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

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Chapter 3

Towards an empirically based notion of the concept of disposition

3. Towards an empirically based notion of the concept of disposition[2]

Debates on the concept of disposition in educational research are theoretically oriented, and show limited empirical applicability. The aim of this study was to evaluate a set of instruments to assess the concept of disposition empirically. In this study scientific research dispositions of academics were considered. We examined three instruments, which differed in their latitude for the respondents: a semi-structured open-ended interview, a hierarchical ordering task, and a structured mapping task. The results show that the semi-structured interview and the hierarchical ordering task enabled assessment of the tacit research dispositions, while the structured mapping task facilitated assessment of the respondents' explicit ideas about their research dispositions. Hence, we suggest for future research to utilize a combination of the instruments.

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3.1 Introduction

The concept of disposition can be identified in various bodies of literature within the educational sciences (Barak, Ben-Chaim, & Zoller, 2007; Bourdieu, 1989; Damon, 2007; Diez & Raths, 2000; Dottin, 2009; Facione, Facione, & Giancarlo, 2000; Laird, 2005; Murray, 2007; Perkins, Tishman, Ritchart, Doris & Andrade, 2000; Pithers & Soden, 2000; Schussler, 2006; Stupnisky, Renaud, Daniels, Haynes, & Perry, 2008). However, there has been little conceptual debate about the concept of disposition in educational research, as the concept is still in an developmental phase (Dottin, 2009). In order to improve the quality of the conceptual debate more attention should be given to the definition of and the ideas behind the concept of disposition. Conceptual misunderstandings are prolonged when concepts remain unclear. In some fields of educational research, for example, the words *disposition* and *attitude* are used interchangeably. Although these concepts are closely related, they are not the same. The concept of attitude used in the psychological literature is contemporarily defined as 'a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor' (sic.) (Eagly & Chaiken, 1993, cited in Albarracin et al., 2005, p. 4, italics in original), while the concept of disposition can be more broadly defined as a person's individual mixture of inclinations to act under certain conditions (Siegel, 2005; Van der Rijst, Van Driel, Kijne, & Verloop, 2007). Situational inducements, such as social norms, group pressure, time on task, or task difficulty, are often opposed to dispositional attributes, such as motives, personality traits, or abilities, in the classification of causes of behaviour in psychology (Trope, 1986). Therefore, the psychological concept of attitude, as in *attitude towards something*, should be discriminated from the broader ordinary notion of *having an attitude*, in the sense that an attitude is commonly considered to be a characteristic way of behaving, while the psychological notion of attitude towards something is a positive or negative feeling towards something. For example, a *scientific attitude* is not the same as an *attitude towards science*. A student can have a positive feelings towards doing laboratory work (attitude as a concept in psychology), while being very critical when performing a lab-work assignment (attitude as a notion in daily life). Bearing in mind this difference, we note that the concept of disposition is more closely related to the commonly received notion of attitude than to the psychological concept of attitude, in the sense that the commonly received notion of attitude and the concept of disposition can both be broadly defined as a person's mixture of inclinations to act under certain conditions.

Few interdisciplinary debates about the concept of disposition exist within educational research, but within philosophy the concept has been overly discussed in recent decades (cf. Fara, 2005; see Malzkorn, 2001 for an overview). Although this debate involves *dispositions of substances*, many arguments also reverberate upon the use of the concept in the social sciences, the *disposition of subjects*. Since the concept of disposition faces similar problems in both fields, the arguments from the debate on dispositions of substances are potentially helpful when considering dispositions of subjects.

3.1.1 Dispositions of substances in modern philosophy

The debate about dispositions in modern philosophy can support academics working with the concept in educational research, especially at the present time, as no commonly accepted notion of the concept of disposition is present in educational research. Because the arguments in the philosophical debate are rather technical and diverse, we are not able to give a full account. For an attractive overview of the debate in modern philosophy, see Fara, 2005 and Malzkorn, 2001. Below, we present the basic arguments from this debate, and deduce three principles of the concept of disposition which are potentially helpful when working towards an empirically based notion of the concept of disposition in educational research.

Dispositional properties of substances, such as solubility or fragility, only relate to *possible* behaviour under certain specified conditions. Categorical properties, such as shape and mass, on the other hand, can be observed directly from actual behaviour. For example, sugar has categorical properties, such as its colour and crystalline shape. These properties can be observed and measured under normal conditions. Its dispositional property cannot be measured under normal conditions, but only under certain specified conditions. A dispositional property is distinct from a categorical property in that it needs specific conditions under which the manifestation of the dispositional property can be observed. For example, we only know that a glass vase has the tendency '"to break (dispositional property) when it falls on a solid floor (condition C)", if and only if (iff) it breaks when it falls on a solid floor (manifestation M)'. This description gives an idea of the Simple Conditional Analysis of dispositional properties, which is generally stated as follows: An object is disposed to M when C iff it would M if it were the case that C. However, this definition of disposition faces several counterexamples, most of which are special cases of the *conditional fallacy* of contemporary philosophy (cf. Bonevac, Dever, & Sosa, 2008; Shope, 1978). The conditional fallacy roughly states that one ignores the fact that the truth of a

statement sometimes depends on whether a particular state of affairs actually occurs, while it should only depend on the assumptions or the definitions, which, therefore, permits several counterexamples. Here we describe only two counterexamples to the Simple Conditional Analysis, which are not directly related to this conditional fallacy. Johnston (1992) described the situation in which a glass vase, which is disposed to shatter when dropped, is carefully covered with packing material. The glass vase still has the disposition to be fragile, but it does not shatter when it is dropped. The disposition of the vase is masked by the external packing material. A similar counterexample was described in Bird's (1998) antidote example. A poison is disposed to kill when ingested, but when an antidote is administered in time the manifestation of the disposition will not be present. In both counterexamples, the packing material and the antidote are items external to the substances, and should, according to our common sense, not eliminate the dispositional property. It seems that a disposition should be related, in one way or another, to some intrinsic property of that substance. Thus, as Fara (2005) puts it, an object '"*N* is disposed to *M* when *C*" is true iff *N* has an intrinsic property in virtue of which it *M*s when *C*'. Thus, there must be an intrinsic property which can serve as an explanatory basis for the disposition. This means that the label of the disposition, e.g., fragility or solubility, does not explain anything in the sense that if we ask why that glass vase is disposed to break when dropped on a solid floor, the answer, because it has the disposition to be fragile, is not adequate. This is similar to the explanation given by Molière's doctor about the dispositional property of opium; it has a *virtus dormitiva* whose nature it is to put the senses to sleep. An adequate answer might be that there is an intrinsic property which causes the manifestation of the disposition. For example, the irregular atomic structure of the vase will not hold owing to the force of the fall. Note, that different intrinsic properties might be considered as a causal basis for the same disposition. For example, fragility might be explained by weak intermolecular bounds or by instability of lager parts (Fara, 2005). Therefore, the causal efficacy of a disposition is debatable. However, in everyday life, the concept of disposition is applied in an explanatory way, often with an implicit assumption of the existence of an intrinsic property as explanatory base.

3.1.2 Three principles for the concept of disposition

From the above discussion on the debate about the concept of disposition in modern philosophy, we can deduce three main principles relevant to this concept. The first principle is that dispositions only become apparent or observable under specific circumstances. Analogous to the fact that the dispositions of substances,

such as the solubility of sugar, only become apparent in specific environments, such as in tea or coffee, dispositions of subjects, such as being critical, most often become apparent in a competitive environments. Furthermore, the simple conditional analysis showed that we have to be specific in describing the exact conditions of a certain disposition. And even if we are, several counterexamples, such as masks or antidotes, can be proposed. These counterexamples do not negate the existence, but merely restrain the manifestation of a particular disposition. Hence, dispositions should always have an explanatory basis which refers to some intrinsic properties.

The second principle, therefore, states that dispositions always have an explanatory basis, which can be found in the intrinsic attributes of the substance or the subject under investigation. These intrinsic properties are durable and stable. Even then, the causal efficacy of dispositions of subjects can not be guaranteed; at least, some debate remains possible about the explanatory value of dispositions. We can, for example, use the concept of disposition to explain behavioural tendencies, but we face the same dilemma as with the concept of dispositions of substances. The concept of disposition labels the presence of an intrinsic property which can appear in a behavioural pattern. The label itself does not explain any characteristic features. However, by labelling something as a *disposition*, we acknowledge that it has characteristics similar to those of other dispositions. This is analogous to labelling an animal as a *vertebrate*. The label only explicates that the animal has the same characteristics as other members of that subphylum. Therefore, the concept of disposition has the potential to support the categorization and understanding of the behavioural patterns of subjects.

The third principle, which can be drawn from the previous discussion about the concept in modern philosophy, is that dispositions can be evaluated empirically. If dispositions of subjects are durable and stable attributes, similar to dispositions of substances, they need an explanatory basis in some intrinsic property of the subject, such as experiences, motives, personality traits, attitudes, skills, or abilities. Since such intrinsic properties are theoretically assessable, it is possible to empirically assess dispositions of subjects. From here we can develop an empirically based notion of the concept of disposition in educational research.

3.1.3 Dispositions of subjects in educational research

Before we continue, we must reflect on a remarkable difference between the dispositions of substances and the dispositions of subjects. Subjects, in contrast to substances, can reflect on their own dispositional attributes. This means that a

subject knows its behavioural tendencies and might choose not to behave according to that specific disposition. For example, a subject who is disposed to be highly critical of the work of others might choose not to be critical of the work of a first-year student. The actual disposition might be masked by the subject's intentions. In the philosophy of the social sciences, the notion that subjects have their own understanding of phenomena which affects the understanding of others is described as the *double hermeneutics* in social sciences (Giddens, 1987). This double hermeneutics restricts the interpretation of the results about dispositions and of matching behavioural patterns of subjects considerably. As described in the following section, we used the three principles to briefly evaluate three bodies of literature in which the concept of disposition has a central place. In these bodies of literature the contexts in which the concept of disposition is used differ. The dispositions of academics, of teachers, and of students have been examined and described in these bodies of literature.

3.1.4 Habitus as a system of dispositions

Bourdieu described the word *disposition* as particularly suited to express what is covered by his concept of habitus. The habitus of a person designates a way of being, a habitual state, and, in particular, a tendency, propensity, or inclination (Bourdieu, 1977). Bourdieu's ideas have been used widely in the field of educational research, especially concerning topics in the sociology and anthropology of education, such as social capital. Bourdieu's *Outline of a theory of practice* (1977) was written as a reaction against the structure-agency debate, at that time, between subjectivists and objectivists, as Bourdieu called them. Subjectivists explained social behaviour from the interpretations of the agents, or actors, while objectivists described social behaviours from abstract structures, external to the domain of the individual agents. Bourdieu attempted to dissolve the debate through a Hegelian dialectic of synthesizing these seemingly opposite ideas. First, Bourdieu noted that social behaviour is not determined by rational thoughts, but by practical logic, the not fully conscious or goal-directed thoughts and feelings of the actors. Therefore, according to Bourdieu, social behaviour is directed not by conscious mental states of agents, nor by abstract theoretical structures transcending individual agents, but by the rather unconscious system of values and dispositions towards specific behaviours. This 'system of durable, and transposable dispositions' is labelled as the habitus of an agent (Bourdieu, 1977). While Bourdieu's ethnographic fieldwork in Kabylia (Algeria) provided the basis for the development of his ideas, French Academia provided Bourdieu with a test case for his theory. The habitus of French academics, for example, is

described as the beliefs, assumptions, and dispositions of scholarship. The concept of habitus provided Bourdieu with a foundation to examine processes of socialization that individual academics experienced in particular research and teaching groups (Bourdieu, 1988; Bourdieu, 1989). In this way, Bourdieu provides an explanation for the existence of research groups and disciplines, which comprise actors who have similar dispositions. The habitus of a researcher can be understood through the system of dispositions, which develops over time in the interaction with other agents in the social field, for example, the other academics in the research group. In this sense, processes of socialization are processes of change of the habitus of an individual agent towards the habitus of other agents in a group. Academics develop their systems of dispositions throughout their academic careers, and when working in new research groups they slowly and unconsciously change their habitus. In this way, researchers tend to develop similar dispositions. Academics also have a teaching task, in which they train students to design, conduct, and report about scientific studies. In teaching students about doing science, academics intentionally, although mostly implicitly, aim to change the habitus of the students towards the teacher's system of dispositions. In a certain way the students are socialised in doing research in a manner similar to that of the particular academic. The ideas of habitus as a system of dispositions can be seen as an alternative sociological or anthropological lens through which social behaviour can be investigated. Bourdieu's ideas are still used by educational researchers to analyze issues in teaching in higher education (Deem & Lucas, 2007; Noyes, 2008).

The system of dispositions of actors are rather stable and durable, but also change over time as a result of experiences, among other things. This provides the intrinsic attributes of the subjects as a strong explanatory basis for the dispositions. Therefore, this body of literature recognizes the second principle. However, the first principle, which states that dispositions become apparent under specific circumstances, cannot be directly related to Bourdieu's use of the concept of disposition. Although Bourdieu describes specific contexts in which actors interact with each other, such as rural areas of Algeria or French academia, he does not explicitly demonstrate which dispositions become apparent under which circumstances. Furthermore, from Bourdieu's theoretical observation that the habitus comprises stable and durable dispositions, we can infer that, in principle, these dispositions are open to empirical assessment. However, Bourdieu does not explicitly refer to instruments, such as surveys or interview schemas, which can be used to evaluate dispositions in educational settings.

3.1.5 Thinking dispositions

Critical thinking dispositions have been of interest to researchers in the field of education because these dispositions potentially provide an explanatory basis for student behaviour. In this body of literature, thinking dispositions have been broadly defined as tendencies toward particular patterns of intellectual behaviour (Perkins et al., 2000; Perkins, Jay, & Tishman, 1993). Perkins and colleagues (1993) put forward a *triadic conception* of thinking dispositions. In their view, three elements, (1) ability, (2) sensitivity, and (3) inclination, should be present in order to induce dispositional behaviour, such as critical thinking. First, a person should have the basic capacities or skills to perform certain behaviour (ability). Second, this person should perceive this behaviour to be appropriate in that particular situation (sensitivity). Third, this person should have the tendency, or drive, to carry out the behaviour (inclination). These three elements are essential for dispositional behaviour to occur, while a particular disposition can be associated with an inclination, tendency, or drive of a person. Facione & Facione (1992) developed a questionnaire to measure critical thinking dispositions. The findings of studies in which this California Critical Thinking Disposition Questionnaire (Facione & Facione, 1992; Facione et al., 2000) were used suggest several sub-dispositions, such as open-mindedness, inquisitiveness, systematicity, and truth-seeking (Facione, Sanchez, Facione, & Gainen, 1995). In this body of literature the disposition to think critically is related to a spirit of inquiry, drawing unwarranted assumptions cautiously, and weighing the credibility of evidence (Barak et al, 2007; Pithers & Soden, 2000). Less clear, however, is the influence of the disposition or sub-dispositions on psychological attributes or educational outcome variables, such as self-efficacy, motivation, or academic achievement (Laird, 2005; Stupnisky et al, 2008).

The triadic conception of dispositional behaviour, described in this body of literature on thinking dispositions, is an interesting example of how to comprehensibly describe specific circumstances under which dispositional behaviours become apparent (first principle). Although no intrinsic attributes could be identified in this body of literature, some psychological attributes were mentioned, such as self-efficacy and motivation. These attributes can potentially serve as an exploratory basis for dispositions (second principle). Furthermore, the questionnaire developed in this body of literature illustrates that dispositions can be assessed empirically. However, the advantages and disadvantages of the evaluation of dispositions through survey techniques were only tacitly touched upon (third principle).

3.1.6 Teacher dispositions

In 2000, the American National Council for Accreditation of Teacher Education (NCATE) published a new set of standards for the evaluation of teacher candidates' performances (Damon, 2007). These standards not only focused on the knowledge and skills required for teaching, but also on teachers' professional dispositions. These teacher dispositions were rather loosely defined issues associated with teacher beliefs, attitudes, and behaviours. Logically, debates arose about the definition of 'teacher dispositions' (described by Damon, 2007; Dottin, 2009; Murray, 2007; Schussler, 2006, among others). In 1985, Katz & Raths already defined teacher disposition as "an attributed characteristic of a teacher, one that summarizes the trend of a teacher's action in a particular context" (p. 301), and contrasted this definition with other constructs, such as habits, skills, attitudes, and traits. Throughout the years, the concept of teacher disposition has been described in different ways. However, a common element can be distinguished, that dispositions describe a pattern of intentional acts in a particular context and at a particular time (Diez & Raths, 2000). The definition of the concept as a pattern of acts does indeed contrast it with the psychological concept of attitude, which is a bi-polar feeling towards something. However, it also indicates that disposition in this sense is a behavioural concept. The definition seems to encourage counting of teacher behaviours to find behavioural patterns and thus teacher dispositions, while the concept of disposition as a tendency to act does not necessarily mean that a disposition results in observable behaviours. This illustrates that in the body of literature on teacher dispositions the concept is observed through a behavioural lens, rather than through a cognitive lens. The debate about the definition and value of the concept of teacher dispositions is unresolved and ongoing in the literature on teaching and teacher education (cf. Damon, 2007; Dottin, 2009; Murray, 2007; Schussler, 2006).

When we compare the body of literature on teacher dispositions to the three principles of the concept of disposition, we firstly notice that the concept is defined through a behavioural lens, and therefore, inevitably, no intrinsic properties are attributed to provide an explanatory basis for the patterns of intentional acts. Therefore, the second principle is not satisfied. Furthermore, teachers' dispositions become apparent under specific circumstances (first principle), for example, during *bumpy moments* in classroom experiences (cf. Kan, Verloop, & Ponte, 2008; Romano, 2006). However, which dispositions or sub-dispositions become apparent during these specific 'bumpy moments' should be identified in future research. Finally, related to the third principle, empirical

measurement techniques which are appropriate to describe teacher dispositions remain to be identified.

3.1.7 Research question

From the previous discussion about the concept of disposition, it is clear that in the social and educational sciences the boundaries for the concept are not yet clearly defined. The debate about dispositions of substances provides three principles, which are potentially useful to define the concept of disposition of subjects. These three principles can set the ground rules to construct a suitably strong notion of dispositions in educational research. One of the gaps identified in the literature on the concept of dispositions in educational research is the empirical foundation of the concept. The aim of this study was to develop an empirically based notion of disposition of subjects through the evaluation of a set of three instruments to assess the concept. The guiding question was *which instruments or combination of instruments can best be used to investigate a persons' research disposition*. Comprehension of the concept improves when more is known about the instruments through which we can measure or assess the dispositions of the participants in our studies.

3.2 Methods

3.2.1 Three instruments to assess scientific research dispositions of academics

In this section, a study of three instruments to assess dispositions, specifically scientific research dispositions of academics, is described. Recently, we carried out a study which showed that scientific research dispositions of academics comprised of six aspects, namely, inclination (1) to achieve, (2) to be critical, (3) to be innovative, (4) to know, (5) to share, and (6) to understand (Van der Rijst et al., 2007). The three considered instruments differed in their degrees of freedom, or latitude, for the participants (Meijer, 1999): (1) a semi-structured open-ended interview, (2) a hierarchical ordering task, and (3) a structured mapping task. Awareness of the tension between latitude for participants in the research instruments and the complexity of the interpretations was expected to generate an improved understanding of the limitations and advantages of specific methods and instruments. For example, the structured questions in a survey should be considered as having a less extended degree of freedom than open-ended questions, while interpretation of the results of the open-ended questions is more complex. The latitude of the semi-structured open-ended interview method was reasonably large, as participants could raise any issue concerning their dispositions towards research whenever they thought it necessary. The

hierarchical ordering task restricted the participants in their freedom to raise issues concerning their research dispositions, in the sense that they only could react to the presented six aspects. Compared to the other two instruments, the structured mapping task had the narrowest latitude. Participants were restricted to reacting to two aspects at a time in a multiple-choice format. Thus, the latitude decreased from interview, via ordering task, to mapping task.

3.2.2 Participants

To investigate the similarities and differences, the three instruments were presented to three participants, Steven, Roger, and David. The names are fictitious in order to preserve anonymity. Steven was full professor at a research institute of chemistry, Roger an associate professor at a research institute of astronomy, and David an assistant professor at a research institute of astronomy. All three participants were academics at a Faculty of Science of Leiden University.

3.2.3 Instrument 1: Semi-structured open-ended interview

The first instrument was aimed at identifying aspects of the participants' scientific research dispositions through coding of the transcripts of the interviews with the participants. A semi-structured open-ended interview was designed and administered, providing the participants with multiple opportunities to raise matters considered to be important. Participants were asked to relate all questions to their daily research practice. General questions, such as “what are the most important aspects of your research attitude,” were asked as well as more specific questions probing participants' research dispositions during research, such as, “which dispositions do you embrace during your research activities?” In this instrument participants received a reasonably large degree of freedom. The frequencies of the codes in the interview fragments were counted and recalibrated to unity, which is the total number of assigned codes, to make comparison with other instruments possible. Hence, aspects close to 1 could be interpreted as mentioned most often, while aspects close to 0 were mentioned least. The interviews took place during the summer of 2006, were transcribed verbatim, and were analysed using codes described in a previous study on the scientific research dispositions of academics (Van der Rijst et al., 2007). For an explanation of the six aspects, see Chapter 2.

3.2.4 Instrument 2: Hierarchical ordering task

The second instrument was designed to identify participants' scientific research dispositions using a structured task. After reading the descriptions of all aspects of

scientific research dispositions, the participants were asked to hierarchically order the six aspects in order of preference, as perceived in their everyday research practice. The aspects were put into a linear order, from the aspect which was most often present to the aspect which was least present. The order was explicitly not interpreted using a normative value by the participants. Participants could react to the presented six aspects and put these aspects in a hierarchical order. The compulsory hierarchical ordering was a additional restriction of freedom. The aspect highest on the preference list was assigned '6'; the aspect lowest on the list was assigned 1. The preferences were recalibrated to unity, which was defined as 21 (6+5+4+3+2+1), so that aspects close to 1 could be interpreted as *high* in the hierarchical order, and aspects close to 0 as *low* in the hierarchical order. The hierarchical ordering tasks as well as the structured mapping tasks, which are explained below, were presented to participants during the fall of 2007.

3.2.5 Instrument 3: Structured mapping task

With the third instrument, all aspects were presented pair-wise to the participants. After re-reading the descriptions of the aspects of scientific research dispositions, the participants were asked (i) if they perceived a clear relationship between the two aspects presented, (ii) if they perceived any direction between the presented aspects, and (iii) if they could rate the strength of the relationship on a three-point scale. A direction was interpreted as causal direction between two aspects. For example, a respondent might indicate that he/she, in general, has an initial drive or tendency to understand a phenomenon, after which he gradually develops a tendency to critically examine that phenomenon. Participants were restricted to reacting to two aspects at a time through multiple-choice-like questions. Based on the data from step two (ii) in the interview scheme, cognitive graphs were constructed and analysed, using concepts from Graph Theory and (social) network analysis (Borgatti, Everett, & Freeman, 1999; Huisman & Van Duijn, 2003). The nodes in a cognitive graph represent the cognitive aspect, whereas the ties between the nodes represent the relationships between the cognitive aspects. Since these cognitive graphs have the same architecture as mathematical graphs, the same mathematical techniques can be deployed, using concepts such as density, centrality, and degree. Similar to Graph Theory, the properties of the nodes (e.g., in-degree and out-degree) as well as the properties of the total graph (e.g., density and reciprocal density) can be applied to assess the metric of these graphs using quantifiable measures. Previous study findings have shown that techniques from Graph Theory can be applied successfully to assess the structural properties of conceptions (Bakkenes,

Vermunt, Wubbels, & Imants, 2007; Wassink, Sleegers, & Imants, 2003). In instrument 3, we applied five concepts from Graph Theory, two to characterize aspects on a global level, namely, (1) global density and (2) reciprocal density, and three to assess properties on an individual node level, namely, (3) overall degree, (4) in-degree, and (5) out-degree.

1. The global density of a graph is defined as the ratio between the number of present ties and the number of possible ties. This is a measure of the completeness of a graph. A complete graph will have global density 1, while a graph without any ties between the nodes will have a density 0. The density can be calculated for directed as well as undirected graphs. To investigate whether the direction influenced the centrality of the nodes in the graphs of the participants, degrees for both the undirected and the directed representation of the graphs were calculated.
2. A second graph property, reciprocal density, is a property of directed graphs. The reciprocal density of a graph is the ratio between the present number of reciprocal ties and the possible number of reciprocal ties. A complete graph, with only reciprocal relations between nodes, has reciprocal density 1, while a graph without any reciprocal relationships has reciprocal density 0. The degree of individual nodes is used to characterize the centrality of nodes within a graph.
3. The overall degree of a node in a directed graph is the sum of incoming and outgoing ties. If we neglect the directions of the ties between nodes we can also calculate the overall degree for the undirected graphs. Within a directed graph we can discriminate between in-degree and out-degree.
4. The in-degree is the number of relations directed towards a node.
5. The out-degree is the number of relations directed away from a node towards other nodes.

For all aspects, the directed overall degree, undirected overall degree, in-degree, and out-degree were calculated. The degree was calculated for both the undirected and the directed representation of the graphs, to investigate if the direction influenced the centrality of nodes. All properties were recalibrated to unity, in order to allow cross-instrument comparisons. Aspects close to 1 can be interpreted as having a central position in the graph, while aspects close to 0 were more peripheral.

Table 3.1 Brief illustrations of participants' verbalizations of their scientific research dispositions (between brackets the absolute frequencies of the codes)

	Steven	Roger	David
To Achieve - ambition - discipline - full of initiative - patience - passionate - persistent	'To concentrate, to focus, that's something central to this profession. It [research] is no hocus-pocus, it isn't very extraordinary. You just need a certain routine and discipline'. (8)	'You can have innovative ideas; however, you have to put these ideas into practice in a scientifically correct and theoretically sound way, and if the ideas do not seem to work afterwards, you just have to dismantle them'. (2)	(0)
To be Critical - critical (general) - critical towards others - honesty - observing - self-critical	'Being critical, being independent, and having the ability to present nicely are the core aspects, in my view, in particular being critical'. (2)	(0)	(0)
To be Innovative - anticipating - associative - choosing own path - creative - original - unconventional	'My intuition tells me how certain processes will evolve. And if I am wrong, I will adapt my hypothesis. Being afraid does not help! On the other hand, doing research is formulating a work hypothesis and then testing this hypothesis. And then you verify or adapt your hypothesis. [...] Intuition that relates to experience and also a kind of creativity'. (6)	'Personally, I consider originality important; however it does not always emerge spontaneously. [...]. I have much respect for researchers who have different ideas, which might not be so fashionable at a particular time. Though they have made a lot of considerations, few others came to similar results'. (3)	'It is possible to do predictable as well as unpredictable research, choosing a direction in which the chances of succeeding are limited; however, if you succeed it will be a major break-through. On the other hand, it isn't possible to work on such risky research projects throughout your career: the chances are too large nothing will come out, a subtle balance is essential'. (1)

Table 3.1 (continued)

	Steven	Roger	David
To Know - curiosity - excitement	'On the one hand, being curious, while on the other hand, not being nervous. Thus, being enthusiastic, on the one hand, and yet again keeping disciplined, and taking the time to proceed by conveniently arranged steps'. (2)	'Curiosity, in particular within science, I suppose, however, that might be my limited perception. Curiosity is a major motive, should be the most important motive'. (3)	'There is a difference between people with a kind of energy, with passion, or love for, oh, wow lets do this, and people showing no passion at all, oh do I have to do this before March 25, okay, I'll think about it on the 24th'. (3)
To Share - explaining - openness to others - persuasive - skilled communicator - working together	'Presenting is, naturally, if it all goes well, an archetypical form, it includes aspects such as being independent, being critical, showing a drive, a passion, it includes all these aspects, doesn't it?' (1)	(0)	'They [good researchers] keep on doing work on their own. They are not only engaged in science policy issues,[…] they […] do their own work, their own calculations, keep thinking about issues, and not just pointing out the direction to go, while others do the hard work'. (1)
To Understand - overview - scrutinizing - solving problems	(0)	'The drive to understand a phenomenon, to feel the inner joy when they understand the issues, when they solve a case, and again, it isn't about just solving puzzles. It is about the joy of understanding issues in a way nobody else understands them'. (1)	(0)

3.3 Results

3.3.1 Results instrument 1: Semi-structured open-ended interview

In total, 19 codes were assigned to Steven's interview fragments, 9 codes to Roger's fragments, and 5 codes to David's fragments. The participants' fragments varied in length. Therefore, the ratios of words per code were calculated to indicate possible differences in global features of the interview transcripts. David had the highest ratio, with 158.8 words per code; Steven had 94.8 words per code; and Roger had 71.8 words per code. Table 3.1 presents, for each participant, a quote illustrating the participant's verbalization of the aspects of his scientific research disposition. The absolute frequency of each code is also presented between brackets in Table 3.1.

From the results presented in Table 3.1, we can judge that Steven most often spoke about the aspects 'to achieve' and 'to be innovative', while aspects 'to understand' and 'to share' were least mentioned during the interview. Roger showed a different picture, when mentioning the aspects 'to be innovative' and 'to know' most frequently, 'to share' and 'to be critical' were not referred to at all. David referred to the aspect 'to know' relatively frequently, while he did not mention 'to achieve', 'to be critical', and 'to understand'. Each of the three participants put emphasis on different aspects of a scientific research disposition.

3.3.2 Results instrument 2: Hierarchical ordering task

All participants were asked to hierarchically order the six aspects in a linear order of their preference in their everyday research activities. In Table 3.2, the orders of preference of the participants are presented, alongside results from the other instruments. Table 3.2 shows that the aspects 'to be innovative' and 'to achieve' were most important to Steven, while the aspects 'to understand' and 'to be critical' were least important, according to the hierarchical ordering task. Roger put most emphasis on the aspects 'to know' and 'to understand' and less emphasis on 'to achieve' in his daily research practice. David, on the other hand, viewed the inclination 'to be innovative' and 'to share' as most preferred in his daily research practice, while the aspects 'to understand' and 'to achieve' scored low on his preference list.

3.3.3 Results Instrument 3: Structured mapping task

With instrument 3, a total of 15 pairs of aspects were presented to each participant. Figure 3.1 presents the graphical representation of the participants' responses to the pair-wise presentation of the aspects of scientific research dispositions. The global density of the undirected graphs ranged from Steven with

0.73, to David with 0.53, and Roger with a density of 0.40. A similar order of the participants was found after the determination of the global density of the directed graphs: Steven with 0.57, David with 0.37, and Roger with 0.23. Global properties of graphs are illustrative when graphs are compared. However, when characteristics of individual graphs are being explored, it is necessary to calculate the properties of individual nodes. Table 3.2 presents the properties of the individual aspects in the graphs of the participants derived from all four properties of the nodes, i.e., undirected overall degree, directed overall degree, in-degree, and out-degree.

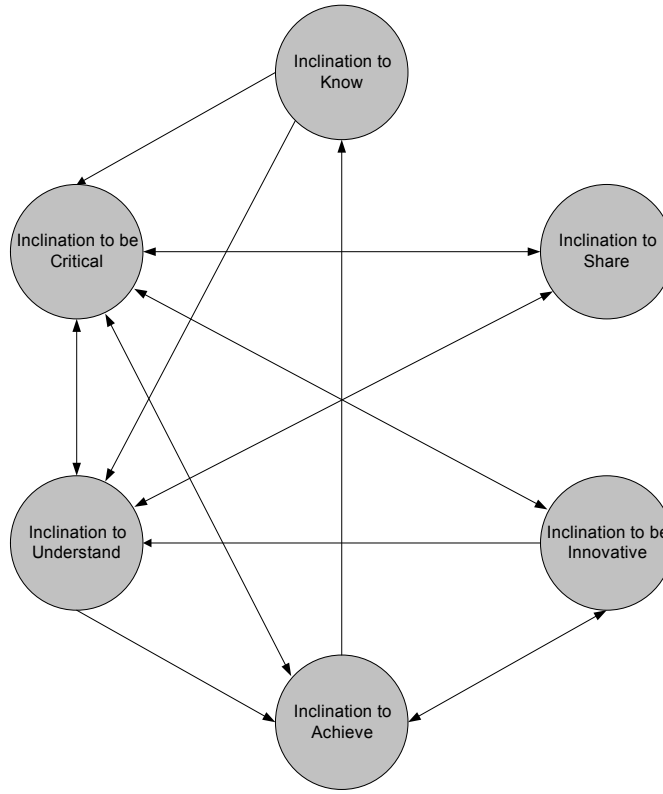

Figure 3.1a Directed graph representation of Steven's scientific research disposition

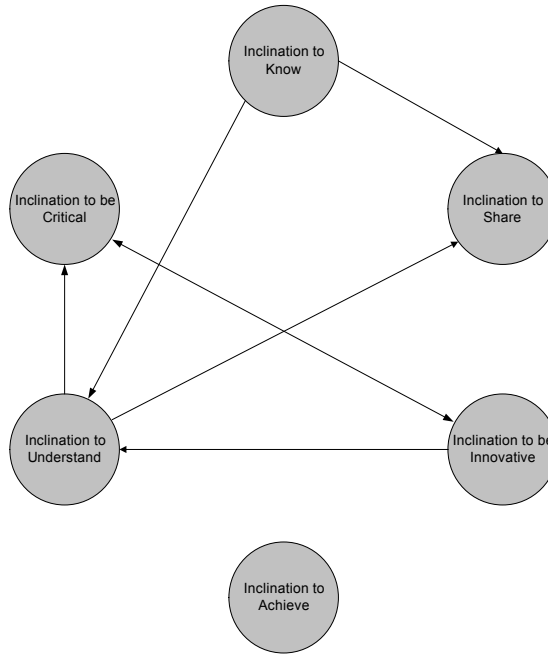

Figure 3.1b Directed graph representation of Roger's scientific research disposition

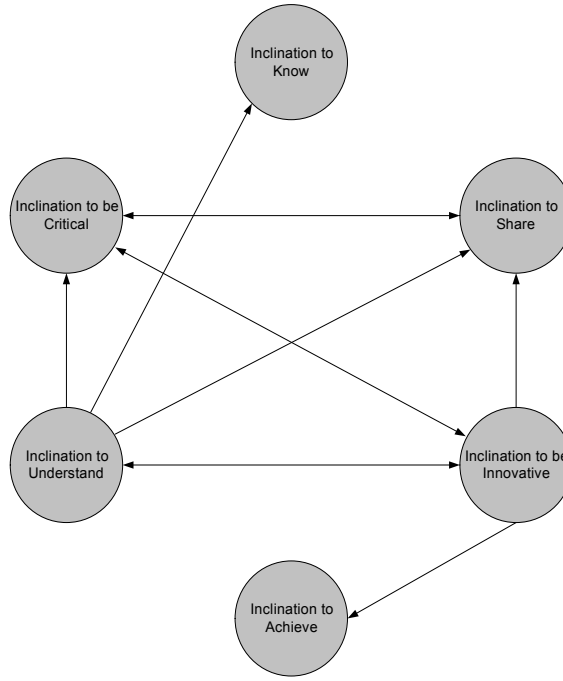

Figure 3.1c Directed graph representation of David's scientific research disposition

Table 3.2.Properties of individual aspects of participants' scientific research dispositions deduced from the cognitive graphs normalised to unity (between brackets: Instrument 1 is a semi-structured open-ended interview, instrument 2 is a hierarchical ordering task, and instrument 3 is a structured mapping task)

		To Achieve	To be Critical	To be Innovative	To know	To Share	To Understand
Steven	Interview (1)	0.42	0.11	0.32	0.11	0.05	0
	Hierarchical order (2)	0.24	0.10	0.29	0.19	0.14	0.05
	Un-directed degree (3)	0.18	0.23	0.14	0.14	0.09	0.23
	Directed degree (3)	0.18	0.26	0.15	0.09	0.12	0.21
	In-degree (3)	0.18	0.29	0.12	0.06	0.12	0.24
	Out-degree (3)	0.18	0.24	0.18	0.12	0.12	0.18
Roger	Interview (1)	0.22	0	0.33	0.33	0	0.11
	Hierarchical order (2)	0.10	0.05	0.19	0.29	0.14	0.24
	Un-directed degree (3)	0	0.17	0.17	0.17	0.17	0.33
	Directed degree (3)	0	0.21	0.21	0.14	0.14	0.29
	In-degree (3)	0	0.29	0.14	0	0.29	0.29
	Out-degree (3)	0	0.14	0.29	0.29	0	0.29
David	Interview (1)	0	0	0.20	0.60	0.20	0
	Hierarchical order (2)	0.10	0.14	0.29	0.19	0.24	0.05
	Un-directed degree (3)	0.06	0.19	0.25	0.06	0.19	0.25
	Directed degree (3)	0.05	0.23	0.27	0.05	0.18	0.23
	In-degree (3)	0.09	0.27	0.18	0.09	0.27	0.09
	Out-degree (3)	0	0.18	0.36	0	0.09	0.36

Table 3.2 shows, among other things, the centrality of aspects in Steven's graph according to the structured mapping task. The aspects ‘to be critical’ and ‘to understand’ had the most ties with other aspects in Steven's graph; the aspects ‘to know’ and ‘to share’ had the least number of ties with other aspects. The number of ties with other nodes is a measure of centrality in a graph. Therefore, the aspects ‘to be critical’ and ‘to understand’ could be interpreted as central nodes, while the aspects ‘to know’ and ‘to share’ were interpreted as peripheral nodes in Steven's graph according to the results from the structured mapping task. In Roger's graph, the aspect ‘to understand’ had the most ties with other aspects, while the aspect ‘to achieve’ had no ties with other aspects. Therefore, the aspect ‘to understand’ could be interpreted as most central, and the aspect ‘to achieve’ was interpreted as most peripheral in Roger's graph. David's graph showed that ‘to be innovative’ and ‘to understand’ had the most ties, while the aspects ‘to know’ and ‘to achieve’ had the least number of ties. Thus, the aspects ‘to be innovative’ and ‘to understand’ could be interpreted as most central, while the aspects ‘to know’ and ‘to achieve’ were interpreted as most peripheral in David's graph.

3.4 Conclusions and discussion

3.4.1 Differences and similarities between the instruments

The results, presented in Table 3.2, can be used to compare the three instruments which assess academics' scientific research dispositions. Note that the results from the three instruments do not always coincide. For example, Steven's interview transcripts and his order of preference give similar results: both instruments present ‘to achieve’ and ‘to be critical’ as the most important aspects, but the results for his graph deviate strongly. Although there are differences between the results of the three instruments, we also observe some similarities on which we can base our conclusions about the instruments.

First, we notice that the interviews and the hierarchical ordering task show similar results for all three participants. The aspects which are most frequently mentioned in the interviews are also the aspects which appear high in the hierarchical order. For Steven the aspects ‘to achieve’ and ‘to be innovative’, for Roger the aspects ‘to know’ and ‘to be innovative’, and for David the aspects ‘to know’, ‘to be innovative’, and ‘to share’ are most important. This indicates that the interview and the ordering task can be used to gauge a similar feature of the concept of disposition.

Second, we notice that for all three participants, the results from the interview do not match with the results from the structured mapping task. For

example, in Steven's research disposition the aspects 'to be critical' and 'to understand' are more central according to the results from the structured mapping task, while 'to know' and 'to share' are more peripheral, i.e., closer to 0. A possible explanation can be found in the crucial differences between the instruments. The degree of freedom within these three instruments decreases from the interview, via the ordering task to the mapping task. The semi-structured interview and the hierarchical ordering gave the participants full insight into what they presented as their scientific research dispositions. The structured mapping task was explicitly designed in such a way that the academics could not easily recognize patterns in their own dispositions. The participants were presented with 15 pairs of aspects in a row. While this task was perceived as cognitively intensive, we can assume that the academics could not easily influence the data towards their explicit ideas about scientific research dispositions. Throughout instrument 3, the academics were repeatedly required to focus on their daily research practices, to ensure that they were relating their answers to their own dispositions in research. Therefore, we assume that the results from the structured mapping task indicate the *implicit*, or tacit, scientific research disposition, while the results from the interview and the hierarchical ordering task represent academics' *explicit* ideas about their scientific research disposition.

Third, the in-degree and out-degree tend to follow the results from the interviews. In most cases, aspects that have an out-degree which is higher than the in-degree are also mentioned relatively frequently in the interviews. Although degrees calculated for undirected graphs are similar to degrees calculated for directed graphs, differences between in-degree and out-degree might indicate more detailed properties of graphs which cannot be gauged using undirected graphs only. Therefore, properties of directed graphs display additional and relevant information with respect to undirected graphs. The observation that the in- and out-degree follow the interview results, and the assumption that the interview gauges explicit ideas about dispositions, indicate that a possible relationship exists between explicit conception of a research disposition and a high out-degree of an aspect within a graph. If this holds in future research, then we can assume that aspects with a higher out-degree than in-degree are fundamental aspects in a person's disposition. In Roger's case, for example, the aspects 'to know' and 'to be innovative' both have higher out-degrees than in-degrees, while the aspects 'to be critical' and 'to share' have high in-degrees. This might indicate that the inclinations to know and to be innovative are fundamental aspects of Roger's disposition. First, he has a passion for knowing and being innovative; second, he is critical and wants to share his ideas.

Fourth, the semi-structured open-ended interview is time-consuming in its data-collection and its data-analysis procedures, especially when more than three participants are involved. The hierarchical ordering task and the structured mapping task are more time-efficient. When the hierarchical ordering task and the structured mapping task are combined, both explicit preference and implicit centrality of aspects can be examined collectively and succinctly.

Finally, the techniques from Graph Theory used in instrument 3 effectively discriminate between characteristics of individual nodes within graphs as well as between structural global properties of academics' cognitive graphs. This comparison shows that analysis techniques from Graph Theory can be used in empirical studies into people's conceptions and cognitions, such as scientific research dispositions.

3.4.2 Implications for an empirically based notion of the concept of disposition

The findings presented here show, among other things, that a distinction can be made between respondents' implicit conceptions about research dispositions and their actual research disposition. The open-ended interview study showed the more explicit conceptions, while the structured mapping tasks represented the tacit conceptions, of academics' scientific research dispositions. In drawing conclusions from this observation, we must pay attention to the differences between the instruments before considering the nature of the concept itself. First, the instruments used in this study differ in the degree of freedom presented to the respondents. Second, a characteristic distinction between instruments can be related to respondents' overview of their previous reactions to the instrument. For example, when completing a survey, respondents are able to re-view previous answers, while during an interview participants have to re-call their previous answers from memory. It is reasonable to assume that respondents were more limited in their awareness of their previous answers in the structured mapping task than during the interview or the hierarchical ordering task. Furthermore, consciously or unconsciously, respondents often try to make their reactions correspond with earlier reactions. Therefore, we can draw the conclusion that the interview and the hierarchical ordering task both assessed the perceived value of respondents to scientific research dispositions. The mapping task was less open to manipulation by the respondents and was more likely to assess respondents' actual scientific research dispositions.

3.4.3 Suggestions for further research

Future research using the instruments presented in this study can potentially identify relationships between properties of academics' dispositions and background variables. Furthermore, we presented a tool to identify various properties of academics' graphs. Although this novel technique is rarely used in educational research (cf. Bakkenes et al., 2007; Wassink et al., 2003), the results presented here appear promising for future research. However, more research is needed, for example, to reveal possible relationships between global properties of graphs and interview results. Further research is also needed to identify fields of research in which this technique can be applied, and to develop the conceptual framework of techniques from Graph Theory. Finally, the validity and the reliability of instruments to assess dispositions in other contexts should be a constant concern to researchers.

Enhancing university teachers' awareness of the influence of their research dispositions on their teaching intentions and behaviours might induce them to more explicitly reflect on the scholarship of teaching (Boyer, 1990; Neumann, 2006). Thus, university teachers should attach high value to their own ideas, experiences, and research dispositions when teaching students how to become scholars in their field of expertise, and should not merely rely on the teaching tradition of the institute. For example, Borda (2007) provides some interesting suggestions for the cultivation and assessment of dispositions in questions, careful use of language, and discourse analysis.

The findings of this study show that the concept of disposition is still in a developmental phase in the educational research literature. Three general principles were identified as potentially supportive to improving the concept of disposition in educational research. We built towards an empirically based notion of the concept of disposition in educational research, by the evaluation of three instruments to assess scientific research dispositions. A combination of the hierarchical ordering task and the structured mapping task provided us with an effort-result efficient combination, in the sense that it produced relevant results and was more time-efficient than the open-ended interview methodology. Generally, to correctly interpret empirical results, there should be a strong relationship between the way concepts are defined and the methods used to assess them. For future research on the concept of disposition in the educational sciences, we recommend to use a combination of these instruments while paying attention to the effects of the different features of the instruments on the results, for example, the latitude of the instrument, or participants' overview of their responses.