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

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Chapter 1

General introduction

1. General introduction

1.1 Introduction

This thesis reports on four studies aimed at improving our understanding of how to bridge the gap between research and teaching in undergraduate university science education. A rationale behind strengthening the link (nexus) between research and teaching is to enhance student understanding of science and scientific inquiry (Boyer Commission, 1998 and 2002; Jenkins, Healey, & Zetter, 2007; Zubrick, Reid, & Rossiter, 2001). To obtain literacy in science and scientific inquiry, students need to acquire disciplinary knowledge and skills, and they also need to develop appropriate scientific research dispositions (cf. American Association for the Advancement of Science, 1990 and 1993). In the studies reported in this thesis, scientific research dispositions were explored, and potential methods to evaluate these dispositions were examined. Next, in order to understand how research and teaching can be linked in science courses, teaching practices at research universities were investigated. Associations were examined between teachers' intentions and approaches to teaching, and between teaching behaviour and students' perceptions of the research intensiveness of the learning environments. Academics were examined, who taught undergraduate university science courses of the bachelor's programmes of the Faculty of Science at Leiden University in the Netherlands. The labels 'teachers', 'teaching staff', and 'academics' are used interchangeably below. The participating academics were involved in both research and teaching. The label 'academics' is used in this thesis to emphasise the scholarly nature of the profession, while the labels 'teachers' and 'teaching staff' refer specifically to the teaching profession.

Debates about the research-teaching nexus originated, among other things, from the desire of policy makers in higher education to promote the research identity of the institutes (Barnett, 2005; Elen & Verburgh, 2008; Jenkins et al., 2003; Simons & Elen, 2007); for other stakeholders, such as curriculum developers, teacher trainers, and teachers, different practical reasons for a focus on the research-teaching nexus can be discerned. Curriculum developers, for example, continually need to re-think the construction and content of the curriculum, especially when this curriculum needs to promote, and not hinder, close ties between staff research, teaching, and learning. Teacher trainers wish to know which competencies teachers need to develop and to strengthen links between research and teaching during their courses. Furthermore, teachers at higher education institutes are important stakeholders in strengthening research in teaching, because they put the integration of research and teaching into action

during their courses. Throughout the years teachers develop a broad variety of teaching experiences in which research is integrated in teaching. By reflecting on these experiences and sharing ideas about teaching with colleagues, teachers in higher education can increase their teaching repertoire and expand their ideas on linking research and teaching. At the end of this thesis several recommendations for teaching practice in higher education are presented. This first chapter describes the context, the relevance, the research questions, and the design of the studies.

1.2 The research-teaching nexus

1.2.1 Higher education and society

In recent decades, changes in society led to a process of transformation in higher education institutes. Technological developments, globalization, and increased international competition altered university life. Although the rise of the so-called 'knowledge society' did not affect their overall civic function as 'knowledge institutes', it did alter universities' organisational structures. In the literature on higher education at least three changes in higher education institutes can be detected. First, the change from an elite system to a mass system affected the internal structures of higher education institutes (Scott, 1995). Especially the teaching function became subject to re-organization. Student-staff ratios changed drastically over the last 50 years, as more and more students needed to be taught. Second, owing to globalization and increased international competition in research, institutes had to change their focus from local to global (Barnett, 2000). A similar development from a local to a global orientation followed for the teaching function of higher education institutes. Finally, a more recent change forced institutes to reflect on quality standards of staff (Ramsden, 2003). Changes to mandatory pedagogical and educational training for academics result from the increased demands from society. Many governments endeavoured to increase the number of graduates from higher education, and many companies set more specific requirements for the competencies of graduates. The idea was that through better teachers and more effective teaching methods more students could be guided by fewer teaching staff. In sum, higher education was becoming 'big business' (Barnett, 2000). Nowadays, stakeholders in higher education request to know if funds are being used effectively, and policy makers require clear evidence-based answers from research in general, and from research into higher education in particular. Therefore, higher education institutes are encouraged to continually explore ways to adjust, in order to prepare for potential changes in society and the demands put forward by various

stakeholders. In this global, changing society, higher education institutes have to continually re-negotiate their position to meet the demands. A clear and distinctive identity can be a strong basis for deciding how to react to changes and demands. The identity of research-intensive universities, such as Leiden University, rests strongly on the importance of research with a strong theoretical relevance, while professional or vocational universities stress the importance of research with practical relevance. The kind of research with which a higher education institute is associated seems to typify the identity of that institute. Recent debates about enhancing links between research, teaching, and learning can be understood from the perspectives described above. The aim of this thesis was to contribute to recent debates about enhancing connections between research, teaching, and learning by investigating academics' views and their teaching practice at a research-intensive university.

1.2.2 Studies on the integration of research in teaching

In recent decades, the aim of strengthening links between research and teaching attracted a great deal of attention from policy makers, curriculum developers, teachers, and researchers in the field of higher education (Barnett 2005; Griffiths, 2004; Healey, Jordan, Pell, & Short, in press; Jenkins, Healey, & Zetter, 2007; Zubrick, Reid, & Rossiter, 2001). The debates were sometimes confused, because the subject of linking research and teaching has many perspectives and many stakeholders (cf. Turner, Wuetherick, & Healey, 2008). Concepts are used differently among different stakeholders, and perspectives are not always understood clearly in debates between stakeholders. For the clarification of the present situation, many studies are focused, as a first step, on defining the research-teaching nexus and describing stakeholders' conceptions about the nexus. Some researchers describe the misunderstandings of the relationship between research and teaching at university in the form of myths (Hughes, 2005; Kinchin & Hay, 2007); others describe philosophical perspectives (Simons, 2006) or examine the conceptions of stakeholders, such as academics (cf. Visser-Wijnveen, Van Driel, Van der Rijst, Verloop, & Visser, in press), policy makers (cf. Neumann, 1992), or students (cf. Turner et al., 2008). Although Hattie and Marsh (1996; 2002) showed that there seems to be no relationship between being an effective researcher and being a good teacher, many teachers at higher education institutes explicitly value the integration of research and teaching at their institutes (Elen & Verburch, 2008; Elton, 1986; Jensen, 1988; Neumann, 1992). Jensen (1988), for example, showed that although academics in higher education institutes in Denmark reported some reservations, such as a perceived difficulty in

combining the twofold task of research and teaching, all preferred to work in an institute in which research as well as teaching was present. Academics have multiple professional roles, of which teaching is often neither the role with the highest priority, nor that with the highest regard among peers and superiors (Colbeck, 1998; Serow, 2000; Young, 2006). Similarly, Gottlieb and Keith (1997) found in an internationally comparative survey study that research was perceived to positively affect teaching, but that aspects of teaching (e.g., course load, student demands) had a negative impact on research. A growing body of research supports the suggestion that the integration of research in teaching is good for student motivation and student learning (Durning & Jenkins, 2005; Elton, 1986; Healey, 2005a; Hunter, Laursen, & Seymour, 2006; Jenkins, Blackman, Lindsay, & Paton-Saltzberg, 1998; Lindsay, Breen, & Jenkins, 2002; Turner et al., 2008). Students perceive many benefits to their learning when research is strongly integrated in their courses (Seymour, Hunter, Laursen, & Deantoni, 2004; Van der Rijst, Visser-Wijnveen, Verstelle, & Van Driel, 2009). Seymour and colleagues (2004) examined student experiences of research activities in the undergraduate phase of university science education, and presented positive student experiences, such as students' increased self-confidence for doing research, increased motivation for the discipline, enhanced understanding of what it means to be a scientist, improved critical thinking skills, and increased knowledge about the scientific process. Robertson and Blackler (2006) found in an interview study that students experienced pride and were motivated by the enthusiasm of their teachers. Students were challenged because they were engaged in research-related activities. Healey and colleagues (in press) showed that, according to the students, the main advantage of enhanced links between research and teaching was that their teachers were enthusiastic and that having a well-known researcher as a teacher excited them (Healey et al., 2003; Turner et al., 2008). Therefore, many higher education institutes in various countries have put much time and effort into bridging the gap between research, teaching, and learning (Elsen, Visser-Wijnveen, Van der Rijst, & Van Driel, 2009; Healey 2005b; Jenkins, Breen, & Lindsay, 2003; Leisyte, Enders, & De Boer, in press). The emphasis in this thesis was on empirically describing what teaching staff at universities can do to enhance links between research and teaching which support student learning about research at universities.

1.3 Teaching in higher education

1.3.1 Higher education as a separate field of research

In 1990, McKeachie showed that research on teaching in higher education had developed a distinctive knowledge base in the course of the previous decades (McKeachie, 1990). Over the years the field of research on teaching in higher education became a distinct area in the educational sciences (cf. Durkin & Barnes, 1986; Forest, 2006; Trent & Cohen, 1973). In the *Handbook of Research on Teaching*, Menges (2000, p. 1122) presented some remarkable and substantial differences between teaching in higher education and teaching in secondary education. Firstly, the function of higher education institutes within society is different from that of schools of secondary education. Higher education institutes often have a research function alongside their teaching function. Additionally, the purpose of higher education differs from that of secondary education in many ways, among which that secondary education has the objective of providing a broad basic (compulsory) education, while higher education institutes offer specialised (optional) training for students. Furthermore, teaching staffs in higher education institutes have much experience in research or in a profession, but often have limited pedagogical and educational training. Therefore, teachers in higher education, more so than teachers in secondary education, are often oriented towards their discipline rather than towards the scholarship of teaching. Other responsibilities than teaching usually prevail for teachers in higher education.

Academics in higher education have different professional roles (Colbeck, 1998; Martin, 1997); the teaching role is not always the most essential part of their professional identity (cf. Beijaard, Meijer, & Verloop, 2004; McAlpine, Jazvak-Martek, & Gonsalves, 2007). Boyer (1997) described four scholarships, four fields of the academic profession: the scholarships of discovery, integration, application, and teaching. The purpose of the scholarship of discovery is to build new knowledge through research. Academics who write textbooks or comprehensive literature reviews in which they interpret the use of knowledge across disciplines work in the scholarship of integration. Academics working in the scholarship of application aid society and the professions in addressing problems. And the purpose of the scholarship of teaching is to ‘study teaching models and practices to achieve optimal learning’. This can be done, among other things, through developing and testing instructional materials and through advancing learning theory using classroom research. Over the last decade the scholarship of teaching has become more and more a topic of interest in research on higher education, in which conceptual as well as empirical manuscripts on various issues

in teaching practice in higher education are disseminated (Healey, 2000; Kreber, 2002; Kreber & Cranton, 2000; Trigwell et al., 2000; Trigwell & Shale, 2004). These studies can be found in the regular peer-reviewed scientific journals in the field of research on higher education, and much of the small-scale teacher research of own practice can be found in the numerous (online) journals on the scholarship of teaching and learning (to name a few, *International Journal for the Scholarship of Teaching and Learning*, *International Journal of Teaching and Learning in Higher Education*). Development in this area can be expected in the coming years, because of the large number of disseminated articles. Especially reviews and meta-studies in which small-scale empirical classroom studies are thematically clustered have the potential to produce new and interesting results about teaching in higher education.

The afore-mentioned studies on the scholarship of teaching are all aimed at contributing to debates about excellence in teaching in higher education through describing and explaining the teaching practice (Kane, Sandretto, & Heath, 2004; Sherman, Armistead, Fowler, Barksdale, & Reif, 1987; Shulman, 2002). Shulman (2002) described six goals of excellent teaching in higher education. First, teachers should ensure that students are engaged and motivated. Second, teachers need to help students acquire knowledge and develop understanding; and third, they need to enable them to demonstrate their knowledge and understanding through performance and action. Fourth, students must be encouraged during their studies to engage in critical reflection of the world; and fifth, they must develop their ability to navigate through the complexities of the world in formulating their own designs for action. Finally, teachers need to foster a lifelong commitment to critical examination and self-development. These goals for teaching in higher education can only be achieved when academics become excellent in their teaching profession. Sherman and colleagues (1987) showed that in theories about the development of excellence in teaching two elements seem to indicate excellent stages of functioning, namely, increased levels of complexity and a wider repertoire of action strategies. Furthermore, according to Sherman and colleagues (1987), awareness and reflection seem to be elements which can strengthen the experience and deepen the learning effect of the teaching experience (cf. Alexander, 2005; Korthagen, 2004; Pickering, 2006). In institutes that aim to support teaching staff in becoming excellent in teaching, professional development trajectories might focus on promoting awareness and reflection in order to improve teaching actions. Professional development trajectories can facilitate teachers by providing, for example, training to become aware of the influence of their approach on student

learning, or to use student evaluation for redesigning of the course content. Research instruments developed and used in the studies reported in this thesis can also be used by teachers and teacher trainers to become aware of factors related to the integration of research in teaching, such as research dispositions, and, subsequently, to monitor these factors during teaching practice.

1.3.2 Research on teaching in secondary education

Although the field of teaching in higher education is a distinct field, relationships with other fields of research in the educational sciences exist. The field of teaching in higher education has close ties with the field of research in teacher education for secondary education. Many results from research in secondary teacher education can be of significant value to teaching in higher education, and some clearly distinct themes in teacher education can also be discerned in the field of teaching in higher education.

Although many differences can be distinguished between teaching in higher and in secondary education, methods to investigate teachers and teaching in secondary education (Verloop, Van Driel, & Meijer, 2001; Shulman, 1986; Shulman, 1987) can also be used for research on teaching in higher education. Note that the knowledge base of teachers in higher education is different from that of teachers in secondary education. A notable difference between teachers in secondary education and those in higher education is that many teachers in higher education institutes have experience in non-teaching professions. Especially teachers in vocational areas of higher education are often familiar with the profession in which they teach courses. Teachers at research universities have experience of scientific research and the academic professional area. Although these professional experiences are not always directly linked to teaching and learning, they are an important element in the knowledge base of teachers in higher education. Teachers can provide students with examples from lived experiences of the profession or of research. Therefore, every effort to bridge gaps between research and teaching can be perceived as an effort to make teachers in higher education aware of the value of their professional research experiences for student learning.

A part of the knowledge base of teachers in higher education which is not often researched in the field of teaching in higher education is domain-specific knowledge, such as pedagogical content knowledge, which is the knowledge necessary to teach specific topics effectively to students (Berry, Loughran, & Van Driel, 2008). There is a growing body of literature about pedagogical content knowledge in secondary education (cf. Abell, 2007; De Jong, Van Driel, & Verloop,

2005; Major & Palmer, 2006; Nilsson, 2008; Van Driel, Verloop, & De Vos, 1998). A notable example of research on pedagogical content knowledge in higher education is the study by Padilla, Ponce-de-León, Rembado, and Garritz (2008) on the chemical notion of 'amount of substance'. The parts of the knowledge base of teaching that are domain specific are of special relevance to academics beginning their teaching careers, because they have not yet acquired a extensive teaching experience in that domain.

An underrepresented element in the research into teaching in higher education is the interpersonal relationship between academics and students. Research into interpersonal relationships has provided much understanding about classroom situations and many useful results for teachers in secondary education (cf. Van Tartwijk, Brekelmans, & Wubbels, 1998; Wubbels, Brekelmans, & Hooymayers, 1992). Interpersonal relationships in higher education are often rather different from the interpersonal relationships developed in secondary education. Therefore, the results cannot be transferred directly from one context to the other, but instruments can be adapted to the context and used to gather data about the various relationships. A notable example is the adaptation to the doctoral research context of a questionnaire often used to measure interpersonal relationships in secondary education, in order to measure the interpersonal relationship between supervisors and PhD students (Mainhard, Van der Rijst, Van Tartwijk, & Wubbels, 2009).

Another topic of interest for teaching in higher education is the assessment of teaching. In the fields of secondary education (cf. Nijveld, Beijaard, Brekelmans, Verloop, & Wubbels, 2006) and vocational education (cf. Bakker, Sanders, Beijaard, Roelofs, Tigelaar, & Verloop, 2008), a broad knowledge base has been developed about issues in the assessment of teaching. Studies have also been reported on the assessment of teaching in higher education, which can support teachers and teacher trainers as well as consultants in the field of higher education (cf. Tigelaar, Dolmans, Wolfhagen, & Van der Vleuten, 2004).

The professional development of teachers in higher education is a broad field (e.g., Eggins & MacDonald, 2003; Hoogveld, Paas, & Jochems, 2005; Stes, Min-Leliveld, Gijbels, & Van Petegem, in press), which is closely connected with the field of secondary teacher education (e.g., Cochran-Smith & Zeichner, 2005; Meirink, Meijer, Verloop, & Bergen, 2009; Tillema & Orland-Barak, 2006). Action research, for example, is a domain of knowledge which can be profitable for the professional development of teachers in higher education (Kember, 2000). Much knowledge about how to guide teachers in action research projects has already

been developed in secondary educational contexts (cf. Ax, Ponte, & Brouwer, 2008; Platteel, Hulshof, & Van Driel, 2008)

In sum, the field of research into teaching in higher education is a separate field, which can build further on knowledge from research conducted in the context of secondary education and teacher education. By fostering the mutual beneficial ties between research on teaching in higher education, teacher education and teaching in secondary education, the field of research on teaching, in general, can grow. Researchers in the field of teaching in higher education can build on previously developed knowledge about the knowledge base of teaching in secondary education and on knowledge from other fields of research in the educational sciences. While the impact of the results from other fields on teaching in higher education is re-negotiated, the specific context factors of teaching and teachers in higher education need to be kept in mind.

1.4 Relevance of the studies

1.4.1 Scientific research dispositions in university education

In many science courses explicit attention is given to knowledge and research skills appropriate to the discipline. However, less explicit attention is given to intangible elements of research, such as scientific research dispositions (Elen & Verburgh, 2008). The underlying rationale of the study of scientific research dispositions is that science teaching and student learning of science in research-intensive environments might be positively influenced by explicit attention to research dispositions in undergraduate science curricula (McLean & Barker, 2004; Elen & Verburgh, 2008; Elen, Lindholm-Ylänne, & Clement, 2007). In this thesis, personal combinations of tendencies to act during research activities are labelled 'research dispositions'. These research dispositions are related to a person's character as well as to a person's contextual situation and circumstances, such as work environment, cultural background, and learning atmosphere. A person's tendencies to act can develop during infancy or later in life, as a result of educational experiences or experiences at work, and can also change according to particular circumstances in the learning environment or working environment. For every person involved in research, a set of personal tendencies to act while undertaking research can be discerned, for instance, a tendency to seek understanding, and a tendency to innovate. Some scientists might focus strongly on critically observing the outcomes of their experiment. Others are relatively more inclined towards developing innovative ideas. Focusing explicitly on a variety of aspects of research dispositions could make it possible for students to develop a realistic and mature picture of scientific practice.

1.4.2 Tangible and intangible elements of the research-teaching nexus

In university teaching, knowledge of concepts, principles, and theories are important elements of scientific literacy, but knowledge about the processes of scientific inquiry can not be neglected (American Association for the Advancement of Science, 1990; 1993). The university curriculum should pay attention to the processes of scientific inquiry when preparing students to be scientifically literate with a mature epistemological disposition (Elen et al., 2007; Elen & Verburch, 2008). The process of scientific inquiry can be emphasised in multiple ways in university curricula in which research and teaching are integrated. However, scientific inquiry cannot be described as a fixed set of general rules or steps that scientists follow. Which steps and procedures are followed within a particular scientific inquiry depends largely on the individual, the context, and the particular investigation (American Association for the Advancement of Science, 1993; chapter 'The scientific enterprise'). Neumann (1992; 1994) suggested a distinction between 'tangible' and 'intangible' ways of integrating research and teaching at universities. The tangible nexus shows how the clearly visible, explicit integration of research in teaching is organised, such as through a research internship or a research practical. The intangible nexus concerns the more tacit, not directly observable integration of research and teaching, such as through developing an inquisitive atmosphere, stimulating critical thinking, or supporting the development of research dispositions. Both tangible and intangible elements in university education are relevant when designing curricula, and when teaching courses, to give students a complete picture of what it means to do scientific research and to be a researcher.

1.4.3 Teachers' intentions and approaches to teaching

According to Norton, Richardson, Hartley, Newstead, and Mayes (2005), teachers' intentions reflect a compromise between teachers' conceptions of teaching and their academic and social contexts. On the one hand, teachers' intentions are influenced by abstract conceptions of what teaching and learning should involve, conceptions of the context in which teachers teach, and perceived control over the teaching practice; on the other hand, intentions determine a person's actions (Ajzen & Fishbein, 2005). This intervening position between teachers' conceptions and teaching practice makes teachers' intentions a relevant object of research. Furthermore, in the field of higher education, many studies have been reported on approaches to teaching (cf. Gregory & Jones, in press; Kember 1997; Kember & Kwan, 2002; Prosser, Trigwell, & Taylor, 1994; Postareff & Lindblom-Ylänne, 2008; Stes, De Maeyer, & Van Petegem, 2008; Stes, Gijbels, & Van Petegem, 2008). The

approach of a teacher gives a characterisation of his/her typical teaching style, similar to how a student's approach to learning describes the student's learning style (Kember, 1997). Teachers' approaches to teaching are context dependent and can, for example, change between courses taught by the same teacher. The Approaches to Teaching Inventory (ATI; Prosser et al., 1994) is frequently used to examine teachers' approaches in higher education. The inventory is often administered to teachers in retrospect of a particular course in order to retrieve the teachers' approach to teaching during that course. Broadly two types of approaches to teaching can be distinguished in the research literature in higher education, a student-focused/learning-oriented and a teacher-focused/content-oriented approach (Kember, 1997; Prosser et al., 1994). The student-centred/learning-oriented approach is characterised by a focus of the teacher on changing students' conceptions, while a teacher-centred/content-oriented approach is characterised by a focus of the teachers on transmitting information to students.

1.4.4 Students' perceptions of learning environments

Several studies into the quality of student evaluations of learning environments show that students' perceptions are a valid source of data about teachers and teaching (Abrami, d'Apollonia, & Cohen, 1990; Braskamp & Ory, 1994; Cashin & Downey, 1992; Marsh & Roche, 1997). The teacher is an important element of the learning environment, and often its organiser and constructor. Students' perceptions of elements of the learning environment, such as availability of supervision or possibilities for feedback from peers, are a rating, not only of the learning environment itself, but also of the teacher. The teacher constructed this environment, within certain constraints, and guided the students through the environment. In their study of postgraduate student evaluations, Marsh, Rowe, and Martin (2002) concluded that student evaluations of learning environments are a reliable source of information. Therefore, students' perceptions of learning environments are an effective method to gather data about teachers and teaching (Abrami et al., 1990; Mainhard et al., 2009). Studies into students' perceptions of learning environments in which research and teaching are closely integrated show that students' perceptions are a relevant resource, not only for the purposes of constructing learning theories, but even more so for curriculum development and teacher development purposes (Jenkins et al., 2003; Van der Rijst et al. 2009).

1.5 Context and research questions

1.5.1 Research context

Leiden University was founded in 1575, and is the oldest university in the Netherlands. Recently, together with other eminent research universities in Europe, Leiden University took the initiative to join forces in a collaborative group labelled the League of European Research Universities. One of the aims of this league is to collaborate and share ideas about research and teaching (Boulton & Lucas, 2008). Since the Bologna declaration, emphasis is put on the internationalisation of national higher educational systems (De Wit, 2006; Elen & Verburch, 2008; European Ministers of Education, 1999). Because of this declaration, among other reasons, the universities in the Netherlands underwent some rather far-reaching innovations, such as the change of the credit system for the study load of courses (European Credit Transfer System), the introduction of the bachelor's-master's structure, and the introduction of English as the first language of instruction in master's programmes. These innovations have led to a more accessible higher education system for international students and staff members in the Netherlands. A new innovation specific to Dutch universities is the prominence given to the professional pedagogical development of teaching staff. Since 2008, the universities in the Netherlands have agreed to initiate a common mandatory pedagogical training course for new staff at universities (Vereniging van Samenwerkende Nederlandse Universiteiten, 2008). Many universities in the Netherlands, including Leiden University, are currently working towards introductory pedagogical training facilities for university staff.

University teachers from the Faculty of Science of Leiden University participated in the studies presented in this thesis. This science faculty comprises eight bachelor's programmes, Astronomy, Biology, Computer Sciences, Life Science & Technology, Mathematics, Molecular Science & Technology, Bio-Pharmaceutical Sciences, and Physics, and twelve master's programmes. Around 1600 students are enrolled in these programmes. The programmes are offered by eleven research institutes, including Leiden Institute of Physics, Leiden Observatory, Leiden Institute of Chemistry, and Institute of Biology Leiden. In these institutes together, an average of 300 PhD candidates conducts their research projects, and up to 350 scientific staff members, from post-doctoral fellows to full professors, and up to 340 other staff members are employed.

1.5.2 Research questions

The studies presented in this thesis were focused on the individual level of teaching and learning: academics' characteristics, such as research dispositions

and teaching intentions, were examined. The central aim of the studies presented in Chapters 2 and 3 was to improve understanding of the scientific research dispositions of experts in the field of scientific research. The overarching aim of the studies presented in Chapters 4 and 5 was to identify patterns between science academics' teaching intentions and their actual teaching practice.

As discussed above, research dispositions are relevant elements of the intangible nexus, and are also an under-emphasised theme in education and in educational research. Therefore, in the first two studies, the nature of scientific research dispositions as intangible elements of the research-teaching nexus was considered. During the first study, aspects of scientific research dispositions of academics were inferred from interviews. Academics were clustered in groups with comparable research dispositions. The main research questions in the first study were the following:

1a) What aspects can be distinguished in the ways science academics conceive of their scientific research dispositions?

1b) What are the differences and similarities between groups of academics with comparable research dispositions?

The research aim of the second study was to develop an empirically based notion of disposition through the evaluation of three instruments to assess the concept of disposition. The question posed in this study was:

2) Which instruments or combination of instruments can best be used to investigate a person's research disposition?

The third and fourth studies were focused on associations between, on the one hand, teachers' approaches and intentions and, on the other hand, actual teaching practice in research-intensive environments. In the third study, academics' approaches were measured using a questionnaire and their teaching practices were investigated through a study of teachers' speech during courses. The central research questions of this study were the following:

3a) What typical sequences can be recognised in individual teachers' speech during course meetings?

3b) Are teachers' typical speech act sequences associated with their approaches to teaching and the method of instruction used during science courses?

Finally, in the fourth study, academics' teaching intentions were inferred through interviews, and their teaching practices were examined through the students' perceptions of the constructed learning environments. The central question in the fourth and final study was:

4) What associations can be identified between teachers' intentions and students' perceptions of the research intensiveness of university science courses?

1.6 Outline of the thesis

In Chapters 2 and 3, two studies are presented which were aimed at gaining a comprehensive understanding of academics' scientific research dispositions. In Chapters 4 and 5, two studies are presented which were aimed at gaining a deeper understanding of associations between teachers' approaches, teachers' intentions, and teaching practice. In Figure 1.1 an overview of all instruments used in this thesis is presented. The instruments are categorized into three groups, representing the underlying variables.

Chapter 2 presents the first study. In this study, academics (n=23) of the science faculty at Leiden University were interviewed about their research dispositions. The participants had different backgrounds in terms of discipline, research experience, and teaching experience. The analysis of the interview data was analogous to procedures of the grounded theory approach; themes and categories were recognised based on participants' responses in the interviews (Bryant & Charmaz, 2007). A hierarchical cluster analysis provided insight into subgroups of participants with similar scientific research dispositions. A principal component analysis of categorical data was performed to explore latent variables underlying these subgroups. Combination of results from the hierarchical cluster analysis with the principal component analysis allowed the clusters to be interpreted in terms of similarities in research dispositions between cases within clusters (Greenacre, 2007).

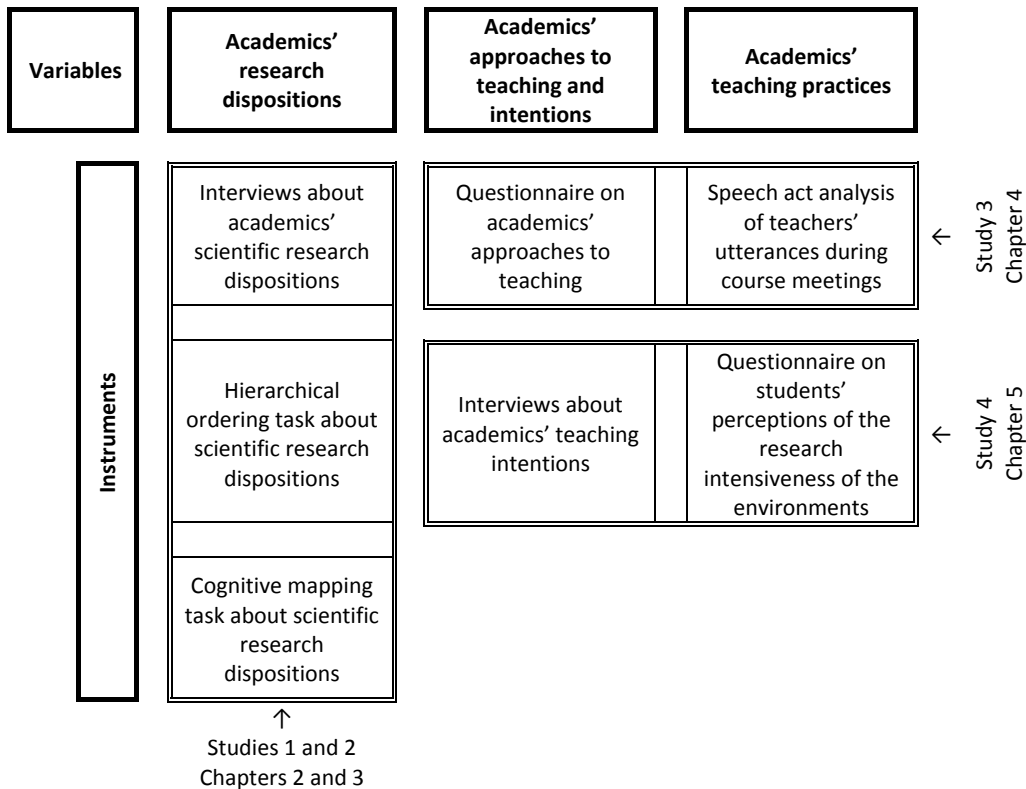


Figure 1.1 Overview of instruments used in the studies, categorised into academics' research dispositions, approaches to teaching and intentions, and teaching practices

The second study is described in Chapter 3. In this study three instruments were compared to identify a person's scientific research disposition. These instruments differed in their latitude for the respondents: a semi-structured open-ended interview, a hierarchical ordering task, and a structured mapping task. The aim of this study was, first, to increase understanding of the concept of research disposition by developing an empirically based notion of disposition, and second, to identify which instrument, or combination of instruments, was most effective in evaluating a person's research disposition.

Chapter 4 describes the third study. Here, a new analysis tool in the field of teaching in higher education, speech act analysis, was developed to investigate teachers' speech during course meetings and to gather information about academics' teaching practice. This analytical framework was based on speech act

theory; it provides a method to investigate teachers' speech repertoires. Typical speech act sequences of the participants were identified, and similar patterns were clustered. Associations between speech acts of academics (n=12) and their approaches to teaching were examined in a mixed method design in this study.

In Chapter 5, associations between teachers' intentions and students' perceptions were identified through the comparison of results from interviews with teachers (n=11) and a student questionnaire (n=104). The analysis of the interview data was analogous to procedures of classic content analysis; existing categories from the literature were used to analyse interview transcripts (Krippendorff, 1980; Ryan & Bernard, 2000). Students' perceptions of the learning environment were used as a window into academics' teaching practice. Associations between students' responses to the questionnaire and teachers' intentions are presented.

In Chapter 6, the main findings and conclusions of the four studies are summarised, discussed, and related to each other. Suggestions for further studies and implications for the practice of teaching in higher education are described.