

Danish University Colleges

Enhancing the quality of programmes through research

Introducing research at a Danish university college

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KIP

MEASURING THE
CONTRIBUTION OF
RESEARCH AND
DEVELOPMENT TO
THE QUALITY OF
PROGRAMMES

RESULTS FROM A DANISH
UNIVERSITY COLLEGE

**Københavns Professionshøjskole
2019**

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**KØBENHAVNS
PROFESSIONS
HØJSKOLE**

INDHOLD

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ABSTRACT

Measuring the contribution of research and development to the quality of programmes: Results from a Danish university college

This paper aims at exploring the impact of the research experience of members of the faculty on the quality of teaching. By applying the framework of attribution analysis, the paper examines the possibility of using survey data based on the quality as experienced by the faculty to measure this impact. The case used in the paper is Metropolitan University College, which was granted the legal basis, as well as public funds, for research activities in 2013. In 2014, 2015, 2016 and 2017, the faculty were surveyed to uncover the impact of research activities. This data provides the basis of the present analysis.

1.0 Introduction^{1 2}

On January 1, 2013, the Danish university college (UC) sector was granted the legal basis, as well as public funds, to conduct applied research and development (R&D) activities. The purpose was to enhance the quality of the degree programmes offered at UCs. This has entailed a significant increase in research qualified (PhD) faculty members, and a significant increase in research activity and output at these institutions. Note that this legislative change came in the wake of a national strategy, the “Globaliseringsstrategien” from 2007-2012, through which funds were made available to UCs with a broad set of purposes. Since 2011, Metropolitan University College has partly used these funds to enhance the quality of programmes through R&D.³

A key mission at universities is to conduct research at the highest possible level. At UCs, the key mission of research is to contribute to growth and development in society, primarily through teaching and learning. Having this distinction in mind, the quality indicators used by universities are not adequate in the context of a UC. It is of utmost importance to address the issue of how R&D have an impact on both teaching and society at large. This paper is focused on how R&D have an impact on teaching and learning, which means that the issue of any impact on society at large will be left to a different paper.

However, it is not easy to measure how R&D have an impact on teaching and learning. At Metropolitan University College, information on the impact of research activities has been collected yearly through several indicators, including data from surveys of the faculty in 2015, 2016 and 2017. This method was chosen with the cost of quality assurance in mind (Lindeberg 2007). Surveying staff is a relatively cheap method of data collection, which can thereby constitute a key indicator in a viable real life quality system.

The surveys indicate a very high utilisation of research experience in teaching. However, the downside of the method is that it only generates data on quality as experienced, and such data are known to be weak. Hence, the purpose of this paper is to explore measures to improve the quality of the reliability and validity of the survey data collected.

2.0 Research question

The empirical literature on the impact of research into the quality of teaching focuses on the correlation between productivity and/or quality (Marsh & Hattie 2002), or more qualitatively on the relationship between the two (Healey 2005; Healey & Jenkins 2009; Jenkins 2004; Mariken et al. 2009). However, we have not been able to find much research on the impact of R&D on teaching and learning when R&D is introduced in an institution which has not previously conducted research, as was the case at the Danish UCs.

¹ An earlier version of this paper was presented at the EAIR 2018 conference. The authors are grateful for the valuable comments from the chair and participants.

² The authors thank Nina Cecilie Svendsen, Jonathan Jagd Hav Hermansen and Siddhartha Baviskar for statistical assistance and consultation.

³ On March 1, 2018 the university college merged with University College Capital to form University College Copenhagen. The work reported in this paper has been done at Metropolitan University College and the results only account for this section of the now merged institution.

The paper aims to explore the impact of the introduction of research on teaching and learning. It does so by answering two questions:

- To what extent is it possible to improve the quality of self-reported outcomes of the faculty members' utilisation of research experience in their teaching - with respect to trustworthiness and rigour?
- What indications does this provide regarding the impact of research on teaching?

3.0 Approach

This paper has been written in an attempt to strengthen the conceptualization of the research-teaching nexus in university colleges. The venture has not been conducted as a research project, as data were collected as a part of quality assurance procedures prior to the definition of the research questions, and resources have not allowed the development of either the questionnaire or the literature review to follow rigorous scholarly procedures. The questionnaire was developed and qualified based on interviews with faculty members and feedback from the respondents over the years. Prior to application of the survey to the entire population, it was tested for technical problems on a smaller group.

The method applied in the paper is inspired by attribution analysis. Attribution analysis can be understood as a pragmatic form of theory-based evaluation. It was developed by John Mayne (2001), of the Office of the Auditor General of Canada, as a way to attain knowledge from already acquired data on performance, rather than designing new studies from scratch. Mayne prescribes four analytical steps: 1) Develop the result chain (programme theory), 2) assess the existing evidence on results, 3) assess the alternative explanations, 4) assemble the performance story (Mayne 2001).

The result chain will be developed with inputs from the legal framework for the provision of higher education at UCs and the Qualifications Framework for Danish Higher Education, as well as the literature mentioned in the background section on linkages between research and teaching.

The existing evidence will primarily be the above-mentioned surveys, which will be qualified by comparison with other evidence, such as how students experience the level of theory, the use of international literature and "test re-test" analysis of the survey.

The performance story will serve as the conclusion of the second research question, i.e. provide a balanced argument about the impact from research on teaching and learning.

4.0 The result chain

The result chain will be developed in three steps. The first step is to sketch out a basic result chain from the legal framework, then the result chain will be enhanced through the legal remarks and finally qualified through research findings.

Basic result chain

The law constituting the legal framework for R&D at UCs is not formulated as a result chain or a programme theory, however there appears to be a rather clear idea of how the basic result chain is expected to unfold. In the law, it is inferred that R&D activities shall bring about knowledge and

solutions to the challenges facing the profession, which will lead to improved teaching and learning (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013).⁴

However, whereas it is rather easy to grasp how research and development translate into new knowledge and new solutions, it is more difficult to grasp how this translates into improved teaching and learning. The legal remarks contain three qualifications that may serve to form a more elaborate result chain (Ministeriet for Forskning, Innovation og Videregående Uddannelser 2013).

Firstly, it is stated that R&D first and foremost are to be pursued in order to ensure that relevant new knowledge is available to full-time degree programmes and professional development programmes (ibid.).

Secondly, it is specified that faculty members should be involved in R&D activities as a “*natural part of their job*” and that “*faculty members [are expected to] participate actively and continuously in the institution’s R&D activities*”⁵. Hence, it appears to be assumed that having faculty involved in R&D will further improve the quality of teaching and learning, and that this in itself may be regarded as an output from the R&D activity.

Thirdly, it is specified that the activities should result in communication in relevant and acknowledged publications, and should be “*circulated for the benefit of students, other faculty members, employers as well as users and citizens, e.g. in the form of the development of new programmes, courses, the development of teaching materials, the preparation of written publications and other dissemination activities*”.⁶ Hence, publications intended for teaching must also be considered as an output alongside research publications.

As a consequence of the three items above, improved teaching and learning should result in better graduates. Considering the formal framework of education, this may be understood within the Qualifications Framework for Danish Higher Education as improved knowledge (theoretical and/or factual), skills (cognitive and practical) and competences (the ability to apply knowledge and skills autonomously and with responsibility).

⁴ This is found in §3 and 5 in Ministeriet for Forskning, Innovation og Videregående Uddannelser (2013).

⁵ The entire Danish sentence reads as follows (the underlined parts are translated): “Med forslaget præciseres det, at underviserne på erhvervsakademierne som en naturlig del af deres virke på kvalificeret vis indgår i praksisrettede og anvendelsesorienterede forsknings- og udviklingsaktiviteter. Det indebærer indsamling, bearbejdning og formidling samt produktion af relevant faglig viden, i samspil og konkrete samarbejder med virksomheder, andre uddannelses- og videninstitutioner m.v. Med forslaget indskræpes således forventningen om, at de fastansatte undervisere deltager aktivt og kontinuerligt i institutionens forsknings- og udviklingsaktiviteter, samt at underviserne og øvrige relevante medarbejdere holder sig løbende fagligt opdateret på nyeste viden fra national og international forskning samt viden fra deres respektive praksisfelter”. (Ministeriet for Forskning, Innovation og Videregående Uddannelser, 2013:16).

⁶ The entire Danish sentence reads as follows (the underlined parts are translated): Institutionernes ledelser skal fremme, at resultater og viden fra gennemførte forsknings- og udviklingsaktiviteter formidles via relevante og anerkendte kanaler og omsættes konkret til gavn for studerende, øvrige undervisere, aftagere og brugere/borgere, f.eks. i form af udvikling af nye uddannelses- og undervisningsforløb, udvikling af undervisningsmaterialer, udarbejdelse af skriftlige publikationer, anden formidlingsaktivitet m.v. (Ministeriet for Forskning, Innovation og Videregående Uddannelser, 2013:16).

Table 1: Basic result chain

Activity	R&D
Output	New or significantly improved programmes or course descriptions. ⁷ Teaching staff is involved in R&D. Publications (research publications and teaching materials).
Outcome	Improved teaching and learning as 1) research output is used in teaching and 2) teachers activate research experience or knowledge gained through research in their teaching.
Impact	Graduates with better knowledge, skills and competences (through better student learning).

Qualified result chain

When working with result chains or other tools inspired by “programme theory” thinking, the most important part is not the categories (in the terminology of the result chain activity/output/outcome/impact), but the link between them that brings about new insights (Rogers et al. 2000).

Usually it is relatively easy to comprehend how the activities bring about output. However, it is much less self-evident how these outputs lead to the expected outcomes and how these outcomes in turn lead to the expected impact. What is the hypothesis that justifies the jump? What is the mechanism (the term used by Pawson and Tilley) that brings them about? Hence, how do publications and teacher research competence translate into improved student learning? In order to address this issue, a better comprehension of the nexus between research, teaching and learning is necessary.

Research-teaching nexus

Since the beginning of the modern university, the link between research and teaching has been debated. Numerous studies have focused on the relationship between excellent research and excellent teaching, finding no or very vague significant correlation between the two – at the individual level (For a review of the literature, see Tight 2016 and Hattie and March 1996).

At the same time, most researchers emphasize that this does not mean that there is no link, just that it is not simple. Prince et al (2007) states that there seems to be two sides to the debate: *“Whether research can support teaching in principle and whether it has been shown to do so in practice. [...] There can be little doubt that potential synergies exist between faculty research and undergraduate teaching, but empirical studies clearly show that the existing linkage is weak.”* (Prince et al. 2007: 283)

In recent years, a range of studies of a qualitative nature have focused on the application and practice of the nexus. The studies can be divided into four foci:

- those offering advice on how the research-teaching nexus may be developed or strengthened;

⁷ The phrase, “new or significantly improved” is used by the OECD in the Oslo manual to define innovation (OECD & Eurostat 2005).

- those examining staff and student attitudes towards the research-teaching nexus;
- those discussing how the research-teaching nexus works or is articulated; and
- those suggesting how the research-teaching nexus might best be researched or related to other areas of knowledge (Tight 2016: 199).

This paper is primarily interested in how participating in research activities might affect teaching, and how it might be measured. Looking at the theoretical basis described above, and especially the strand of research on how the nexus works, very little research has been done on the possible link between participating in research and teaching practices, equivalent to the link between the output and the outcome in the result chain in this study. Instead, the focus is on the link between teaching practices and students' learning and satisfaction, equivalent to the link between the outcome and the impact in the result chain in this study. For example, the development of various models for how research-based teaching can affect students has often been based on a very large range of qualitative case studies (Damsholt et al. 2018).

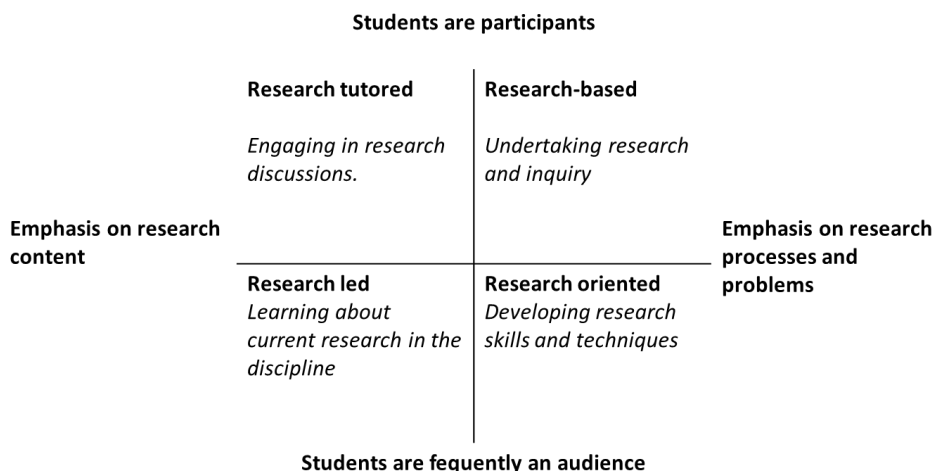
Healey and Jenkins' model of the teaching-research nexus

The four-field model of Mick Healy and Alan Jenkins is an often-used model to conceptualize the link between undergraduate teaching and research – in this study to elaborate the link between outcome and impact. They identify four different ways of “*engaging undergraduates with research and inquiry*” (Healey & Jenkins 2009) along two axes. One axis has a learning situation with “emphasis on research content” at one end, and “emphasis on research processes and problems” at the other end. The other axis addresses the main actor in the learning situation, having “students as participants” at one end and “students as audience” at the other.

By crossing the two axes, they end up with four forms of teaching where students are engaged with research:

- **Research-led:** In this learning situation, students are expected to learn about current research in the discipline. Students are primarily audience and the focus is on content.
- **Research-oriented:** In this learning situation, students are expected to develop research skills and techniques. Students are primarily audience in the teaching situation and the focus is on research processes and problems.
- **Research-based:** In this learning situation, the students are undertaking research and inquiry themselves. Hence, the students are active and involved with the research processes and problems.
- **Research-tutored:** This learning situation engages students in research discussions based on existing research results. Students are active and preoccupied with research content.

Figure 1: Healey and Jenkins’ model of the teaching research nexus



Reproduced from Healey and Jenkins (2009, p. 6).

It is of the utmost importance to underline that Healey and Jenkins focus on undergraduate studies in general. The purpose of the UCs is to offer professional bachelor degrees, whereas the purpose of the universities is to qualify the student for a postgraduate research education, i.a. Hence, when the model argues that students should develop research and inquiry skills, in the context of this paper this primarily refers to skills transferable to their future profession, such as systematic observation, and not to research skills per se.

However, as previously mentioned, the model is very focused on learning situations and not on how research activities enhance the quality of these situations. Thus, in the table below, the four forms of teaching are used to infer and specify the links between the outcomes and impacts - the form of teaching being the “mechanism” that creates the nexus between outcome and impact. The form of teaching is placed in the centre, the research outcomes relevant to this kind of learning situation on the left side, and the specific impacts that might result from the form of teaching in question, derived from the Qualifications Framework for Danish Higher Education, on the right side. The outcomes mentioned below are not meant to be a comprehensive listing of possible outcomes, nor is the list of possible impacts on student learning all-embracing. This is especially so, as surprisingly little research into how research qualifies, or is expected to qualify, teachers and/or improve the quality of teaching has been identified.

Table 2: Research-led research-learning nexus

Outcome of research that is expected to improve the quality of teaching	Form of teaching	Impact: Graduates with better knowledge, skills and competences⁸
Through participation in research, faculty are exposed	Research-led In this learning situation,	Improved development-based knowledge of the applied

⁸ Inspired by Ministry of Higher Education and Science (2008).

to new research results that are used in their teaching.	students are expected to learn about current research within the discipline.	<i>theories and methodologies of the profession and the subject area.</i>
Faculty are able to improve the quality of the teaching of research results by using their own experience.	Students are primarily audience and the focus is on content.	Improved skills in <i>evaluating practice-oriented and theoretical issues as well as explaining the reasons for and choosing relevant solution models.</i>

Table 3: Research-oriented research-learning nexus

Outcome of research that is expected to improve the quality of teaching	Forms of teaching	Impact: Graduates with better knowledge, skills and competences
Teaching materials are produced that allow students to work with research methods <i>relevant to their profession.</i>	Research-oriented In this learning situation, students are expected to develop research skills and techniques. Students are primarily audience in the teaching situation and the focus is on research processes and problems.	Improved knowledge of the <i>practice, of applied theories and methodologies, as well as the ability to reflect on the practice and application of the theories and methodologies of the profession.</i>
Teaching materials are produced that allow students to gain insight into their field of work.		Improved practical skills concerning applying <i>the methodologies and tools of the subject area, as well as mastery of the skills related to work in the profession.</i>
Faculty with research experience are better qualified to guide and advise students on research methods.		

Table 4: Research-based research-learning nexus

Outcome of research that is expected to improve the quality of teaching	Forms of teaching	Impact: Graduates with better knowledge, skills and competences
Faculty with research experience are better qualified to guide and advise students on research methods.	Research-based In this learning situation, the students undertake research and inquiry themselves. Hence, the students are active and involved with the	Improved practical skills concerning applying <i>the methodologies and tools of the subject area as well as mastery of the skills related to work in the profession.</i>

	research processes and problems.	Improved competence to identify and develop their own knowledge, skills and competences related to the profession.
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Table 5: Research-tutored research-learning nexus

Outcome of research that is expected to improve the quality of teaching	Forms of teaching	Impact: Graduates with better knowledge, skills and competences
Through participation in research, faculty are exposed to new research that is used in teaching.	Research-tutored This learning situation engages students in research discussions based on existing research results. Students are active and preoccupied with research content.	Improved knowledge of the practice of the profession and the subject area.
Faculty with research experience are better qualified to guide and advise students on their work with primary research sources.		Improved skills in communicating practice-oriented and academic issues and solutions to collaborative partners and users
		Improved competence to independently participate in discipline-specific and interdisciplinary collaboration and assume responsibility within the framework of professional ethics.

This section has developed a result chain based on the legal framework, justified by using Healey and Jenkins' four ways of linking research and teaching. In the following section, existing evidence will be used to assess it.

5.0 Assessing the existing evidence on results

A common challenge of working with theory-based evaluation approaches is that it is relatively undemanding to establish evidence about activities and outputs, whereas it is much more difficult to establish evidence about outcomes and impacts – especially in a cost-effective way. As table 6 shows, this is the case at the Metropolitan University College as well.

Table 6: Strength of evidence

Activity	High quality data on:
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	Time spent on R&D by different categories of staff and internal and external funds used⁹.
Output	High quality data on: Research publications, faculty with research experience (PhD), and self-reported data on publications intended for use in teaching situations.
Outcome	Survey data collected on how faculty use their research experience in their teaching.
Impact	Knowledge about the impact on student learning is limited.

This paper focuses on the outcome, because this is the part of the result chain in which evidence exists, though the quality of the evidence is most uncertain. However, before we turn to the survey, it would be worthwhile to mention some of the main results in terms of activities and outputs:

- Man-years spent on R&D: from 52.5 in 2013 to 79 in 2017
- Number of PhD-qualified members of faculty: from 61 in 2013 to 117 in 2017
- Number of yearly published peer reviewed articles: from 34 in 2013 to 91 in 2017¹⁰
- Number of yearly published educational books: from 6 in 2013 to 12 in 2017

5.1 The survey

The survey of how faculty apply their research experience in teaching was developed in order to study the outcome of the strategic priority: *More teachers doing research*. It takes its point of departure in Statistics Denmark's interpretation of OECD's definition of R&D personnel, thus focusing on the those members of the faculty who have spent more than 5% of their man-years on R&D¹¹.

Since 2014, the survey has asked those faculty members who personally fall within the definition of R&D (henceforward R&D faculty) to what extent their R&D participation in the given year has contributed to their teaching in different ways. In the two latter years, part of the survey was also sent to faculty members who had not been involved in R&D in the year in question. This part of the survey addresses the use of new knowledge from practice/industry or from research conducted at Metropolitan University College, or elsewhere.

The survey of the R&D faculty is based on two main themes: The method by which R&D has influenced the respondent's teaching; and through what teaching methods such influence was exerted.

The survey was developed in close collaboration with faculty, but unfortunately no result chain was constructed, nor was it research based. Thus, the survey cannot directly be linked to the result

⁹ This is reported in the annual knowledge accounts from the Danish UCs (Danske Professionshøjskoler 2017).

¹⁰ In addition to the internal report, this is documentable through Scopus and Web of science.

¹¹ Since 2016, Statistics Denmark has changed the threshold to 10%. This is not incorporated in the survey.

chain described above, including Healey and Jenkins' model. However, one could argue that the survey's questions explore different ways of incorporating R&D in teaching. Following this line of thinking, one can use Healey and Jenkins' model as a point of departure, and locate the questions in relation to the two axes – student participation and content of teaching.

In Figure 2, the questions within the two themes are positioned along the axes of the model.

Figure 2: Student participation and content of teaching

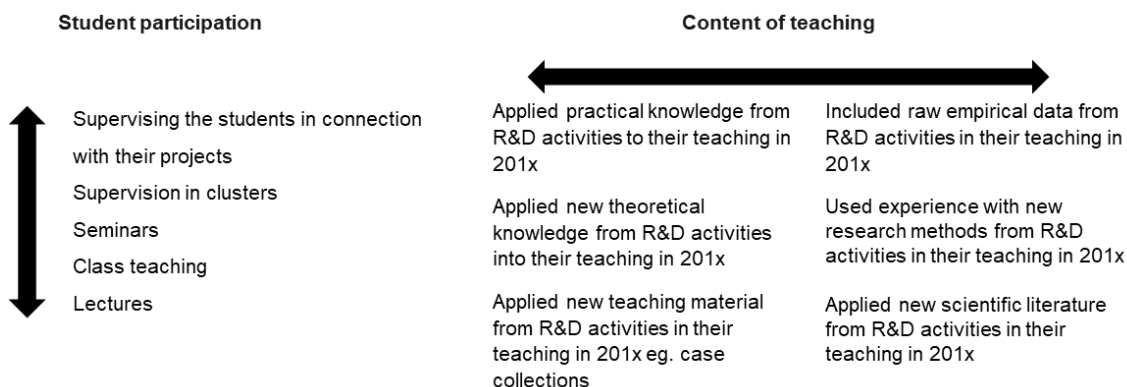


Table 7 shows the percentage of R&D faculty replying to a *great extent* or to a *very great extent* to the different ways of incorporating R&D in teaching.

Table 7: Results of survey

Axes	Survey questions	2014*	2015	2016	2017	AV G
Emphasis on research content	Applied new theoretical knowledge from R&D activities in your teaching in 201x	37%	51%	59%	57%	51%
	Applied practical knowledge from R&D activities to your teaching in 201x	39%	59%	58%	41%	49%
	Applied new scientific literature from R&D activities in your teaching in 201x	20%	25%	42%	58%	36%
Emphasis on research processes	Applied new teaching material from R&D activities in your teaching in 201x, e.g. case collections	14%	24%	35%	36%	27%

and problems	Included raw empirical data from R&D activities in your teaching in 201x	16%	31%	38%	30%	29%
	Used experience with new research methods from R&D activities in your teaching in 201x	20%	37%	41%	40%	35%
Students as participants	Supervising the students in connection with their projects		46%	53%	48%*	49%
	Supervision in clusters			16%	14%*	15%
	Seminars			21%	13%*	17%
Students as audience	Class teaching			56%	55%*	56%
	Lectures			34%	29%*	32%
Used any of the above to a large extent in your teaching (computed)		57 %	73%	72%	73%	69%

* In 2017, it was possible to state that the respondent did not use that method of teaching. As it was not possible in the preceding years, they are not excluded from the report.

** The scale of response was different: *To a high degree, To a certain degree, To a lesser degree, Not at all, Not relevant*. The results from 2014 are based on the first-mentioned possible answer.

57-73 % of R&D faculty find that, to a large extent, they use their participation in R&D in their teaching. This 57-73 % is distributed across the different questions in the survey.

Using the survey as evidence, we can conclude that the faculty's involvement in R&D is indeed being incorporated into the teaching, mainly focused on content rather than methods and process of research. That was to be expected in the light of the difference between universities and UCs mentioned earlier.

However, if this is robust evidence, a question remains: Is this in fact the situation, and if so, is this utilization giving the wanted outcome, i.e., more competent and skilled graduates? In the following section, the evidence will be tested regarding trustworthiness and rigour.

6.0 Assess the alternative explanations

What is addressed in the survey, is the effect as assessed by the faculty. It is known that this is not a rigorous indicator of effect. Hence, a possible alternative explanation of the positive results of the survey is that not much happened in terms of any impact on teaching, but faculty report impacts resulting for some other reason. The reason could be that faculty members themselves have learned from the activities, or expected this to be the right answer.

In order to assess whether this alternative hypothesis could be justified, attempts have been made to improve the quality of the results of the survey in five different ways: Internal reliability, control

of contributing factors, use of new literature, findings from similar surveys and reported impacts on students.

6.1 Internal reliability

The survey has been studied in terms of internal reliability in the 2017-survey. This survey was sent to 507 people with a response rate of 71 %¹² (n = 358).

With the help of Siddhartha Baviskar, lecturer at University College Copenhagen, it has been possible to do a test of internal reliability through the study of internal consistency and test-retest.

Internal consistency reliability

Internal consistency reliability refers to the degree of interrelatedness among the items in a scale. It was assessed using Cronbach's alpha coefficient for all scales. Cronbach's alpha is considered an adequate measure of internal consistency. A low Cronbach's alpha indicates a lack of correlation between the items in a scale, which makes summarizing the items unjustified. A very high alpha indicates high correlations among the items in the scale, i.e., redundancy of one or more items (Terwee et al. 2007). Nunnally and Berstein (1994) proposed a criterion of 0.70-0.90 as a measure of good internal consistency.

Table 8: Summation of results from test of internal reliability

Questions	Number of items (a = T1, b = T2)	Scale	Alpha (n) at least one answer	Correlation a-b: Pearson/Spearman (n)
Question 5: To what extent has your participation in R&D activities in 2017 contributed to...	v6_1a- v6_6a	From 1 = Not at all to To a very great extent = 5	0.90 (75)	0.85***/0.82*** (31)
	v6_1b- v6_6b		0.90 (32)	
Question 6: To what extent have you used your experiences from R&D activities in 2017 in relation to the following teaching methods...	v7_1a- v7_5a	From 1 = Not at all to To a very great extent = 5	0.84 (75)	0.84***/0.84*** (31)
	v7_1b- v7_5b		0.91 (32)	
Question 7: To what extent have you communicated knowledge acquired through your	V8_1a- v8_5a	From 1 = Not at all to To a very great extent = 5	0.81 (81)	0.80***/0.75*** (33)
			0.67 (33)	

¹² One invitation to the survey was sent, and three reminders.

participation in R&D activities in 2017?	V8_1b- v8_5b			
Question 10: To what extent have you applied new knowledge in your teaching in 2017 from the following sources?	V11_1a- v11_8a V11_1b- v11_8b	From 1 = Not at all to To a very great extent = 5	0.72 (165) 0.72 (62)	0.70***/0.70*** (60)
Question 12: How often have you searched for literature in research databases to acquire new knowledge in 2017?	v13a v13b	From 1 = =Not at all to At least once a week = 6	---	0.72***/0.73*** (64)
Question 13: Please respond to the following statements: I have set up alerts in databases I have set up alerts on specific electronic journals	V14_1a- v14_2a V14_1b- v14_2b	From 1 = No to Yes, several times = 3	0.73 (178) 0.86 (64)	0.88***/0.84*** (64)

Note: *** Correlation is statistically significant at $p < 0.001$.

As table 8 shows, Cronbach's alpha coefficient was between 0.70 and 0.90– and thus satisfactory -- for all scales except one, that is question 7: *To which extent have you communicated knowledge obtained through R&D to the below-mentioned groups of people*. The alpha coefficient for this scale at T2 was 0.67 (compared to 0.81 at T1).

Test-retest reliability

Test-retest reliability is the extent to which scores on the same version of a questionnaire for the same persons are the same over time (Kersten et al. 2016). The survey of 2017 was sent out again to a limited group of faculty two weeks after the original survey. Of the 178 volunteering to get the survey resent, 64 responded (36 %). The test does not consider the implication of self-selection in the sample, which could cause a bias in the sample.

Test-retest reliability was assessed by testing whether repeated measurement two weeks later led to stable measurement results. It was assessed using Pearson's product-moment correlation and the results of all analyses were checked using Spearman's rank correlation coefficient. The latter is appropriate when one or both variables are ordinal (as in this case) and robust, and when

extreme values are present. Pearson's correlation coefficient of 0.7 or higher was considered acceptable (Raven-Sieberer et al. 2014).

As table 8 shows, Pearson's correlation coefficient for the test-retest ranged from 0.70 (acceptable) to 0.88 (good). The corresponding values of Spearman's correlation coefficient were in a very similar range.

Overall, these results suggest that the internal consistency reliability and test-retest reliability for these scales are satisfactory.

Control of contributing factors

In order to test the validity of the survey, hypothesis of contributing factors was tested. The basis of the hypothesis was the authors' understanding of what is of importance for participants in R&D in order for them to use the experience of participation in their own teaching.

Three hypotheses were tested:

- A. The more time the teacher spends on R&D activities, the better chance there is of teachers using this in their teaching
- B. If teachers have prior research experience in the form of a PhD, they are more likely to utilise their experience from the R&D activities in their teaching
- C. The longer teachers have been employed, and thus the broader their teaching experience, the more likely they are to utilise their experience from the R&D activities in their teaching

If correlation can be seen in the data, it could indicate validity, i.e. that the data is actually measuring what it is supposed to if it is consistent with expected patterns.

Question 5 in the survey addresses a range of ways in which a teacher involved in R&D could use this experience in his or her teaching. The question addresses six ways of using R&D experience, and each way of using R&D is rated on a scale from "Not at all" to "To a great extent". An additive index was constructed on question 5¹³ in the 2017 survey¹⁴, and the correlation was tested between the index and each of the three hypotheses.

In the table below, the additive index and the three hypotheses are statistically described. The correlations coefficient (R^2) of a simple linear regression between the additive index and each contributing factor is presented in the last column.

¹³ Applied new theoretical knowledge from R&D activities into your teaching in 2017
Applied practical knowledge from R&D activities to your teaching in 2017
Applied new scientific literature from R&D activities in your teaching in 2017
Applied new teaching material from R&D activities in your teaching in 2017 e.g. case collections
Included raw empirical data from R&D activities in your teaching in 2017
Used experience with new research methods from R&D activities in your teaching in 2017.

¹⁴ The study acknowledges the inconsistent use of the survey's scale. In this test, the scale ordinal scale is giving numeric values (1-5) to construct an additive index, thus treating the scale as an interval. Hence, the results should be regarded as indicative rather than conclusive.

Hypothesis (variable)	N	Min	Max	Mean	Std. deviation	R ²
Additive index	160	6	30	18,84	6,1	
A. R&D activities (hours)	159	80	1865	403	369	0,14
B. PhD	159	0	1	0,4	0,49	0,01
C. Employment (years)	159	2	36	9,82	6,69	0,00

R&D hours was the only factor having an explanatory force (R²) on its own.

Using the three expected contributing factors as well as sex and age in a multivariable regression, the regression had a R² of 0,19 - indicating that the factors combined explain 19 % of the variations in the index. Still "time used on R&D" (sig p<0,001) was the only significant factor¹⁵ from the hypotheses mentioned above. However, sex and age were included in the multivariable regression and age (sig 0,05) proved significant, whereas sex and years of employment did not.

	Standardized Coefficients		t	Sig.
	B Coefficient	Standard Error		
Constant	10,891	2,966	10,891	2,966
Time spent on R&D (hours)	,007	,001	,007	0,001
PhD.	-,612	1,038	-,612	1,038
Sex	-,122	,988	-,122	,988
Age	,138	,064	,138	,064
Years of employment	-,115	,079	-,115	,079

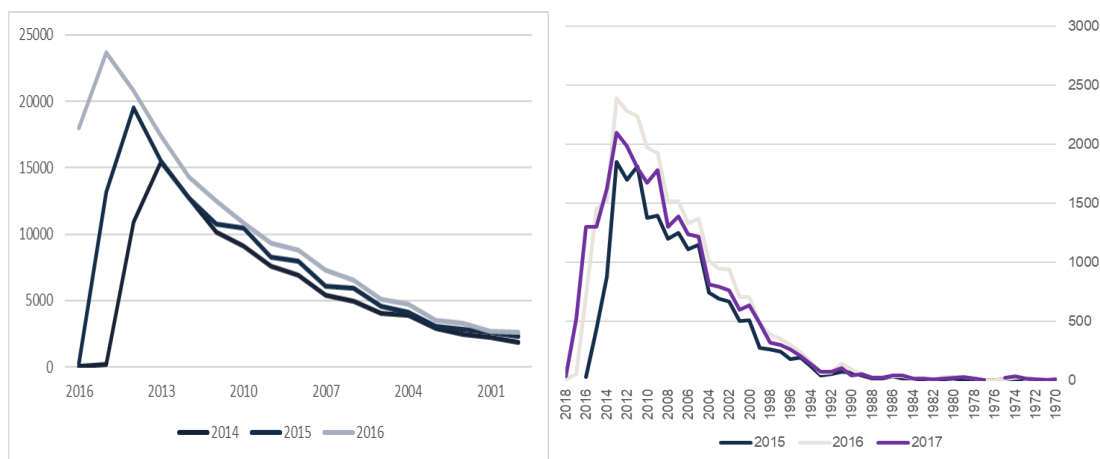
Concluding, the positive correlation between time spent on R&D and use of R&D in teaching supports the validity of the result chain. The fact that there is no positive correlation between a variable such as having a PhD qualification is unexpected. On the other hand, many have stated in their comments in the survey that the impact is to some degree based on their re-acquaintance with scientific methods, which could suggest an impact on non-research trained faculty.

¹⁵ Using a significance level of $\alpha=0.05$

6.2 New literatures

One of the most highly rated items in the survey is use of new literature. Figure 3 and 4 show the year of publication for all articles downloaded and all copyrighted material uploaded to the learning-content-management-system¹⁶.

Figure 3 and 4: Download of articles 2014-2016 and uploaded articles to the learning-content-management-system 2014-2016, distributed on publication year



The two figures above give an indication of increase in downloads and uploads; it is evident that new literature is being used.

6.3 Findings from similar surveys

The Independent Research Fund Denmark (IRFD) conducted a survey on the impact of their donations in 2015. The survey found that 77% of the grant recipients believed that their research activity did strengthen their teaching (Det Frie Forskningsråd 2016), which is relatively close to the 71-73 % from the survey of R&D personnel.

However, it is not obvious what to conclude from this. The survey was conducted in a very different population (elite researcher vs. faculty, who would typically do significantly less research than grant recipients). Also, the IRFD was using a different questionnaire and teaching different programmes (professional bachelor programmes vs. bachelors, masters and PhD programmes).

Therefore, on one hand it could be argued that it is a far stretch to say that the surveys validate each other, since the two groups of responders differ too much. On the other hand, it could be argued that this is an indication that research is being utilised in teaching to a high degree – with the caveat that the degree of utilisation is difficult to measure accurately with a survey, and/or that the intensity and scientific quality of research have few implications for research utilisation in teaching. The latter point is consistent with the lack of coherence between research productivity and quality of teaching found in Marsh and Hattie (2002).

¹⁶ This is registered to pay the licensees. 2017-data for articles is still not processed.

6.4 Impact on students

The Danish National Survey of Students at the UCs and the Metropolitan University College's survey of graduates are conducted approximately biannually.

The surveys are not designed to measure the impact of research on teaching, yet there are a number of issues that it may be relevant to explore more closely, even though it is reasonable to question whether students are qualified to answer the questions referred to.

Table 7: Results from the Danish National Survey of Students at UCs, 2010-2016

Question	2010	2012	2014	2016
I have an impression that teaching is based on the latest knowledge relevant to my programme¹⁷	69	71	72	73
Teaching has for the most part a high academic standard¹⁸	68	69	69	73
The link between theory and practice in teaching is good¹⁹	64	65	66	69

Note: In the questionnaire, the students answered the questions on a scale from 1 to 10, where 1 is the lowest and 10 is the highest rating. Afterwards, the answers were transferred to a scale from 0 to 100 by the evaluators. If a student has answered 1 to a question, the answer is converted to the score 0. If the answer is 2, it is converted to 11, 3 to 22 and so on (Studietilfredshedsundersøgelse 2016).

Generally, the students experience that teaching is largely based on the latest knowledge and has a high academic standard, just as the link between theory and practice is good. However, the positive trends begin before the research activities might be expected to be grounded in the institution, and the change is rather small²⁰.

In conclusion, it can be said that the student survey does not indicate that research has had a high impact on student learning, yet it does not suggest the opposite either. It would be difficult to argue a positive impact on teaching if the items had shown a negative trend.

¹⁷ Jeg har indtryk af, at undervisningen er baseret på den nyeste viden inden for min uddannelsesretning.

¹⁸ Undervisningen har for det meste et højt fagligt niveau

¹⁹ Der er en god kobling mellem teori og praksis i undervisningen

²⁰ Do note: statistical test of significance will be done before the working paper is published

Table 8: Results from Metropolitan University College's Survey of Graduates, 2016

Question: How would you rank your own level regarding:	High or very high	Average	Low or very low
Your ability to acquire new knowledge²¹	80%	19%	1%
Applying relevant scientific knowledge in your job situation ²²	56%	38%	7%

In the survey of the graduates, the questions were revised in 2016 to include the two items above. On one hand, there is a tendency for the students to rank their abilities within *acquiring new knowledge* and *applying relevant scientific knowledge* high. Especially the item concerning the application of scientific knowledge may be defined as high, as it was only in 2013 that legislation required their course of study to be based on scientific knowledge²³. On the other hand, there is no relevant data to compare the result with, in order to estimate whether it is a high or low rating.

Making the same methodological reservations as in the case of the student survey, it can be argued that there is a weak indication that the graduate survey supports the result chain.

Summing up

Table 9: Indication of strength of the survey's contribution to the result chain

Item	Result
Test-retest reliability	Supports the reliability of the survey as an adequate measuring instrument
Control of contributing factors	Supports the validity of result chain
New literature	Supports the validity of result chain
Findings from similar surveys	Inconclusive
Impact on students – national student service	Inconclusive – positive trend
Graduate survey	Inconclusive - positive indications

Summing up the evidence on alternative explanations, no evidence has been identified that invalidates the result of the survey. However, with exception of the one approach (the use of new

²¹ At kunne tilegne mig ny viden

²² At anvende relevant videnskabelig viden i min jobfunktion

²³ §4 stk.1. Professionshøjskolernes uddannelser skal bygge på forskning- og udviklingsviden inden for de relevante fagområder samt viden om praksis i de professioner og erhverv, som uddannelserne er rettet mod. Tidligere 3 stk. 3. En professionshøjskole skal sikre, at uddannelsernes videngrundlag er karakteriseret ved professions- og udviklingsbaseret, jf. 5 stk. 2.

literature), it has been difficult to identify documentation that substantially validates the result of the survey. For this reason, alternative explanations cannot be rigorously dismissed.

7.0 Conclusion: Assembling the performance story

This paper set out to explore the impact of the introduction of research on teaching and learning.

It has done so by attempting, within an attribution analysis framework, to improve the quality of *self-reported outcomes concerning the utilisation by faculty members of research experience in their teaching*. Furthermore, the paper has attempted to establish what indications the analysis can provide regarding the impact of R&D on teaching in UCs.

It has been demonstrated that it is possible to provide a substantial grounding of the survey in Healey and Jenkins' model of the linkage between research and teaching.

It has been more difficult, based on existing evidence, to form an irrefutable argument dismissing the alternative story, i.e. that the faculty reporting is based on wishful thinking and overly optimistic reporting on the result. On the other hand, no evidence has been found that supports this alternative story either.

To conclude this paper, a performance story about introducing R&D can be summarised as follows:

When we enhance R&D activities, then more faculty members are engaged in R&D.

When more faculty members are engaged in R&D, then more faculty members increase their methodological and scientific knowledge and competence.

When more faculty members are engaged in R&D, then more relevant material, scientific as well as teaching, is being produced.

When faculty increase their methodological and scientific knowledge and competence, then the members will utilise their experience in their teaching.

When more relevant scientific materials are produced, as well as teaching materials, then relevant material will be included in the teaching.

When more relevant material is included in the teaching and the teachers utilise R&D experience in their teaching, then students will improve their skills in terms of acquiring, understanding and applying new and/or scientific knowledge.

As a concluding remark it should be underlined again that this paper is based on data which has been collected as part of quality assurance procedures prior to the definition of the research questions, and resources have not allowed the development of either the questionnaire or the literature review to follow rigorous scholarly procedures. The authors hope that the paper can inspire proper research on the reliability and validity of using a faculty-reported survey as an instrument for measuring the impact of research and development on teaching.

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