example: scope and placement of bachelor and master thesis in the study programme, as well as organisation of research methods courses.
Process	Use of student-active learning forms	Multiple data sources. Self reported data from students (i.e. *Studiebarometer*), as well as self-evaluation reports from institutions and/or staff surveys.
	Variation of teaching and learning methods	The combination and variety of teaching and learning methods employed in the study programme. Data sources for such information would be self-evaluation from study programmes. Another possible source for such data could be student feedback or staff questionnaires.
	Involvement in staff research (on master level primarily)	Share of students involved in staff research.
Output	Assessment practices	Quantifiable data from curriculum regarding share of various assessment methods.

4 Brief concluding comments

The report has examined empirical evidence on the research-education link and how it has been studied in literature. Drawing on findings form the literature review and existing work in the Norwegian context we have developed a set of indicators that could be used in the Norwegian context. In the beginning of this report, we outlined three groups of questions for this study. In this final concluding section, we reflect on these questions.

Question 1. *How can one examine the effects the interplay between research and education has on the quality of education, and students' learning outcomes? What methods and data can one use to examine the interplay between research and education? For the last question, a typology of different types of interplay between research and education will be useful.*

A set of input, process and output indicators can provide insights to the effects of the link between education and research. In existing literature, a range of various approaches have been identified. For instance, both quantitative and qualitative methods have been used to examine the interplay between research and education, and these studies have taken various units of analysis. What is also clear in existing research is that this is a very complex relationship. Not only is the relationship difficult to measure (and measurements frequently result in contradictory results), the core concepts themselves are ambiguous and contextually embedded (disciplinary, institution, country). In general, there are some aspects of the literature that have become more mainstreamed (i.e. the widening spread of undergraduate research). At the same time, much of the literature on positive links is not very specific on the actual mechanisms of the link.

In general, the typology provided by Healey (and later revised by Healey and Jenkins) is one of the most widespread models. While some additional modifications have been provided over time, in general, the four quadrants appear to be rather well established in the literature. In addition to this, various models have been developed for further distinguishing between various ways in which students engage with knowledge, and their level of autonomy in engaging with knowledge.

Literature points towards multiple possible operationalisations for the link between education and research. Multiple translations of what research-based learning (as a term for *forskningsbasert utdanning*) also remain in the Norwegian system. While the unclear nature of the concept in the Norwegian context has been pointed out on multiple occasions throughout the years (Hyllseth, 2001; Kyvik & Vågan, 2014; UHR, 2010), it appears that the concept has remained ambiguous in Norway. This also makes measurements and use of indicators very complex, as they would need to be able to cover a range of possible activities and interpretations. This is also part of the rationale for why some of our proposed indicators are rather broad. A key consideration here is to assure that the use of indicators

does not hamper educational innovation. As indicated in the three brief illustrations of good practice – incentives and initiatives can take place on various levels, thus it could be seen as beneficiary to avoid indicators that would constrain such processes.

Some of the indicators we have proposed have also been used in the Norwegian context for other purposes, related to concerns of student learning and quality. Thus, we argue that it should not be a goal in itself to create *more* indicators, instead, there is a need for a conscious reflection on how and for what purposes particular indicators are used.

Question 2. *Are there disciplinary differences? Are there disciplines or subjects where a productive interplay of research and teaching is harder to achieve and/or less likely to have a positive effect on the quality of education and research?*

One could be tempted to give a very brief answer to this question and merely argue that, yes, this is the case. This is also not very surprising, considering that the notion of research varies across disciplines. In the beginning of this report, we referred to a broad and narrow conception of research. However, even within the narrow conception, the various categories (hard/soft, pure/applied) provide distinct ways of engaging with research work. Furthermore, there are also some discipline-specific traditions for educational practices.

This review has emphasized that the discipline is only one of the sources for differences. In addition to the discipline, the interplay is likely to vary across countries, institutions and units within the institution (i.e. faculties, departments in addition to the disciplines). Furthermore, the link can also vary across different levels of education. This highlights that this link between education and research is highly contextually embedded, making one-size-fits-all approach to measurement rather complicated.

As a way to tackle this diversity, we suggest to view this interplay as an emphasis on student-active and inquiry-based learning. The essence of this way of thinking is that students are activated in the learning process, they become introduced to the specific methodology and approaches of that knowledge field and broadly develop their research literacy. Taking this perspective, one can argue that it can be equally relevant for all disciplines and subjects, as the approach is embedded in the particular subject/discipline.

It is important to emphasize that while there appears to be considerable support for emphasizing student-active learning forms in the literature, it is also stressed that research-based education should in fact take multiple forms and that *only* focusing on students doing research (the research-based quadrant of Healey model) would not be a desirable trend. For instance, this can also mean that in the process of developing particular research skills, students also need to learn *about* research and research methods (the teacher- and content-centred quadrant of Healey model). Thus, while we emphasize student-active learning, this also means a broader research-based view on curriculum organisation as a whole, including also assessment practices.

Question 3. *Even though it is most common to think that research affects education, we also want to map how different aspects of education can affect the quality or content of research. In other words, what interactions between education and research can potentially benefit research?*

In this aspect, existing research is scarce, with the few studies that have examined this direction of the link have identified the positive benefits of including students in research projects that can in turn have a positive effect on publication patterns. These studies are however rather limited in number and emphasize particular teaching methods. It would seem that such direction would thus be most relevant to examine on Master (and PhD) level. We did not find existing studies of teaching-research links that show that traditional classroom teaching in general has a positive impact on research.

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