The research-teaching nexus in the sciences : scientific research dispositions and teaching practice

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Summary

Introduction

Although policy makers, as well as academics and students, show a positive appreciation for the nexus between research and teaching at universities, it is not always self evident for academics how to organize courses that positively influence a close connection between research, teaching and learning. The studies in this dissertation examine academics, affiliated with the Faculty of Sciences of Leiden University, who have both a research task and a teaching task. Central in these studies are three themes: research dispositions, teaching intention and teaching practice. In research literature on higher education, research disposition is recognized as a relevant but often underrepresented theme. Examples of aspects of a research disposition are: to critically observe research data, to share new findings and to be curious about new models and theories. The first two studies specifically address the identification of underlying aspects of the scientific research dispositions of academics. The central aim of the last two studies is to identify associations between on the one hand the teaching intentions and approaches and on the other hand current teaching practice of academics with respect to connections between research and teaching.

Chapter 2: Aspects of scientific research dispositions

In Chapter 2, an interview study is described in which academics (n=23) were asked about their scientific research dispositions. The interviews were analyzed and participants' responses about their research dispositions were categorized. In this study, two research questions were central. The first research question was: *What aspects can be distinguished in the ways science academics conceive of their scientific research dispositions?* The analysis of the response to the interview questions led to a categorization of six qualitatively different aspects of scientific research dispositions, namely the inclinations (1) to achieve, (2) to be critical (3) to be innovative, (4) to know, (5) to share knowledge, and (6) to understand.

The second research question was: *What are the differences and similarities between groups of academics with comparable research dispositions?* Similarities and differences in the background variable of groups of academics were described. Academics with similar scientific research dispositions were grouped through a combination of a hierarchical cluster analysis and a principle components analysis, with the aim to identify similarities and differences in background variables between groups. The results suggested that academics within applied and experimental research domains more often put emphasis on the inclination 'to be innovative' and 'to be critical', whereas academics from research domains with a theoretical orientation, such as theoretical physics or

mathematics, relatively more often put emphasis on the inclination 'to achieve' and 'to understand'. This finding suggests that disciplinary, institutional and/or scientific culture differences have an influence on the scientific research disposition of academics.

Chapter 3: Methods for the measurement of research dispositions

After the identification of different aspects of research dispositions, as described in Chapter 2, potential ways to study dispositions of persons were examined into more detail. In the study described in Chapter 3, first the notion of 'disposition' in the research literature is described, with the aim to identify principles to be used for the development of an empirical basis of 'disposition'. Next, three instruments to study the research disposition of individuals have been studied in a case study approach (n=3). The instruments which were examined are a semi-structured interview with open questions, a hierarchical ordering task and a cognitive mapping task. During the hierarchical ordering task the participants were asked to give a linear ordering of the six aspects related to their own research disposition, ranging from 'most applicable' to 'least applicable'. During the cognitive mapping task, the aspects of a research disposition were presented pair wise, and the academics were asked to explain the relation between each couple of the two aspects.

The central research question in this chapter was: *Which instruments or combination of instruments can best be used to investigate a person's research disposition?* It was demonstrated that the concept of disposition in the research literature still is in the making. In many scientific studies the notion of disposition is not primarily based on experimental data, but on theoretical assumptions. Three general principles were identified that are potentially supportive to an empirically based notion of disposition. The first is that a disposition only becomes visible under specific circumstances. Secondly, explanations for specific aspects of a disposition can in principle be found in somebody's intrinsic qualities. And thirdly, a disposition can in principle be studied empirically. Three potential methods to measure the disposition of a person were described in this chapter. A combination of the hierarchical ordering task and the structured cognitive mapping task turned out to be useful in the sense that this combination revealed relevant results and was more time efficient than a semi-structured interview method with open questions. The results suggest that a difference can be made between implicit and explicit views of academics about their research dispositions. Furthermore, the results suggest that the interview and the ordering task gauge a similar characteristic of the notion of disposition, namely the explicit

views of the participants. The structured cognitive mapping task suggested that implicit or tacit scientific research dispositions can be identified.

Chapter 4: Speech acts

The central aims of Chapter 4 are to recognize and describe sequences of speech acts that characterize the language of the teacher and to describe associations between these typical sequences and the approaches to teaching during the courses, in which research and teaching were connected. In this study, the speech acts of the participating teachers (n=12) were audio taped during the course meetings. An analysis scheme was developed to characterize the rationale behind the speech acts. The teachers were also asked, in retrospect, to fill out a questionnaire about their approach to teaching.

In this study, the first research question was: *What typical sequences can be recognised in individual teachers' speech during course meetings?* The transcripts of the interviews were analyzed with the coding scheme, based on the speech act theory from language philosophy, developed by John L. Austin and John R. Searle. This theory describes the intentionality behind speech expressions and gives a categorization in types of speech act. For example, the speaker of an assertive speech act (such as to inform or to reflect) has the intention to convince the listener and to give the listener an equal opinion in accordance with the content of the expression, whereas the speaker of a directive speech act (such as to advise or to instruct) has the intention to persuade the listener to perform an act in accordance with the content of the expression. Two groups of teachers were identified on basis of the sequences of their speech acts, one group using relatively more assertive speech acts, the other group using relatively more directive speech acts.

The second research question central in this chapter was: *Are teachers' typical speech act sequences associated with their approaches to teaching and the method of instruction used during science courses?* The analyses of the speech acts of teachers in course meetings showed that during lectures teachers mainly use assertive speech acts, whereas during practicals teachers relatively more often use directive speech acts. During lectures teachers mainly explained and gave overviews of the course content, whereas during practicals teachers more often gave instructions to students, for instance about how to proceed with the assignments. This result resembles the general perception of lectures and practicals at universities and indicates that this type of analysis gives a realistic characterization of the language behaviours of teachers during course meetings. Associations between the speech acts and the teachers' self-report of their

approach to teaching were analysed through comparing teachers' speech acts with results from a questionnaire about approaches to teaching. Teachers who put emphasis on students' conceptual change, more often used directive speech acts, such as asking questions and giving advice, whereas teachers who put emphasis on knowledge transfer more often used assertive speech acts, such as giving information and making predictions. Apparently, teachers who put emphasis on students' conceptual change seek a dialogue with the students, in which questions and advices have a dominant role, whereas teachers who put emphasis on knowledge transfer often explain and give information to the students.

Chapter 5: Teachers' intentions

The central aim in Chapter 5 is to describe associations between the teachers' intentions and students' perceptions of research intensive learning environments. During interviews with university science teachers (n=11) prior to their courses, teachers were asked to describe their intentions towards the role of research in their courses and their intentions towards the development of research dispositions of their students. After the courses the students (n=104) were asked to complete a questionnaire about the research intensiveness of the learning environments. The research question central in this chapter was: *What associations can be identified between teachers' intentions and students' perceptions of the research intensiveness of university science courses?* The results showed that the teachers' intentions were only partially congruent with the perceptions of their students. The results suggested a difference in congruency of the teachers' intentions and the students' perceptions between 'tangible' and 'intangible' elements of research in the courses. The tangible nexus between research and teaching is expressed in elements such as the use of data of the research of the teacher during students' assignments, whereas the intangible nexus is expressed in less visible elements of the curriculum such as the creation of a research atmosphere or the stimulation of the development of students' research dispositions. The congruence between teachers' intentions and students' perceptions appeared stronger for the visible elements of the nexus. Possibly, the implicit parts of research are more difficult for students to perceive than are the visible elements. Incongruence between teachers' intentions and students' perceptions can yield misunderstandings, unfavourable for the learning process of the students in the sense that students might develop unrealistic notions of the nature of science and scientific investigation or a less limited research disposition.

The results suggested that intangible elements of the nexus between research and teaching deserve explicit attention of the teacher and the students.

Chapter 6: Conclusions and discussion

In Chapter 6 the conclusions are summarised, the strengths and the limitations of the studies are described, and recommendations for further research and for teaching practice are given. The general conclusions can be summarized in four points: aspects of the research dispositions of academics, methods for the evaluation of research dispositions, teachers' speech acts and teachers' intentions regarding research in teaching.

Research dispositions of academics

- Six aspects are fundamental to research dispositions: inclination (1) to achieve, (2) to be critical, (3) to be innovative, (4) to know, (5) to share knowledge, and (6) to understand (Chapter 2).
- Academics from more applied and experimental fields of study tend to put more emphasis on 'to be innovative' and 'to be critical', whereas academics from fields with a theoretical research orientation tend to focus more on 'to achieve' and 'to understand' (Chapter 2).

Evaluation of research dispositions

- A distinction can be made between academics' explicit conceptions and their tacit conceptions of their research dispositions (Chapter 3).
- Semi-structured open-ended interviews and hierarchical ordering tasks show explicit conceptions, whereas structured mapping tasks represent the tacit conceptions of academics' research dispositions (Chapter 3).

Teachers' speech acts

- The typical sequences of teachers' speech acts illuminate their speech act repertoires in action (Chapter 4).
- Teachers who emphasised conceptual changes of students more often use directive speech acts, such as questions or instructions, whereas teachers who emphasised knowledge transfer more often use assertive speech acts (Chapter 4).

Teachers' intentions regarding research in teaching

- Teachers' intentions are moderately congruent with students' perceptions of the research intensiveness of the learning environments (Chapter 5).

- Teachers' intentions related to tangible elements of the nexus are relatively more coherent with students' perceptions than are teachers' intentions regarding intangible elements of the nexus (Chapter 5).

Practical and theoretical implications

At the end of Chapter 6 recommendations for further research and implications for teaching practice are discussed.

In relation to further research, it was recognised that new research instruments have been developed and applied during the studies, such as a categorization of the aspects of research dispositions, a method for the analysis of teachers' speech acts, and a questionnaire to evaluate students' perceptions of research activities during course meetings. These research instruments were developed in the context of university science education and can potentially also be made applicable for other contexts.

Implications for teaching practice are discussed for policy makers, teachers, and students. The results from the studies suggest that the categorization of aspects of research dispositions can be helpful for the design and re-design of educational programmes at universities. Students can profit from the acquaintance with a variety of research dispositions of their teachers. A design of the curriculum in which attention is drawn towards the development of research dispositions can be of help for offering additional learning possibilities to students. Furthermore, appreciation of the variation between academics, such as variation in research dispositions and speech repertoire, can be helpful for educational policy makers when considering human resource management.

Some of the instruments, which are used in the studies, can also be made applicable for practice. For example, the method of analysis of speech acts also offers teachers and teacher trainers in higher education the possibility to evaluate and reflect on their speech act repertoire. Previous studies showed that student evaluations of learning environments are an effective instrument for teachers to reflect on their own teaching practice. A second example can be found in the questionnaire about students' perceptions of the research intensiveness of learning environments. This questionnaire can be applied as an evaluation instrument to improve the understanding of how students perceive the learning environments and specifically the research activities during the course meetings.