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Individual Student Learning Dispositions - Teacher and Student Perspectives on Incoherences and Their Development

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Abstract

General principles of teaching and learning function differently with different students (Shuell, 1996). This dissertation ties in with research investigating individual differences of students with regard to their sets of cognitive and motivational-affective characteristics, i.e. their learning dispositions as outcomes of and prerequisites for learning processes regarding different subject domains. The thesis transferred the Shannon-Wiener diversity index from theoretical biology to educational science and additionally suggested configural frequency and latent class analysis to supplement current methodology regarding individual differences with the additional measurement of within-student characteristics diversity. Firstly, the dissertation uncovered the high diversity and commonness of incoherences in the interaction of cognitive and motivational-affective characteristics within student dispositions. Secondly, it found that students' mathematics and language arts teachers did not perceive the same amount of within-student characteristics diversity. In contrast to student findings, teachers dominantly saw coherent dispositions, especially an "overall average" student. Thirdly, student and teacher findings exhibited noticeable differences between the two subject domains, mathematics and language arts. Fourthly, this dissertation explored if incoherences can be temporary phenomena by investigating the development of self-underestimating students, a prevalent incoherent disposition found regarding physics instruction (Seidel, 2006). For this student group, significant positive and negative development as well as stagnation was observed after a school year. Finally, the thesis found that positive development for this student group was associated with higher overall internal learning processes. Findings from this dissertation imply that educational research as well as teacher education should address individual differences in student dispositions, their development and connected learning processes more comprehensively and with respect to the subject domain to eventually adapt teaching to offer conducive individual student support.

Zusammenfassung

Allgemeine Grundsätze des Unterrichts und Lernens funktionieren unterschiedlich für verschiedene Schüler (Shuell, 1996). Diese Dissertation knüpft an die Forschung zu individuellen Unterschieden in Bezug auf kognitive und motivational-affektive Merkmale von Schülerinnen und Schülern an, also deren Lerndipositionen als Ergebnisse und Voraussetzungen für Lernprozesse in unterschiedlichen Fachdomänen. Die Arbeit übertrug den Shannon-Wiener Diversity-Index aus der theoretischen Biologie in die Bildungsforschung und schlug zudem Konfigurationsfrequenz- und latente Klasseanalysen vor, um die aktuelle Methodik zur Messung individueller Unterschiede um die zusätzliche Messung von Merkmalsvielfalt innerhalb der Dispositionen zu ergänzen. Zum einen deckte die Dissertation so die hohe Merkmalsvielfalt und Häufigkeit von Inkohärenzen im Zusammenspiel von kognitiven und motivational-affektiven Merkmalen innerhalb von Schülerdispositionen auf. Außerdem zeigte sich, dass Mathematik- und Deutschlehrkräfte die Merkmalsvielfalt innerhalb der Dispositionen ihrer Schülerinnen und Schüler nicht im selben Ausmaß wahrnahmen. Im Gegensatz zu obigen Schülerbefunden sahen die Lehrkräfte vor allem kohärente Dispositionen, besonders einen "kohärent-durchschnittlichen" Schüler. Des Weiteren zeigten Schüler- und Lehrerbefunde merkliche Unterschiede zwischen den beiden Fachgebieten Mathematik und Deutsch. Zum anderen erforschte diese Dissertation, ob Inkohärenzen in Schülerdispositionen vorübergehende Phänomene sein können, indem sie die Entwicklung von sich selbst unterschätzenden Schülerinnen und Schülern, einer verbreiteten inkohärente Disposition bezogen auf den Physikunterricht (Seidel, 2006), untersuchte. Für diese Schülergruppe war eine wesentliche positive und negative Entwicklung sowie Stagnation nach einem Schuljahr zu beobachten. Zuletzt stellte die Arbeit zudem heraus, dass die positive Entwicklung dieser Schülergruppe mit höheren internalen Lernprozessen verbunden war. Die Erkenntnisse aus dieser Dissertation implizieren, dass die empirische Bildungsforschung sowie die Lehreraus- und -weiterbildung umfassender und in Bezug auf die jeweilige Fachdomäne auf individuelle Unterschiede in Schülerdispositionen, deren Entwicklung und die damit verbundenen Lernprozessen eingehen sollten, um schließlich gezielte Unterstützung gemäß individueller Lerndispositionen im Unterricht zu ermöglichen.

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Contents

Chapter 1

Introduction

"General principles of teaching and learning undoubtedly exist, and although these principles can inform both our understanding of the teaching-learning process and the selection of appropriate instructional methods, these pinciples often operate in substantially different ways with different students, in different content areas, and in different instructional settings" (Shuell, 1996).

1.1 Learning and Teaching in the 21st century

Political and public debate has shaped our understanding of learning and teaching in the 21st century. Important impulses have come from international large-scale studies like the Program for International Student Assessment (PISA, Organisation for Economic Co-operation and Development, 2014), policies like the United States (US) No Child Left Behind Act (United States Federal Education Legislation, 2002), and the United Nations (UN) Convention on the Rights of Persons with Disabilities (The United Nations, 2006). These programs and policies have sparked essential new perspectives on learning an teaching.

The perspective on students' and their learning has changed in two fundamental ways. Firstly, in an increasingly complex world, where jobs as well as the participation in public or community life demand complex skills (e.g. Jenkins, Clinton, Purushotma, Robison, & Weigel, 2009), the outcomes of learning have been spotlighted (Lenski, Richter, & Pant, 2015). To enable the learners to successfully master these complex demands, the goal of learning has moved from pure knowledge acquisition to the con-

struction of competences; including motivational and affective components (McClelland, 1973). Countries like Germany have set national educational standards to measure educational success in terms of what students knew and could do. This was formulated as subject-related and interdisciplinary competencies that students should have acquired up to a certain educational stage (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bundesrepublik Deutschland, 2006), which included specific knowledge, but also motivational or social aspects. Hence, the outcomes of learning are now regarded to be multifaceted.

Secondly, these programs and policies have yielded a more differentiated understanding of the world and the acknowledgement of individual differences. In the educational debate, it is growing increasingly clear that students are approaching learning situations with their individual propensities. Differences in students have been regarded from an outward perspective of gender, race, disability, or social and migration background (e.g. Birenbaum & Nasser, 2006), but also inward differences in cognitive and motivational-affective characteristics (e.g. Snow, Corno, & Jackson, 1996). The latter include differences in characteristics like students' prior knowledge or self-concept of ability that proximally affect learning processes (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Seidel & Reiss, 2014). This yields a notion of individual multifaceted student prerequisites. Since both, student competencies and characteristics, can also be viewed from the respective alternate angles as outcomes of and prerequisites for learning, their ideas are merged in the term student learning dispositions in this dissertation. These individual dispositions shape the way students learn and are shaped by learning.

Together, these two understandings of students learning dispositions have also changed our understanding of teaching. Teachers must adapt instruction to suit individual multifaceted sets of characteristics and develop multifaceted competencies. The programs and policies mentioned above have shaped regulation demanding teachers to "individualize instruction for students with diverse learning needs" (DeLuca & Lam, 2014). However, implementation in practice is still far from excellent. In Germany, for instance, over half of students surveyed for the 2012 PISA studies said their mathematics teachers "never or rarely ever" gave different tasks to students based

on their varying progress in class (Schiepe-Tiska et al., 2013). Therefore, requests for teacher professional development measures for a support of "reliable diagnostic judgments of learning prerequisites" can be heard (Nieder & Frühauf, 2012). This makes sense since, in order to implement differentiation and individualization in the classroom, teachers must know their students. They must know more about the differences in their learning dispositions on the one hand. On the other hand, to provide individual student support, they must also know how dispositions can develop and which teaching and learning processes are connected to this development. This calls on educational research to promote a more thorough understanding of these issues and mechanisms.

This dissertation aims at advancing this current discussions on learning and teaching in three ways. Firstly, a re-focus of established lines of research around student dispositions paired with methodological considerations suggests additional ways of looking at students' individual differences. Secondly, a juxtaposition of student data with teacher perceptions of student dispositions in a methodologically new way gives additional insights into teachers' views upon these differences and allows including this viewpoint into future research. Thirdly, an exemplary look at the development of student dispositions and the connected learning processes gives first hints at possibilities for individual student support.

1.2 Research Framework

The connection of these concepts of learning and teaching in research can be illustrated in the Opportunity-to-Learn model, also called Supply-Use Model (Helmke, 2012), that is based on theoretical considerations of Fend (1981) and Helmke & Weinert (1997) and has been adapted by many researchers including Seidel & Reiss (2014); Seidel (2014). The framework model of this dissertation is based on these models and can be found in Figure 1.1. As a Supply-Use Model, it divides the mechanisms of action during instruction into a supply, a use, and an outcome side. In these models, the *Outcomes* of teaching and learning explicitely include cognitive aspects like knowledge, but also motivational-affective components like interest (Seidel & Reiss, 2014). Likewise, student learning prerequisites, labeled *Individual Characteristics*, that influence these learning outcomes include cognitive as well as motivational-affective aspects. This dissertation

focuses on those student characteristics that can be seen as prerequisites and outcomes of learning. Students' sets of cognitive and motivational-affective components are called student learning dispositions and are included in these two components of the framework model. Theoretical background on these learning dispositions is given in Chapter 2. The interplay of the different cognitive and motivational-affective components is the first focus of Study I of this dissertation. Study II examines the development of the learning disposition from prerequisite to learning outcome with regard to self-underestimating students, a specific incoherent learning disposition.

In traditional Supply-Use Models, the connection of *Teacher Competences* to these *Individual Characteristics* is only via the *Teaching Processes* they initiate to spark students' *Individual Learning Activities* according to their characteristics. Since this dissertation is focusing on diagnostic competence as a special teacher competence that specifically focuses on students' characteristics, the framework model of this thesis highlights this special connection by adding an additional *eye* arrow representing teachers' view on their students' characteristics. These teacher perceptions of student learning dispositions are the second focus of Study I. Theoretical background is given in Chapter 3.

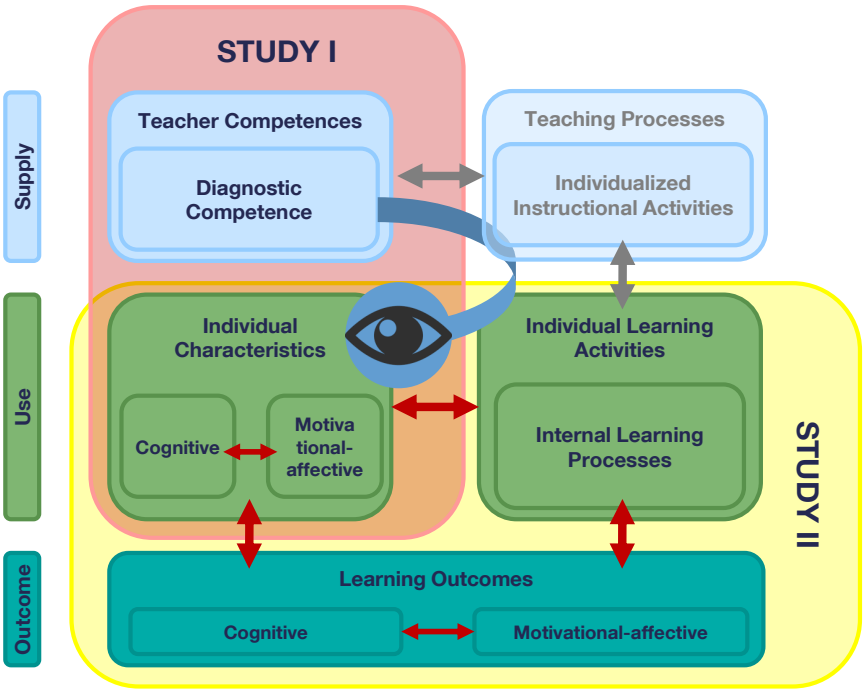

Figure 1.1: Framework model for this dissertation – Supply-Use Model adapted from Seidel & Reiss (2014)

Teaching Processes are not directly considered in the empirical studies of this thesis. However, they are included in the framework model, the theoretical background (in Chapter 3), and final discussion (Chapter 8) of this dissertation since adaptive or individualized teaching processes are the intention of how teachers diagnostic ability should embrace students' individual dispositions in practice. Finally, Study II of this thesis deals with the *Individual Learning Activities* that are, in the model, precipitated by those *Teaching Processes* and shape how learning prerequisites, *Individual Characteristics*, translate to learning *Outcomes*. It views the cognitive and motivational internal learning processes of self-underestimating students. Chapter 4 provides theoretical background on these learning processes.

For this dissertation, external aspects of traditional Supply-Use Models, like students' family background or the context of the educational system, are disregarded to focus on the core interaction of *Teacher Competences*, *Individual Characteristics*, *Individual Learning Activities*, and *Outcomes* that is investigated in this thesis. To acknowledge and explore the profound role that the domain or subject plays for the importance of individual student characteristics on learning as well as their interaction, this thesis contrasts findings from two different domains, mathematics and language arts. Since domain specificities permeate every component of this model, they are not included as a separate entity here. Rather, they are taken on in all respective background chapters (Chapters 2, 3, and 4) as well as a separate research question in Study I (see Chapters 5 and 6) and the discussion in Chapter 8.

1.3 Aims and Scope

Regarding all elements illustrated in the mechanism, research has brought important findings within the past century. Yet, there is still an uncountable number of open questions in each field. This dissertation connects different strands of research around the teacher and student perspectives on students' learning dispositions and focuses on exploring incoherences in and the development of their interplay.

In light of the current political relevance of individuality, this thesis connects the focus on individual differences among students to the heart of educational psychology: students' characteristics that shape their learning. Therewith, it connects a functional-

pragmatic understanding of cognitive and non-cognitive competences as the attributes required for successfully performing particular actions (McClelland, 1973) as learning outcomes with the cognitive and motivational–affective student characteristics, like prior knowledge or subject-related interest, that have been studied in educational research as crucial prerequisites of learning (Snow et al., 1996). To accommodate these notions terminologically, this thesis uses the term *students' learning dispositions* as individual students' sets of characteristics in their current state being outcomes of past learning and prerequisites for future learning. Their crucial role in learning is reviewed in Chapter 2.

In this, the thesis examines research on student characteristics from a new angle: Currently, many studies are concerned with the interplay of different characteristics as variables. Questions of reciprocal effects or frame of reference models, for instance, ask if self-concept can *on average* predict achievement or vice versa or how mathematics achievement *generally* relates to self-concept regarding language arts (Marsh & Craven, 2006; Marsh, 1986; Möller, Retelsdorf, Köller, & Marsh, 2011). Instead of investigating how different characteristics as variables relate to each other, this thesis wants to draw attention to the individual. It ties in with studies that have examined the interplay of characteristics *within* a student and its connection to learning outcomes (Linnenbrink-Garcia, Pugh, Koskey, & Stewart, 2012; Lau & Roeser, 2008; Seidel, 2006). These authors have all found that many students exhibit incoherences in the interplay of characteristics, i.e. they pair high values in some characteristics with low or medium values in others. Moreover, considering a set of characteristics, they find that these incoherences have distinct effects on different aspects of student learning. These incoherences can only be uncovered by approaching the field of student characteristics with specific so-called person-centered methodology since methods centered around variables might average these phenomena out. However, up to now, research has not found how diverse the interplay of cognitive and motivational-affective characteristics in students' dispositions. Moreover, it is unclear how common incoherences are. Thus, the exploration of (what this thesis calls) *within-student characteristics diversity* and the incoherences in characteristics interplay are the focal point of Study I, which is covered in Chapter 6. Differences in subject domains are explored by contrasting findings from two different domains, mathematics and language arts.

Also, incoherences have, up to now, only been investigated at one given point in time (Linnenbrink-Garcia et al., 2012; Lau & Roeser, 2008; Seidel, 2006). Hence, it is unclear if and how they can develop. The thesis reviews studies that examine the development of different student characteristics across students or student groups to generate insights on how development of an exemplary incoherent student disposition, the *self-underestimating* students, whose low self-concept does not align with their high cognitive skills, might evolve. On the one hand, research suggests that their prior knowledge, as the most powerful predictor of cognitive learning gains, can ensure their further cognitive advantage (Hattie, 2009). Still, it is uncertain if this further cognitive success can trigger an alignment of self-concept. On the other hand, their low self-concept might trigger effects like effort withdrawal or lack of engagement in learning opportunities, which can yield cognitive decline (Elliot & Church, 2003; Graham & Golan, 1991). Since the role of such effects in the development of incoherent profiles is ambiguous, Study II of this thesis investigates the development of this self-underestimating student disposition over one school year in Chapter 7 again from a person-centered view.

The focus on individuality has broad implications for teachers and teaching. This thesis shortly reviews the discussion around *individualized learning*, where local as well as international studies overwhelmingly find that current instruction lacks differentiation and teaching activities aimed at smaller groups or even the individual learner (e.g. Schiepe-Tiska et al., 2013). While other studies explore teaching methods to expedite individualization in the classroom, including methods to foster students' independence and collaboration (e.g. Volet, Vauras, Salo, & Khosa, 2017) or technological aids (e.g. Westbury, 2006), the focus of this dissertation lies between these two angles by regarding the teacher competence essential for individualization: teachers' ability to recognize the individuality of their students. A reexamination of the research studying the way teachers perceive student dispositions is given in Chapter 3.

To this end, the thesis connects terminology and research discussion around teachers' *diagnostic competence*, which has inspired research from a political idea of school improvement, to the empirical notions of *teacher judgment accuracy* as well as psychological findings around *teacher perceptions* and biases in judgment processes.

This field of research is still in the process of consolidating the different findings on what and how teachers perceive and how they judge based on these perceptions. From biases in teacher judgments investigated deeply in the 1960s to 80s (e.g. Rosenthal & Jacobson, 1968) to modern eye-tracking studies (e.g. van den Bogert, van Bruggen, Kostons, & Jochems, 2014), research is still trying to complete the picture. As opposed to this research that is attempting to understand these complex processes, a growing field of research regards specific measures of diagnostic competence. Assigning a number to the agreement of teacher judgments with student data from tests and questionnaires makes it easier to compare and consider this measure in empirical studies. This is where all studies on teacher judgment accuracy are located. However, such a quantification has, up to now, only been established regarding teachers' judgments of single characteristics. Truly regarding the individual student disposition must include finding out how teachers perceive the interplay of characteristics. This is where this thesis ties in. All of these strands of research give indications towards how teachers might perceive the interplay of different characteristics and their awareness of possible incoherences. However, they cannot yet answer this question with certainty. Therefore, Study I in Chapter 6 of this dissertation explores teacher perceptions alongside student assessments and adds to the current state of research. Again, domain differences are regarded and discussed.

Finally, this thesis also takes a look at the individual learning activities and the connected individual developments of dispositions that are already taking place in today's classrooms in Chapter 4. It starts by locating theoretical and empirical considerations of learning as individual activities and processes into the focus and connecting them with conceptions of teacher support on the one side and individual student development on the other. Drawing on practical findings of the sparsity of external individualized learning activities in form of different tasks, problems, or interactions in current instruction (Nieder & Frühauf, 2012), the thesis explores the inherently individual *internal learning processes* and ties them to their role for disposition development. This field has also slowly integrated cognitive and motivational-affective aspects. On the motivational side, research around self-determination theory Deci & Ryan (2002) has found that intrinsic motivation as well as specific psychological needs are strongly connected to learning outcomes – motivational-affective as well as cognitive ones (Diseth, Danielsen, & Samdal, 2012; Tsai, Kunter, Lüdtke, Trautwein, & Ryan,

2008; Jang, Reeve, Ryan, & Kim, 2009). On the cognitive side, the thesis ties the teacher side, where cognitive activation is considered a crucial aspect of instructional quality, to the perspective of the individual student. Their engagement in cognitively challenging processes is useful for deeper understanding and processing and as such connected to better learning outcomes (Lipowski, 2015). Interestingly, cognitive learning activities can also be connected to development in motivational-affective characteristics, like interest (Fauth, Decristan, Rieser, Klieme, & Büttner, 2014). Nevertheless, these lines of research, too, have rarely focused on the individual student and differential effects for different student dispositions. Hence, the specific role of of motivational and cognitive learning activities in the development of dispositions with incoherent cognitive-motivational-affective configurations cannot be deduced from existing research. As one step towards an answer to this question, Study II of this thesis regards the connection of disposition development of self-underestimating students to their perceived internal learning activities.

Together, this dissertation aims to refocus the attention of different areas of research towards the individual student. By building on established lines of research regarding all three aspects, student characteristics, teacher judgments, and internal learning activities and connecting them around the topic of individual differences, this thesis can add to the state of research in many small ways. Especially, the two empirical studies, as the core of this thesis, answer research questions that arise from this new angle of consideration of the established fields. Their findings raise new questions for educational research and practice when thinking of individual students' learning dispositions.

Smaller parts of the following three chapters on the theoretical background regarding the research of this dissertation and the final discussions chapter are taken from manuscripts that have been published or submitted for publication (Huber, Häusler, Jurik, & Seidel, 2015; Huber & Seidel, submitted). The two empirical chapters of the thesis consist largely of the two empirical research studies described in these two manuscripts.

Chapter 2

Individual Student Learning Dispositions

In the 21st century, individual differences and diversity of learners are key elements in the discussion about learning and teaching (Perry & Winne, 2001). This chapter regards students' individual learning dispositions as specifications of such individual differences.

In the framework model of this thesis, individual student learning dispositions are comprised within the *Individual Characteristics* as cognitive and motivational-affective prerequisites of students' *Individual Learning Activities* as well as the cognitive and non-cognitive competences as *Outcomes* of these learning processes. The theoretical background presented in this chapter integrates the focus on outcomes into educational psychology's paramount line of research around student characteristics. In this, the derivation of learning dispositions grounded in competence and characteristics conceptualizations builds the foundation for the in-depth discussion of the interaction of cognitive and motivational-affective aspects. Opening room also for the encompassment of aspects of development.

2.1 Dispositions as Outcomes and Prerequisites of Learning

This dissertation's conceptualization of individual differences in students' individual learning dispositions originates from two prominent notions regarding student learning: the multifaceted sets of competences as outcomes and the individual multifaceted student characteristics as prerequisites of learning. At the same time, it can be embedded into other concepts of students' individual differences, for instance, defined by their environment.

2.1.1 Conceptualization of Student Learning Dispositions

The word disposition is derived from the latin *dispositio* which described the way something was arranged. It has several slightly different notions in the English language. This definition in this thesis is derived closest to the meanings as "a preparation", "a state of readiness" (Wikipedia, 2016), since this is what competences should be as an outcomes of learning and what characteristics are as prerequisites for future learning.

In determining the role different student dispositions have on learning, this chapter draws mainly on the research of student characteristics. Nevertheless, the incorporation of competences as outcomes of this learning is chosen to highlight the importance of development of these dispositions through learning processes. Regarding *competences* as mentioned in this regard, this thesis refers to a pragmatic understanding of the term. Throughout educational research, different approaches to conceptualizing competences include a generic, a normative, and a pragmatic one (Klieme et al., 2010). While the generic one, based on Chomsky (1986), sees competence as a system generating performance and is regarded in contrast to the latter, normative notions of competence have been formulated by Roth (1971)) or Baumert (2002) and entail ideals of *Bildung* and basic cultural tools. More pragmatically, Weinert (2001) has discussed the idea of "key competencies" introduced by international standardized large-scale assessments like PISA as "competencies understood to cover knowledge, skills, attitudes and values" (OECD, PISA Framework). In this thesis, competencies are understood as context-specific dispositions for achievement (Klieme et al., 2010).

At the same time, this thesis understands a learning disposition to comprise a student's current state of all cognitive and motivational-affective characteristics relevant to his learning. Thus, this thesis calls the components of a learning disposition *characteristics*. As one example, academic self-concept regarding a specific subject is part of a students' learning disposition in this subject. It is conceptualized in multiple models (for a review, see Marsh, 1990c) and is defined as "a person's perception of himself" regarding that subject (Shavelson, Hubner, & Stanton, 1976). It is influenced by an individual's experiences and environment. For students' self-concept regarding a subject domain, the learning experiences and environment play an important role. Hence, it is an outcome of educational processes itself (Shavelson et al., 1976) and furthering self-concept is a major concern in any educational setting (Marsh & Hau, 2003). On the other hand, it has powerful effects on students' learning (Marsh, 1986) and is a prerequisite for successful learning (Hattie, 2009; Marsh & Craven, 2006).

The term disposition in connection with students' cognitive and non-cognitive characteristics has been used in educational research (Heinrichs, 2015, p.10). However, internationally, it is not widespread. In leading journals of educational research, the term appears seldom (e.g. Journal of Educational Psychology has only one article titling "disposition" in the last century). If used, it often describes motivational-affective aspects of learning prerequisites grouped together, including attitudes, perceived parental expectations, or effort (for instance towards the study of mathematics Birenbaum & Nasser, 2006) or emotional traits (Young, 1927). Yet other studies refer to dispositions as a student's inclination towards certain learning activities in particular (e.g. effortful cognitive activities for students with high "need for cognition", Fleischhauer et al. 2010). Other studies are closer to the definition of "readiness", for instance teachers' readiness to respond "realistically and constructively" (Burkard, 1962). None of these uses contradict the way of using the term disposition within this thesis. Yet, its approach is broader.

2.1.2 Dispositions as Specifications of Individual Differences

Conceptualizing learning dispositions as specifications of students' individual differences also does not contradict other approaches taken in educational research to describe individual differences among learners and their role for learning. Many

studies have explored the impact of learner background like gender, race, immigrant or socio-economic background on learning (e.g Birenbaum & Nasser, 2006; Tatre & Fennema, 1995). This notion of individual differences or diversity originates from economic considerations beginning in the 1950s United States where women and people of color increasingly joined an up-to-then homogeneous workforce of white men (Bendl, Hanappi-Egger, & Hofmann, 2012). In modern diversity considerations where our understanding of gender, race, or immigrant background are growing more and more complex, heterogeneous, and non-categorical (e.g. Lipphardt, 2015), considerations of differences have also started to focus more on the individual characteristics proximally tied to the object of investigation. For learning, this means aiming attention at the student characteristics directly affecting learning processes. According to theoretical models (e.g. Seidel & Reiss, 2014) and empirical studies (e.g. Cohen et al., 2009) these include cognitive characteristics like general cognitive ability or level of knowledge and motivational-affective characteristics like interest or self-perceptions. Cohen et al. (2009), for instance, found that treating self-perceptions has a mediating effect on minority students' achievement gap. At the same time, it is important to note that considering diversity in student background variables like gender, race, or socio-economic background does not translate into homogeneous subgroups regarding student dispositions of cognitive and motivational-affective characteristics. While these background variables have an impact on a student's self-concept or prior achievement (e.g. Hornstra, van der Veen, Peetsma, & Volman, 2013), there is still considerable variety within these groups. Regarding the interaction of self-conceptions and achievement, for instance, a person-centered analysis of black studentsf, for instance, also uncovered four distinct ways these concept relate: 29% with high values for both, 11% with low values for both, 36% with high self-esteem and low achievement, and 24% vice versa (Hope, Chavous, Jagers, & Sellers, 2013). Thus, this dissertation focuses on the individual differences between students with regard to their learning dispositions that directly influence their learning activities.

Student learning dispositions have important roles not only in learning processes, where they make students more or less likely to engage, persevere, or succeed in certain activities over others. Student dispositions also shape students' academic aspirations (Korhonen, Tapola, Linnanmäki, & Aunio, 2016) and students' career choices. Math

achievement and self-efficacy, for instance, predict high school students' decisions for science, technology, engineering, and mathematics (STEM) majors (X. Wang, 2013). Hence, their further investigation in research is desirable.

2.1.3 Dispositions: Sets of Cognitive and Motivational-Affective Characteristics

Looking at both, learning outcomes and prerequisites, a number of characteristics play a dominant role. Traditionally, cognitive aspects are most prominent. First, knowledge has been extensively studies as both, the prominent outcome of learning processes and, by influencing how new information is processed and comprehended, crucial prerequisite for learning (Pintrich, Marx, & Boyle, 1993; Alexander, Schallert, & Hare, 1991). Knowledge is here defined as a student's "personal stock of information, skills, experiences, beliefs, and memories" regarding a subject matter (Alexander et al., 1991, p. 317). Tied to this, students' achievements as measurements of this knowledge are certainly outcomes of learning processes. At the same time, students' prior achievement is also the most powerful predictor for future learning success (Hattie, 2009). Additionally, a students' general cognitive ability affects learning outcomes in a profound way (Deary, Strand, Smith, & Fernandes, 2007). In this dissertation, general cognitive ability is understood to be a students' "general ability to think or solve problems in situations that are novel to the individual, i.e. not familiar from learning experience" (Perleth, 2008). Even though this ability is considered to be rather stable over one school year, there are arguments that it can be increased in longer term by engaging in challenging learning tasks (Dweck, 1986).

However, as Pintrich et al. (1993) argue, cognition alone cannot satisfactorily describe learning. Today, the concept that "nearly as much teaching may take place in the affective domain as in the cognitive" (Prawat, 1980) is commonly accepted. Hence, research increasingly highlights that beyond cognitive features, motivational-affective characteristics are crucial for students' learning as well (Dai & Sternberg, 2004). Subject-related interest has been linked to achievement (Schiefele, Krapp, & Winteler, 1992), but also shapes educational professional choices (Morgan, Isaac, & Sansone, 2001) and is therefore an important outcome of educational processes. In this thesis,

interest is understood to be a student's relation to subject matter that "emerged from an individual's interaction with his or her environment" (Hoffmann, 2002). Further, self-concept, as mentionned above, is an important outcome and prerequisite for learning success.

2.1.4 Within-Student Interplay of Characteristics in Student Dispositions

When looking at different student characteristics, complex interactions have been found (e.g. Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005). For instance, the complex interplay of achievement and self-concept has been thoroughly studied from a variable-centered point of view (cf. Marsh & Martin, 2011). Many recent studies have picked up these ideas and have looked at the interplay of these characteristics more closely – also over time (Stäbler, Dumont, Becker, & Baumert, 2017).

Beyond connections between the characteristics themselves, the analysis of the role of a combination of different cognitive and motivational-affective student characteristics, like general cognitive abilities, interest, or self-concept, for learning has become the focus of studies like Hornstra et al. (2013) or Wormington, Corpus, & Anderson (2012). Furthermore, studies have identified how different sets of characteristics relate to educational processes and outcomes. Linnenbrink-Garcia et al. (2012) found that certain combinations of interest, self-efficacy, and prior knowledge were related to higher learning outcomes. Furthermore, Seidel (2006) could show that the combination of cognitive and motivational-affective characteristics was critical for students' perception of their learning environment. Lau & Roeser (2008) recognized that certain configurations of characteristics were connected to student achievement and engagement. The specific composition of characteristics also made a difference regarding students' involvement in class and their situational learning motivation (Jurik, Gröschner, & Seidel, 2013, 2014).

2.2 Incoherent Dispositions and Within-Student Characteristics Diversity

Looking more closely at those studies that have examined the interplay of different student characteristics, it became apparent that for many students the different characteristics did not align, revealing what this thesis will call *incoherences* in the interaction of student characteristics. Studies find students that are able but not confident (Lau & Roeser, 2008), knowledgeable but not interested (Seidel, 2006), or self-efficacious but only moderate achievers (Linnenbrink-Garcia et al., 2012). More specifically, Lau & Roeser (2008) categorized 30-45% of students into inconsistent patterns. For almost all of their types, there was only partial alignment. Some studies have even started explicitly to highlight pseudoconcurrences in characteristics interplay (Fiedler, Freytag, & Unkelbach, 2007). Also the aforementioned study by Hope et al. (2013) found 60% of students to have either high self-esteem and low achievement, or vice-versa. Yet, no study has focused on how different students really are with respect to their within-sets of student characteristics. This *within-student characteristics diversity* will be addressed in Study I in Chapter 6.

2.2.1 Uncovering Incoherences and Measuring Diversity in the Interplay of Characteristics

Uncovering these incoherences in the interaction of student characteristics is a question of methodology as well. The interplay of student characteristics has largely been explored by studying how the characteristics as variables were interrelated. Whether studies use regression or more complex modeling including latent constructs (e.g. Marsh et al., 2005), many of the variable-level connections found in these studies are low to moderate. This might be, because individual differences in the interplay are averaged out in these models. Linnenbrink-Garcia et al. (2012), for instance, found only small effects of cognitive and motivational-affective characteristics on learning outcome when taking a variable-centered approach, but uncovered the strong relationship of student characteristics to learning gains employing person-centered analyses.

In their conceptual paper of the analysis of individual differences, Snow et al.

(1996) state that regarding individual differences "there is need also to improve research and evaluation methodology. This involves rediscovering and applying old, useful methods as well as inventing new ones." Following their call, this dissertation considers both alongside established methods of educational research. With configural frequency analysis, the thesis applies an old, useful method known from psychological research outside of the educational field. Additionally, with the Shannon-Wiener Diversity Index, the dissertation makes an innovative translation of methodology across fields from biology into the educational research field. Both methods are introduced in depth in Chapters 5 and 6, but some background is given here.

Configural frequency analysis offers a way for contingency table data to identify over- and under-frequented patterns by comparing observed to expected cell count (Stemmler, 2014). Since its goal is not the grouping of all individuals, it allows exploring the diversity in a population from a different angle than other person-centered methods by identifying small *overfrequented* subgroups. It has been used in psychological research (von Eye, Mun, & Bogat, 2008), but has not been connected so far with student diversity analysis.

Diversity measurement, in general, is known to other disciplines. Biology, for instance, uses diversity indices to measure and compare the amount of diversity in naturally occurring systems, like forests (Rao, 1982). A commonly used index in biology is the Shannon-Wiener Diversity Index which allows to measure diversity in nature similarly to information contained in a message (Pielou, 1966). Measuring diversity with a diversity index has also spilled over into other disciplines, for instance economics (Fisch & Oesterle, 2003). Study I transfers this knowledge from biology to the field of education and supplements variable- with person-centered approaches. Through this innovative methodology, the thesis sheds more light onto the considerable diversity in the within-student characteristics interplay.

2.2.2 The Self-Underestimating Student as an Example of an Incoherent Disposition

One example for an incoherent student profile is the self-underestimating student. For this student group, high achievement is not met by an accordingly high self-concept

of ability in that subject. Quite to the contrary, these students think very poorly of themselves with regard to this subject.

Study II of this dissertation examines this student group more closely. It refers to a prior study by Seidel (2006) who indicated five different student dispositions for physics instruction found at the beginning of the school year that showed differences in the interplay of their cognitive and motivational-affective characteristics. An overview can be found in Table 7.1 in Chapter 7. The self-underestimating group found in this study made up for 29% of students overall. In some classrooms their share was up to 65% of students.

This student group is an excellent example of an incoherent learning disposition, since the contrasting levels of different cognitive and motivational-affective characteristics make it difficult to predict this dispositions' role in the learning process and resulting outcomes. High content knowledge indicates that these students have high capacities for achieving (Hattie, 2009). However, since they are underestimating their abilities, students might hold themselves back from engaging in critical situations for development. Indeed, research suggests these students often fail to live up to their potential (Elliot & Church, 2003). Different psychological processes using unrealistically low expectations, worst-case scenarios, or effort withdrawal are connected with missed learning opportunities and reinforce the low self-esteem they originate from (Elliot & Church, 2003). Hence, a low self-concept is not only regrettable in itself but may actually hinder cognitive advancement.

Certainly, other incoherent dispositions could be interesting cases for future research. For instance, the opposite of self-underestimation, an overconfidence in one's own ability, can also be detrimental for learning (Dunlosky & Rawson, 2012; Roelle, Schmidt, Buchau, & Berthold, 2017). Unfortunately, it has not been established how such detrimental incoherences in students' learning dispositions arise. Studies find that the overall inaccurate calibration of self-concept can be grounded in information deficit or neglect, but also in uncertainty in the interpretation of feedback (Dunning, Heath, & Suls, 2004). While for many individuals the self-concept aligns well with their cognitive abilities, there are individuals who are more likely to underestimate what they know or are capable of (Ackerman & Wolman, 2007). The role of gender, for instance, was

investigated in Jurik et al. (2013). But this study also showed that, even though more girls than boys underestimated their abilities, gender played no role, for instance, in self-underestimators' engagement in class.

2.3 Student Dispositions in Different Domains

Despite educational psychology's generic understanding of learning, leading educational researchers like Lee Shulman highlight that learning processes are inherently domain-specific (Baumert et al., 2010). On the students' side, findings regarding student characteristics often vary between subjects. Additionally, research has found that even more general appearing student characteristics like self-perceptions are specific to certain domains. For instance, self-concept is one of the student characteristics for which differences across domains (and cross-domain interactions) are most studied (e.g. Marsh, 1990a, 1992; Marsh, Byrne, & Shavelson, 1988). Empirical test of these authors with methods like factor analyses revealed that self-concept as a student characteristic must be regarded subject-specific.

In addition, the interaction among characteristics depend on the domain considered. For instance, interest is tied more closely to achievement for mathematics than for language arts (Schiefele et al., 1992). Also, self-concept and grades are connected closer for mathematics than for language arts (Marsh & Craven, 2006). Furthermore, general cognitive ability explained more of the variance in mathematics achievement than in any language instruction (Deary et al., 2007). Bong (2001) highlights the domain-specificity in the interplay of different motivational student characteristics. The author explains that such concepts must be defined and assessed in reference to specific situations and contexts in order to ensure their predictive validity. Hence, their generalizability across domains – that provide significantly different situations and contexts – of single characteristics and especially their interaction is difficult. Looking at the interaction in particular, the distribution of students into disposition group in Seidel (2006) used for Study II of this thesis, for instance, was also discussed to be connected to physics as a subject (Jurik et al., 2013). In schools, physics is perceived to be among the most difficult subjects only suitable for some students (Osborne, Simon, & Collins, 2003) and motivational-affective characteristics like interest and self-concept are comparatively low

(Hoffmann, 2002). Also, the connection of characteristics to other educational outcomes must be viewed subject-specific. The role of student characteristics in educational aspirations, for instance, is different for mathematics than for verbal domains (Korhonen et al., 2016).

With the focus on the learner as an individual, research views the student's characteristics regarding different subject domains to relate as well. One of the most prominent ideas is the frame of reference model introduced by Marsh (1986) that investigates the relationship of achievement and self-concept in the domains mathematics and language arts and finds paradoxical relations between achievement and self-concept in mathematics and verbal domains. Moreover, Guo, Marsh, Parker, Morin, & Dicke (2017) found that for the interaction of achievement and self-concept regarding different science domains there were negative dimensional comparison effects for contrasting and positive for related domains.

Because of all these considerations, caution must be advised when translating findings from one domain to another. Established lines of research are working towards this goal. In a vast number of studies, e.g. Marsh and colleagues examine the connections they postulate with regard to different subjects. For instance, the reciprocal effects model, describing the interplay of self-concept and achievement over time, has been extended to domains like physical education (Marsh, Chanal, & Sarrazin, 2006). Like in this case, transfer is often done from mathematics, which is the most widely researched domain, to other more under-researched domains (Anderman, 2004). Still, while some of these broad connections can be found across domains, exact interrelations still vary between domains (Marsh & Craven, 2006; Marsh et al., 2006). This is why Study I of this dissertation regards student and teacher perspectives on the interplay of student characteristics with regard to two different domains, mathematics and language arts.

2.4 The Development of Student Dispositions

Finally, the question of development of students' individual learning dispositions is fragmented in research. In the study of the development of single student characteristics, variable-centered research has focused on finding out more about causal ordering of student characteristics trying to answer which student characteristic predicts which in

the future. Most researched is the interplay of self-concept and achievement over time. By now more naive models of one characteristic strictly causing the development of the other (e.g. self-enhancement model vs. skill development model for self-concept predicting achievement and vice versa, Calsyn & Kenny, 1977) have been replaced by a more complex understanding of reciprocal effects (Marsh & Craven, 2006). Moreover, on a variable level, studies have looked at the development of two or more characteristics (e.g. achievement and self-concept) and their interaction over time. Results of Stäbler et al. (2017), for instance, indicate that a non-congruence in achievement and self-concept due to the big-fish-little-pond effect found by Marsh and colleagues (e.g. Marsh & Hau, 2003) might diminish over two years of schooling.

To the question what sparks development, many strands of research give an input. On the one hand, there are interventions on motivation that influence the development of cognitive and non-cognitive characteristics (e.g. Blackwell, Trzesniewski, & Dweck, 2007). When it comes to teachers' role in the development, Chapter 3 briefly connects teacher judgments to their teaching actions and Chapter 4 gives more detail on how certain teaching actions that offer individual support can shape the development of student dispositions.

Furthermore, research is growing more and more differentiated. Even longstanding understandings of developmental paths, like the Matthew effect (i.e., for instance in reading, good readers learn at a higher pace resulting in a widening of the achievement gap) have been challenged (Pfost, Hattie, Dorfler, & Artelt, 2014). That study finds neither an overall increase nor decrease in reading differences between students. Instead, they highlight individual differences in the development. Findings like this give support to the notion that the development of student characteristics cannot be regarded separately. The entire student disposition must be taken into account.

For an even fuller picture, additional background information can sometimes provide additional insights. For instance, growth rates in different characteristics sometimes vary. While, for instance, immigrant children in early childhood start with lower language skills in the majority language, their development in this characteristic is faster than for majority children (Becker, Klein, & Biedinger, 2013; Kieffer, 2011). On the other hand, studies have found that the developmental change in self-concept

does not depend on gender or cultural setting (Nagy et al., 2010). Also other external factors certainly play a role in the development of dispositions. Especially for students in secondary school, large developmental changes can affect the development of their learning dispositions. A. J. Martin & Steinbeck (2017), for instance, find considerable connections of puberty hormones and puberty status on students' motivational characteristics like self-efficacy. These external causes for changes still demand individual support in students' development since even (or especially) for students with certain backgrounds or for this particular age group, teachers can, for instance, shape powerful antecedents of self-efficacy like mastery experiences for their students (Bandura, 1994; Britner & Pajares, 2006).

In general, the focus on individual student characteristics that shape learning processes and outcomes of this dissertation should not misguide readers into a false sense of predetermination of students' learning. Research has shown that for the *development* of students, characteristics of the teacher and instruction are most influencial (Lipowski, 2006; Schacter & Thum, 2003). Especially in the development of students with weak prerequisites, teachers can make a difference (Babu & Mendro, 2003). But also regarding the development of incoherent dispositions, studies have found that students can be supported in learning. Roelle et al. (2017), for instance, found that mere information about the detrimental effects of overconfidence in one's own abilities lead to a more realistic self-concept. Moreover, knowledge acquisition for this student group only improved after teachers also provided adequate support regarding effective coping strategies for the 13-15-year old students. Hence, teachers' roles in student disposition development are critical.

Study II of this dissertation focuses on the development of students of the self-underestimating disposition that exhibits high cognitive and low motivational-affective characteristics in Chapter 7. Implication of results for teachers are discussed in Chapter 8.

Chapter 3

Teachers' Diagnostic Competence and Teacher Perceptions of Student Dispositions

Teaching must be tailored to different students with different characteristics (Schunk, 2012). Yet, instruction can consider student diversity and offer individual learning support only if teachers know about these individual differences in their students. This diagnosis of individual learners is a main challenge in teaching (Corno & Snow, 1986). This chapter reviews research on teachers' diagnostic competence and teachers' perceptions of students' learning dispositions.

Regarding the framework model of this dissertation, diagnostic competences as specific *Teacher Competences* shape *Teaching Processes* to create *Individual Learning Activities* for students according to their *Individual Characteristics*. However, diagnostic competences as specific teacher competences look onto these individual characteristics more directly (represented by the *eye* arrow). The theoretical background presented in this chapter relates the many perspectives that studies have taken to describe this connection with a focus on teachers' view onto the interplay of different cognitive and motivational-affective characteristics within learning dispositions.

3.1 Teachers' Diagnostic Competence as a Prerequisite for Individualized Instruction

The need to adapt instruction to individual learners has been studied for more than a century (M. Wang, 1980; Corno, 2008). With the rise of diversity as an issue in the educational debate, recent policies (e.g. United States Federal Education Legislation, 2002) increasingly demand to "individualize instruction for students with diverse learning needs" (DeLuca & Lam, 2014). This is also backed by experts of educational research, who urge that students need individual support according to their set of characteristics in order to learn successfully (Shuell, 1996). Yet, in practice it is seldomly done (Nieder & Frühauf, 2012; Schiepe-Tiska et al., 2013).

Teaching can consider student diversity and offer individual learning support only if teachers diagnose their students' characteristics and the diversity in their interaction. This central challenge in teaching (Corno & Snow, 1986) is considered one of the four basic professional competences of a teacher, called diagnostic competence (Weinert, 2001). This concept is seized by a growing number of empirical studies supplementing established knowledge about teachers' perceptions and judgments with new insights. However, research has not yet gained a full picture.

3.1.1 Individualized Instruction

Different terms are used throughout educational research, practice, and policy to describe concepts that are alternatives to "one size fits all" teaching approaches. Even though not consistently used between different studies, different terms have slightly different connotations. *Individualized instruction* or *differentiated instruction* have long refered to distinguishing teacher actions between different individuals, small or large groups (e.g. Quirk, Steen, & Lipe, 1971; Keislar & Stern, 1970). This grouping might be temporary or permanent. *Adaptive teaching* is used in different contexts including differentiation in a whole-class setting without grouping (Corno, 2008; Beck et al., 2008). Terms like *student-centered* or *learner-centered* teaching or instruction are commonly used as umbrella terms for the above (Deboer, 2002).

At first, the idea of the individualization of instruction can sound frightening to

practitioners who are already facing increasing pressures from standardized testing and structural reforms. Hence, topics closely tied to individualized instruction and coping with diversity like inclusive education, i.e. including former special education students into every classroom, currently still cause concerns in teachers (Yada & Savolainen, 2017; Gavish, 2017). Planning, preparing, and essentially holding individual lessons for every student sounds daunting. Hence, this dissertation wants to clarify what is meant by individualized instruction whose prerequisites and possible outcomes this thesis examines: The ideal is not an individual lesson for each student. Apart from being financially impossible, the very foundations of modern educational research have already highlighted the benefits of learning collaboratively – if it is done right (e.g. Vygotsky, 1978). Instead, this dissertation uses the term individualized instruction for any adjustment of instructional planning or implementation that takes individual student dispositions into account.

Research on individualized instruction specifies small adjustments in instructional planning and implementation that could ensure basic qualifications for every student and an increase in individual learning success for many. First, there are elements of instruction that are inherently individual, like feedback. Feedback is a crucial tool in individualized instruction that is paramount in everyday teacher-student interactions (Hattie & Timperley, 2007). It can also be used in instances of self-directed learning (Asterhan, Schwarz, & Cohen-Eliyahu, 2002), which is another field where individualization can be implemented. Teachers' individual input, for instance in self-directed learning, has been examined under the term scaffolding where teachers provide ongoing diagnosis, calibrated support, but increasingly fade this out towards students' independent learning (Van de Pol, Volman, & Beishuizen, 2012; Puntambekar & Hübscher, 2005). Furthermore, the use of group work is also connected to individualization, since the teachers' deliberate decisions on grouping and tasks in collaborative learning make a crucial difference for learning success in these environments (Volet et al., 2017). Moreover, research has found that certain types of instruction seem to be more suitable for students with certain characteristics. For instance, students with a low self-concept of ability profited more from cooperative vs. direct instruction in physics instruction (Hänze & Berger, 2007). Hence, such instructional methods should be used deliberately and their possible effect and benefit for different students must be kept in mind.

Even though theoretically, teachers plan and implement instructional activities according to their appraisal of their students' dispositions (Alvidrez & Weinstein, 1999) and choose tasks and assemble learning groups according to their judgment of students' characteristics (Ready & Wright, 2011), in practice, teachers still make infrequent use of differentiating teacher measures in their everyday classrooms (Nieder & Frühauf, 2012; Schiepe-Tiska et al., 2013). When using the term assessment, even in its beginnings, educational research has found deficits in formative assessment, the type of assessment used to track students' progress for their learning support (Harlen & James, 1997). While highlighting the importance of teacher judgments in formative context for student learning, the authors also detect a lack of clarity how this can be done. Moreover, older research has already shown that teachers rather look at groups than the individual student: In order to get a more personal understanding of teacher perception of student affect, Prawat (1980) analyzed teachers' written descriptions of classrooms events. He found that teachers seldomly use the individual as a unit of description and rather focus on the entire class or on groups. In addition, when considering individual student's affect, teachers focused more on interpersonal than intrapersonal adjustment – indicating, again, their focus on the group rather than the individual.

3.1.2 Diagnostic Competence

In order to successfully plan and implement the above measures into teaching, different teacher competences are needed. Of the traditional triad content knowledge, pedagogical content knowledge, and pedagogical knowledge (Shulman, 1986), all play a role in implementing such measures. For instance, in the provision of individual feedback or the choice of individual questions and tasks, teachers' pedagogical content knowledge is essential. For these acts of teaching, teachers must be aware of common misconceptions or know helpful examples, to name examples (Reiss, Heinze, Renkl, & Groß, 2008; Reiss & Hammer, 2013). Furthermore, non-cognitive competences that play a role in establishing a supportive classroom climate or a productive learning atmosphere and structure are also needed to successfully implement measures of differentiation and individualization (Tonelson, 1981). Still, one of the most crucial determinants of success of individualized instruction is teachers' ability to determine their students' current learning disposition.

Weinert (2000), who suggested *diagnostic competence* as one of the four basic professional competences (along with content competence, didactical competence, and classroom management competence), defines it as "a set of skills to be able to continuously assess the knowledge, the learning progress and performance problems of the individual students, as well as the difficulties of different learning tasks in the classroom, so that the didactic action can be based on diagnostic insights" (p. 16). This is how this term will also be used in this dissertation.

In practice, on the one hand, many countries have included teachers' diagnostic competence into their teacher competence frameworks, which consist of either in broad areas of competence (e.g. France, Hungary) or in detailed lists of competencies (e.g. Belgium, Estonia) teachers should possess or acquire in their profession. In some cases (e.g. Germany, Ireland) these framework developments have also been connected to reforms (European Commission, 2013). This further highlights the importance of this concept. On the other hand, expert recognize great deficits in teachers regarding their diagnostic competence (Weinert, 2000). The latter criticizes that diagnostic competence is rarely taught in teacher education and professional development. Other authors also note the lack of learning opportunities for diagnostic tasks (Praetorius, Lipowsky, & Karst, 2012) or that those skills are only trained on the job (Lorenz, 2011). This lack of formal learning opportunity further urges the question of where in-service teachers stand in terms of their ability to see their students' dispositions.

3.1.3 Diagnostic Competence in Different Domains and Educational Settings

Teachers' diagnostic competence as well as its role for teaching and learning must be considered domain-specific. Unfortunately, in many studies teacher perceptions are only examined regarding one subject (e.g. Campbell et al., 2014) or on a primary school level (e.g. Alvidrez & Weinstein, 1999), but few systematically compare them between different subjects. Regarding the individualized teaching tied to diagnostic competence, there are a few subject comparisons. (Westphal, Gronostaj, Vock, Emmrich, & Harych, 2016), for example, found that students perceive instruction in mathematics to be more adaptive to individual abilities than in language arts and, at the same time, that

there is a greater variance between mathematics teachers to do so. These authors also find that teachers' diagnostic competence predicts this students' perception of in-class differentiation for mathematics – but not for language arts. Hence, diagnostic competence seems to play a slightly different role in these two subjects.

Furthermore, the educational setting of teacher judgment and their impact must be considered. Most studies on teacher judgments are done in a primary school context (e.g. Gabriele, Joram, & Park, 2016). While this might be reasonable since the organizational structure of many educational systems as well as developmental considerations make primary school a particularly important time for teacher judgments, it makes the generalization of results to a secondary context in general and specific domains in particular very difficult. Study I of this thesis examines teacher perceptions of within-student characteristics diversity with regard to two distinct prominent subjects of secondary education, mathematics and language arts, to explore differences depending on the domain.

3.2 Teacher Perceptions and Judgments of Cognitive and Motivational-Affective Student Characteristics

Looking more directly at teachers' perceptions and judgments of student characteristics, even more terminological consolidation is necessary, since different terms originate in different lines of research. The first line of research refers to teachers' assessment of student abilities. Teachers assess their students in various ways at different occasions. Assessment as any "process that provides information about the thinking, achievement or progress of students" (Crooks, 2001) can be broadly differentiated into summative assessment (of learning) and formative assessment (for learning) (Harlen & James, 1997). Formative assessment defined as those "activities undertaken by teachers [...] which provide information to be used as feedback to modify the teaching and learning activities in which [teachers and students] are engaged" (Black & Wiliam, 1998). Hence, this concept is related to the teachers' diagnostic competence, but focuses more on the tools to get this information. Since the focus of this thesis lies more on

the teachers' point of view, this term is seldomly used here. Instead, this dissertation regards *teacher perceptions* or *teacher judgments*.

Research on *teacher perceptions* is generally concerned with viewpoints on a certain issue. Connected to student characteristics, it often implies methodologically that teachers were asked for their impression of certain aspects regarding the student in a rating questionnaire (e.g. Cornbleth & Korth, 1980). However, also deeper insights, for instance from conversational interviews, are regarded (e.g. Sweet, Guthrie, & Ng, 1998). *Teacher judgments* on the other hand is often used in a more technical context where teacher ratings are juxtaposed with data from student tests and questionnaires. This is often done to measure *teacher judgment accuracy* (e.g. Südkamp, Kaiser, & Möller, 2012). Other authors, however, use the term teacher judgments when focusing on teachers' thinking (Stern & Shavelson, 1983). As the empirical study of this dissertation is largely concerned with uncovering teachers' viewpoints, but also juxtaposes it to student assessment data, both terms, teacher perceptions and judgments are used depending on the context.

Many of these empirical studies have examined the role that teacher perceptions or judgments play for students' learning success. The term *teacher expectations*, that originates from research like the Rosenthal & Jacobson (1968) study of the so-called Pygmalion effect, is used to focus on what teacher ratings meant for student achievement. In case of the Pygmalion studies, they acted as self-fulfilling prophecies. Yet, also research on teacher perceptions and judgments examined this connection. Therewith, even early studies found that teacher perceptions of their students' characteristics greatly affect student learning (Stern & Shavelson, 1983). This is also confirmed from the assessment point of view: As opposed to grading or other summative teacher assessments, formative teacher assessment has a large impact on student learning (Black & Wiliam, 1998; Crooks, 1988).

Furthermore, empirical research reinforces the notion that teacher perceptions and jugdments shape their teaching actions. For instance, teachers' judgments on their students' motivation was connected to the level of support they realized in their classroom environment (Hadré & Sullivan, 2009). In between these perspectives, is the effect of diagnostic competence on student perceptions of instruction: students

rate the instruction of teachers with high judgment accuracy as more adaptive to their abilities (Westphal et al., 2016). Moreover, teacher perceptions also play a role for teachers' enjoyment of and confidence in teaching (A. J. Martin, 2006). Overall, the importance of teacher perceptions has been highlighted from different sides. The next step is to bring together the different viewpoints on how well teachers can actually judge their students' dispositions. According to Schrader (2009), two lines of research can provide hints at the state of this teacher ability: First, research regarding teacher judgment accuracy and its conditions and second, research regarding the process of those judgments.

3.2.1 Teacher Judgments and Their Accuracy

Regarding the agreement of teacher ratings with information from student tests and questionnaires, findings vary profoundly depending on the characteristic considered. On the one hand, large meta-analyses show that teachers are relatively able to accurately assess their students' achievement (overall agreement of teacher perceptions and student assessment $r \approx .65$; Hoge & Coladarci 1989; Südkamp et al. 2012. However, even regarding this characteristic, large parts of variance remain unexplained (Kaiser, Retelsdorf, Südkamp, & Möller, 2013). Furthermore, research suggests that teachers have more difficulty accurately judging their students regarding other student characteristics such as intelligence or motivation (Spinath, 2005).

Additionally, the measurement of judgment accuracy itself remains an issue. Findings juxtaposing the different methods uncover discrepancies due to measurement and conclude that it is difficult to speak of a general diagnostic competence based on data of judgment accuracy (Spinath, 2005). Some research suggests the focus on accuracy is misleading. Studies show that is is not the accuracy of teacher judgment that predict student achievement, but over- and underconfidence in those judgments that does (Gabriele et al., 2016). In these mixed findings on teacher judgment accuracy for different characteristics, it is difficult to make clear predictions on the perception of characteristics interaction based on this line of research alone.

3.2.2 Teacher Judgment Processes and Biases

The other line of research giving insights into how teachers might perceive student dispositions is concerned with the judgment process. Overall, the judgment process is not fully understood. For cognitive characteristics, research has identified criteria that teachers use to infer, for instance, level of knowledge. These include, for example, changes in demeanor, using shortcuts, or the ability to explain (Reynolds, Martin, & Groulx, 1995). For motivational-affective characteristics, teachers often also focus on the students' actions in class (Prawat, 1980). Yet, specific criteria are not agreed upon for those and other characteristics, like interest or intelligence. Students' actual behavior surely influences teacher impressions and predictions (Cornett-Ruiz & Hendricks, 1993), but it is unsure what teachers actually notice in classrooms (van den Bogert et al., 2014). The latter study also highlights, that what teachers notice varies between teachers.

At the same time, research has found that teacher judgment processes are prone to biases: These include teacher beliefs, stereotyping, regression and sampling effects (Fiedler, Walther, Freytag, & Plessner, 2002). Teacher beliefs, in particular, play a fundamental role in teacher perceptions and judgments (Pajares, 1992). Additionally, stereotyping connects teacher beliefs to student background variables such as gender, ethnic or socio-economic background (e.g. Tiedemann, 2002). Besides explicit expectations, teachers also have implicit, sometimes prejudiced, attitudes to achievement of certain groups of students (Peterson, Rubie-Davies, Osborne, & Sibley, 2016). These can be powerful and studies connected them directly to students' differences in learning outcomes (van den Bergh, Denessen, Hornstra, Voeten, & Holland, 2010). Interestingly, teachers do not seem to believe their assessment of students' characteristics is closely connected to concepts of diversity (DeLuca & Lam, 2014). In addition, there are many aspects of teacher characteristics that play a role for judgments and judgment processes. For instance, teacher variables like self-efficacy impacts teacher judgments of student characteristics (Miller, Ramirez, & Murdock, 2017).

3.2.3 Teacher Perceptions of the Within-Student Interplay of Characteristics

Even though, the two lines of research above hint that teachers' views of their students' characteristics might differ from what student assessments of these characteristics reveal, they focus either on separate student characteristics or on general judgment tendencies. Therefore, they cannot predict how teachers perceive individual students and the interplay of different characteristics within students' learning dispositions. Regarding this interplay of characteristics, several findings must be considered. At the same time as teachers seem to overestimate heterogeneity between their students with regard to one characteristic (e.g. achievement in Westphal et al. 2016), different lines of research suggest that teachers might underestimate heterogeneity *within* their students concerning different characteristics. First, empirical studies find that teacher judgments of different characteristics are tied closer than the actual characteristics. For instance, teachers expect students who they rate low on prior achievement to also be less motivated or less engaged (Urhahne, Chao, Florineth, Luttenberger, & Paechter, 2011; Kaiser et al., 2013). On the other side, this agrees with findings that human judgment has the tendency to overgeneralize. Thorndike (1920) first studied the general psychological tendency of judgment regarding one aspect of an individual spills into impressions on others, the so-called halo effect. This effect has been found for judgments in many fields, including education (Fiedler et al., 2002). Related to these findings, Fiedler et al. (2007) also found that teachers seem to infer (close) connections of characteristics within individuals from relationships measured on group-level. They call this phenomenon the pseudocontingency illusion.

Because of these many influences on teacher perceptions, we still do not know if teachers really see the individual students to adequately individualize their teaching to it. This is why Study I examines the interplay of student characteristics from a teacher's perspective as well. Via the person-centered methodology and especially the diversity indices' property of allowing statistical comparisons between student and teacher perspective, the thesis describes patterns of teachers' views on the within-differences in their students – as a prerequisite for offering individual learning support.

Chapter 4

Individual Students' Learning Processes and Development

This chapter regards students' learning processes. In the framework model of this dissertation, *Individual Learning Activities* are precipitated by *Teaching Processes* and retroact to those. Together, they describe the student and teacher side of everyday instruction. In this, learning activities describe the *use* students make of teachers' *supply* in instruction. At the same time, learning activities shape the development of dispositions – from learning prerequisites, *Individual Characteristics*, to learning *Outcomes*, which is examined in this dissertation. Therefore, the focus of the theoretical background presented lies on the role of learning processes in disposition development. Nevertheless, ties of certain learning processes to teaching actions are touched to provide a foundation for the discussion of the educational relevance of findings in Chapter 8.

4.1 Learning as Individual Processes Connecting Teacher Actions to Individual Development of Student Dispositions

Not all research clearly fits into the supply-use logic underlying this dissertation. In some studies, learning processes are overlooked. These studies examine the effects of teaching actions on students' learning outcomes directly – without explicitly mentioning the learning processes in between. For instance, specific classroom management strate-

gies can enhance students cognitive as well as their social-emotional characteristics (Korpershoek, Harms, Boer, van Kuijk, & Doolaard, 2016). In this regard, research finds that the cognitive and motivational–affective development of students can be influenced by instruction (Kunter et al., 2013). However, in the fuller picture, it is through individual learning activities, that these effects takes place: Teachers monitor, foster, and scaffold students motivational and cognitive internal learning processes (Pritchard, 2009).

In this connection of learning processes to teaching actions, learning activities are also connected to teachers' diagnostic competence treated in Chapter 3. Depending on how teachers perceive their students, they offer varying degrees of supportive environments in their classrooms (Hadré & Sullivan, 2009). This is also formulated as the goal of diagnostic action being the optimization of individual learning processes (Ingenkamp, 1970). This is how learning processes are tied in with the research on teachers' diagnostic competence in this thesis. However, before research can comment on how teachers can shape learning environments to support individual learning processes, we need to take a closer look at the role of different learning processes in the development of students' dispositions.

4.2 The Importance of Internal Learning Processes for Disposition Development

Learning processes can be divided into external and internal learning processes. External learning activities are the observable actions students engage in, like problem solving on a worksheet or text discussions in small groups. Research has found, however, that it is not general activity that is connected with learning outcomes, but meaningful engagement within the activities (Graham & Golan, 1991; Chi, 2009). This phenomenon of meaningful engagement is described by internal learning processes. Hence, internal learning processes are the parts of students' learning that take place in students' heads during instruction, the students' internal *use* of instruction. These processes have cognitive and motivational-affective aspects.

4.2.1 Motivational Internal Learning Processes

Motivational internal learning processes have been found to have profound impact on learning outcomes (Schiefele & Schaffner, 2015). At the same time, these motivational learning processes are connected to effective teaching (Seidel, 2015). In Study II of this dissertation, motivational internal learning processes are described by students' intrinsic learning motivation as well as their perceived fulfillment of their basic psychological needs.

Intrinsic Learning Motivation

This dissertation characterizes intrinsic motivation by the fact that a learning activity creates joy and satisfaction and thus the action itself is a sufficient incentive for action (Seidel & Reiss, 2014). Intrinsic motivation is strongly connected to both, cognitive and motivational-affective learning outcomes. For instance, intrinsic motivation can further cognitive outcomes like conceptual learning (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Moreover, intrinsic learning motivation is found to be connected with students' self-esteem (Pajares & Valiante, 1999; Praetorius, Greb, Lipowsky, & Gollwitzer, 2010). The effect to outcomes might go through other parts of the learning process, (e.g. external learning activities that spark new internal learning activities). Niemiec & Ryan (2009) conjecture that more intrinsically motivated students are more willing to engage in less interesting tasks and place more value on academic activities. This added commitment translates into deeper learning and higher outcomes.

Several aspects of teaching are connected to students' intrinsic learning motivation. More stimulating tasks, for instance, are connected to higher intrinsic motivation (Guthrie et al., 2006). Also, the way tasks are introduced make a difference for students' intrinsic motivation (Niemiec & Ryan, 2009).

Basic Psychological Needs

According to self-determination theory, three basic psychological needs underlie human's motivation: social relatedness, support of competence, support of autonomy (Deci & Ryan, 2002). The theory of self-determination, in general, investigates the conditions supporting or hindering "the natural processes of self-motivation and healthy psychological development" (Ryan & Deci, 2000). Regarding the field of education,

their important role in the learning process has been studied in various settings and for various cultural backgrounds (Chirkov, 2009).

Looking at learning outcomes, for adolescents, a sense of autonomy and relatedness is shown to promote their self-esteem (Allen, Hauser, Bell, & O'Connor, 1994) and influence their general self-perception (Diseth et al., 2012). Additionally, a fulfillment of the basic motivational needs is strongly connected to students' sense of self and personality development (Deci & Ryan, 2008; Krapp, 2005). Tsai et al. (2008) connected the satisfaction of these needs to the development of students' interest. Overall, the fulfillment of basic psychological needs and experience of intrinsic learning motivation during instruction can lead to positive affective learning outcomes in students (Korthagen, Attema-Noordewier, & Zwart, 2014). But it has effects also on the cognitive side: Students that feel more supported in their autonomy, achieve better on long-term and short-term tests of conceptual understanding (Vansteenkiste et al., 2004). Jang et al. (2009) also found that the satisfaction of the three basic psychological needs led to higher overall achievement in students.

These aspects of internal learning, again, affect other parts of the learning process. Research finds that the satisfaction of basic psychological needs is connected to a pattern of increasing classroom engagement in students over a school year (Jang, Kim, & Reeve, 2016). Since it also enhances students' willingness to communicate in class (Joe, Hiver, & Al-Hoorie, 2017), it shapes their learning opportunities during teacher-student interactions in the widely used classroom talk. In addition, it is connected to students' overall learning engagement (Zhen et al., 2017) which might translate into the pursuit of more challenging tasks or problems.

Furthermore, the satisfaction of students' basic needs is also connected to teaching actions. Defering the learning process and considering the impact of teaching on development directly, teaching which addresses the three psychological needs has more impact on students' motivational characteristics (Pritchard, 2009; Rakoczy, Klieme, & Pauli, 2008). Regarding the learning processes' connection to teaching, the satisfaction of students' basic psychological needs has been connected to teachers supportive activities in class (Reeve & Jang, 2006). Moreover, the way in which teacher instruct and set tasks is connected to students' satisfaction of all three basic needs (Niemiec & Ryan,

2009). Recent studies additionally indicate that it might be emotionally supportive teacher-student interactions that initiate the positive perceptions of autonomy support and social relatedness (Ruzek et al., 2016). Moreover, an overall positive learning climate can impact the satisfaction of basic psychological needs in students (Joe et al., 2017).

4.2.2 Cognitive Internal Learning Processes

Besides motivation, students' cognitive learning processes are crucial for learning and development (Helmke, 2012). This thesis refers to students' self-reported cognitive learning activity as "the kind of activity that really promotes meaningful learning" (Mayer, 2004, p. 17), i.e. students' reported information processing in terms of basic elaborations, meaning to be able to follow the instructions of the teacher and to connect information to pre-experiences. Other terminology in research includes *higher order thinking*, *challenging tasks*, or *thoughtful discourse* from the student perspective. At the same time, from the teachers' side, the term *cognitive activation* is prominently used. Teachers who use cognitive activation support their students' cognitive learning activities.

Regarding students' learning outcomes, cognitive internal learning processes are in a cognitive-constructivist understanding useful for deeper understanding and processing and as such connected to better learning outcomes (Lipowski, 2015). Regarding cognitive learning outcomes, research shows that there is a link between students' basic cognitive activation and students' achievement (Baumert et al., 2010). More generally, cognitive learning activities are connected with cognitive development (Bransford, Brown, & Cocking, 1999). On the motivational-affective side, studies also find effects of cognitive internal learning processes. For instance, when regarding so-called deep learning activities, D'Mello & Graesser (2012) find that learner's affective states are not only activated, but continuously transformed.

In the connection to teaching, cognitive activation of students is seen as an important aspect of high-quality instruction (Klieme, Lipowsky, Rakoczy, & Ratzka, 2006). Cognitive activation includes shaping targeted cognitive activities for learners, in particular cognitive conflicts (Kunter et al., 2011). This means teachers must not only

activate basic concepts and beliefs in the learner, they must also create perturbation of the same (Minnameier, Hermkes, & Mach, 2015).

4.2.3 Domain Differences in Learning Processes

Like student dispositions and teacher judgments, learning processes must be considered domain-specific, since they depend on the subjects' knowledge domain (Seidel & Shavelson, 2007). On the one hand, external learning activities can vary considerably depending on the subject domain. For instance, while critical text analysis is a prominent activity in language arts (Schuster, 2003), scientific experiments are a fundamental part of student learning in science (Willer, 2003).

On the other hand, for all subjects, different external activities aim at similar motivational and cognitive internal learning processes as the ones presented above. Studies find that science field trips can trigger students' intrinsic motivation (Holmes, 2011), just as certain reading activities evoke intrinsic motivation (Wigfield, Guthrie, Tonks, & Perencevich, 2004). Likewise, an experiment can elicit meaningful cognitive activity (Minnameier et al., 2015), and so can teacher-student interaction (Baumert et al., 2010) – both if constructed appropriately.

Moreover, despite even young childrens' measured differentiation of internal learning processes, like their intrinsic motivations, across subject domains (Gottfried, 1990), the *effects* of learning processes on learning outcomes are assumed to be comparable across domains. For instance, Tsai et al. (2008) found that a satisfaction of students' need for autonomy had comparable beneficial effects on students' interest for mathematics as well as first and second language instruction. Likewise, cognitive internal learning processes across domains aim to build conceptual and procedural knowledge that is elaborated and organized (Lipowski, 2015; Seidel & Shavelson, 2007).

4.3 Internal Learning Processes and Development of Students with Incoherent Dispositions

Even though many studies examine the effects of learning activities on learning outcomes, few do this with a focus on the individual student. Rather, studies ask if a

certain learning activity is *on average* connected to higher motivational or cognitive learning outcomes. This is regrettable since we know that certain types of instruction seem to be more suitable for students with certain characteristics (e.g. the students with a low self-concept of ability who profited more from cooperative versus direct instruction in physics, Hänze & Berger, 2007). This suggests that learning processes, too, play a differential role for different students' learning success. One of the few studies that did address individual differences highlights that, for example, the connection of basic psychological needs and students' learning engagement is mediated by students' cognitive and motivational-affective characteristics (Zhen et al., 2017). However, research does not know enough about these differential effects yet.

Regarding a prediction of disposition onto students' learning processes, Seidel (2006) found that self-underestimating students, as an entire group, report lower perceptions of their internal learning processes than other students. Students with a self-underestimating disposition report significantly lower intrinsic learning motivation and a lower level of cognitive learning activity than the average student (Jurik et al., 2014). Moreover, they also feel less socially related and less supported in their competence (Seidel, 2006). It is, however, not clear if remaining variance in internal learning processes *within* this group are connected with diverging development over the school year.

For the focus group of Study II of this dissertation, the aforementioned findings of a connection of the fulfillment of basic psychological needs and experience of intrinsic learning motivation to positive affective learning outcomes in students (Korthagen et al., 2014) and the connection of cognitive learning activities with cognitive development (Bransford et al., 1999), are important. However, since both areas of learning activities also have effects on the opposite domain of student characteristics and the interactions of these processes are largely unknown, the study will provide interesting new insights into these connections.

Chapter 5

Research Agenda

5.1 Research Questions

This chapter gives a brief overview of the research questions as addressed in this dissertation. They have developed from the open questions in current research delineated in the previous chapters. The first three research questions are subject of Study I, the fourth and fifth questions are examined in Study II of this dissertation. This chapter provides a broader embedding of the research questions of this dissertation. The exact wording in the empirical studies and corresponding conjectures based on the theoretical background are given in the studies' documentations in Chapters 6 and 7.

5.1.1 The Diversity Within Students' Learning Dispositions

From the first studies that investigated the sets of student characteristics in individuals employing person-centered rather than variable-centered methodology came the insight that, for many students, incoherences shaped the interplay of different cognitive and motivational-affective characteristics. Studies found students that were able but not confident (Lau & Roeser, 2008), knowledgeable but not interested (Seidel, 2006), or self-efficacious but only moderate achievers (Linnenbrink-Garcia et al., 2012). At the same time, research showed that these incoherent dispositions had effects on students' learning outcomes (Linnenbrink-Garcia et al., 2012; Seidel, 2006; Lau & Roeser, 2008; Jurik et al., 2013, 2014). However, only few studies existed and all focused on finding *groups* of students with a similar configuration of characteristics. Hence, it remained unclear how diverse the interplay of cognitive and motivational-

affective characteristics in students‘ dispositions is when each individual is recognized in its individuality. Moreover, the existing studies showed that large portions of the considered students belonged to incoherent profile groups. Yet, since the heterogeneity within groups is unknown, we could still wonder how common incoherences really are. Furthermore, the studies considered student dispositions with regard to one subject domain only. Hence, we do not know how the within-student characteristics diversity and incoherent dispositions vary between subjects. Consequentially, Study I of this thesis investigated the diversity in the interaction of the cogntive and motivational-affective student characteristics in students' dispositions and focused on the exploration of incoherences. It considered the dispositions with respect to two different subject domains, mathematics and language arts, of the same group of students to study variations between subjects.

5.1.2 Teacher Perceptions of Within-Student Characteristics Diversity

From early studies on teacher expectations to modern eye-tracking studies that aimed at understanding the teacher judgment process, research agreed in two main points: Firstly, teacher perceptions are crucial for high-quality teaching and secondly, teacher perceptions are not yet fully understood, but there are indications that it is difficult for teachers to see their individual students' learning dispositions. While especially the quantifying approach of teacher judgment accuracy integrated the investigation of teacher perceptions into the empirical mainstream research, many aspects remained unclear, such as the exact measurement of this accuracy (Spinath, 2005), large between teacher variation in teacher judgment accuracy with regards to cognitive characteristics (Kaiser et al., 2013), unclear findings on judgment accuracy regarding motivational-affective characteristics, and the consequential question of diagnostic competence as a general teacher trait (Spinath, 2005). Thus, in the focus on the individual students and possible incoherences in their dispositions introduced above, it remained unclear whether teachers saw the possible diversity in the interplay of different cognitive and motivational-affective characteristics and especially, potential incoherences in this interplay. This is why Study I also considered teachers' perceptions on the within-student characteristics diversity in mathematics and language arts classrooms.

5.1.3 Domain-Specificity of Within-Student Characteristics Diversity and Teacher Perceptions

General appeals to empirical educational research to include considerations of specific subjects domains into their investigations (Baumert et al., 2010) are grounded in the understanding that teaching and learning functions differently in different domains (Shuell, 1996). Regarding students learning dispositions, different cognitive and motivational-affective student characteristics were found to be connected more closely for mathematics than for language arts (Schiefele et al., 1992; Marsh & Craven, 2006; Deary et al., 2007). Regarding teacher perceptions, teachers were hypothesized to integrate subject-related attitudes into their judgment of student characteristics (Prawat, 1980), which migh also lead to differences in the perception of within-student characteristics diversity. Hence, Study I explored the the interplay of cognitive and motivational-affective characteristics within student learning dispositions as well as perceptions of mathematics and language arts teachers of the same student group's dispositions with respect to two different domains, mathematics and language arts.

5.1.4 The Development of Incoherent Student Dispositions

The connection of different student characteristics to their development and learning outcomes regarding other characteristics are examined in established studies in the field. Marsh et al. (2005), for instance, explored the effect of achievement, interest, and self-concept on eachother over time. As opposed to earlier notions of clear causality, modern findings pointed towards a complex interplay of these characteristics, also over time. To date, this interplay had not been regarded from the viewpoint of the individual employing a person-centered perspective. Also, the incoherences found in the studies on student characteristics mentioned above (Linnenbrink-Garcia et al., 2012; Seidel, 2006; Lau & Roeser, 2008) had not been regarded over time. For incoherent dispositions in particular, it remained unclear if these incoherences can be temporary phenomena. Thus, Study II exemplarily regarded the development of self-underestimating student over a school year.

5.1.5 Students' Internal Learning Processes Connected to This Development

In the consideration of learning processes, especially internal learning processes, research referred to the individual student (e.g. Deci, Vallerand, Pelletier, & Ryan, 1991). However, in research design and methodology, the consideration of cognitive or motivational-affective characteristics in the effect of learning activities has only begun. While theoretically, scholars pointed out that learning is perceived and executed differently for each individual (Shuell, 1996), these learning activities were rarely connected to learning outcomes for different subgroups with different learning characteristics (Zhen et al. 2017 being one of the few studies). Therefore, Study II compared learning processes for the different groups of development. In particular, it explored which learning processes were connected to potential positive development of students with incoherent dispositions.

These five research questions guide the empirical part of this thesis. With this work in particular, this dissertation aims to advance current knowledge.

5.2 Methodological Approach

The two studies in this dissertation presented in the following two chapters employ a similar methodological approach. Hence, some information on important similarities and distinctions in methodology are given at this point. This will also yield a more general understanding of the results and allows discussing methodological viewpoints of this thesis in the general discussion of Chapter 8.

5.2.1 Samples, Designs, and Instruments

Samples

For both studies of this dissertation, student groups from secondary school were considered (eight grade for Study I, ninth grade for Study II). Secondary school, and this age group in particular, was chosen for several reasons. First, for this age, student characteristics have already formed in a distinguishable manner, yet is still evolving. This is important, since motivational-affective characteristics are measured

using student questionnaires with self-assessment items (for details see below and methods sections of Study I and Study II in Chapters 6 and 7). Especially motivational-affective characteristics can be measured more reliably and have been formed with regards to specific domains, which is less pronounced for younger students (Marsh, Craven, & Debus, 1998; Krapp, 2000). The latter is crucial in this thesis' aim to juxtapose different subjects. Furthermore, students' dispositions in this age group play an especially important role since they also affect higher education and career choices made in the following years (Korhonen et al., 2016; X. Wang, 2013). For possible future interventions, this age group would therefore be especially interesting.

The student sample for both studies came from the higher tracks of German secondary schools. A student group from one or two tracks only (Gymnasium for Study I, Gymnasium and Realschule for Study II) was chose to highlight the within-student characteristics diversity in a group generally considered to be rather homogeneous. In some scientific discussions, the tracked school system is already considered to be a measure of differentiation according to individual dispositions (Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006). While this might be true to some extent, Study I shows that even in a rather homogeneous group of students, the interaction of different cognitive and motivational-affective characteristics exhibits great diversity. Study II is a consecutive study to Seidel (2006). In this respect, it examines the development of a specific subgroup of students from this study, yet maintains all students for reference purposes. Germany was chosen primarily as the location of the researchers involved in the study. However, its tracked school system (see above) and the national discussion around diagnostic competence in political and local educational research settings make this country an interesting place for this research.

Student disposition data as well as teacher data (for Study I) was collected with regards to different subjects. Study I juxtaposes student dispositions for mathematics and language arts. Study II examines student dispositions with respect to physics. Hence in total, three important domains of secondary education are included in the studies of this dissertation to offer insights on student learning dispositions for different domains.

Designs

The data for both studies was obtained as part of two larger studies: the *Interaction* study, supported as 'Opportunities to Learn' by a research grant of the German Research Foundation (DFG, SE1397/7-1), for Study I and the German subsample of the *IPN Video Study*, supported as 'Teaching and Learning Processes in Physics Instruction' by a research grant of the German Research Foundation (PR 473/2–2), for Study II. Both studies were designed to connect students dispositions to learning processes. The Interaction study additionally incorporated teachers' perspectives on student dispositions. Learning processes were measured by student questionnaires (see methods section below) as well as video-taped classroom observations. To focus on the student dispositions (the student and teacher perspectives on within-student characteristics diversity for Study I and the development and its connection to *student perceptions* of learning processes for Study II), the video observations were disregarded for the studies of this dissertation.

Study I only regards students' dispositions at the beginning of the school year. Due to the complexity resulting from the comparison of two perspectives (student and teacher) in two subject domains (mathematics and language arts), the examination of development was left to further research. Study II consideres student disposition at the beginning and the end of the school year and focuses on the development of a specific subgroup of students (the self-underestimating students). Student perceptions of learning processes were measures at mid-school year following the video-taped lesson.

Instruments

The two studies employed similar instruments to measure student dispositions. Both employ a subscale of the Kognitiver Fähigkeitstest (KFT, cognitive ability test), a test frequently used in Germany to measure general cognitive ability (Heller & Perleth, 2000). The subscale consisted of 25 figure analogy items, which were coded dichotomously (0 = incorrect, 1 = correct). Study I reports the total number, Study II the percentage of correctly answered items due to differences in the subsequent scaling for analyses.

As a further cognitive characteristic, Study I consideres the students' prior

achievement in terms of their grades from the previous school year. Despite the complexity behind the creation of school grades and discussions around their use in educational research, they are widely used as valid achievement measures (Cliffordson, 2008) and as such were assigned to the cognitive terrain in Study I. After all, prior achievement is a prominent predictor of learning success (Hattie, 2009; Marsh & Martin, 2011). Grades in Germany range from 1 (excellent) to 6 (insufficient), but were recoded so that a higher value indicates a higher prior achievement. In Study II, a knowledge test regarding physics was administered to measure the students' prior knowledge. Items from various sources were adapted and details on this test can be found in the methods section of Chapter 7.

Both studies conducted student questionnaires surveying students on their interest and self-concept regarding the respective subject domain. Items for Study I were taken from the 2012 and 2009 questionnaires of the Program for International Student Assessment (PISA) going back to (Baumert, Gruehn, Heyn, Köller, & Schnabel, 1997) for interest and (Marsh, 1990b) for self-concept. Items for Study II were developed for the IPN Video Study (Hoffmann, Häußler, & Peters-Haft, 1997; Hoffmann, Häußler, & Lehrke, 1998). The item developments for both studies originate in the same theoretical models of interest and self-concept regarding subject domains specified in the theoretical background in Chapter 2 (Adams & Wu, 2002; Seidel, Rimmele, & Dalehefte, 2003).

Teacher questionnaires on their perceptions of student dispositions and student questionnaires on their perception of internal learning activities were specific to each study and therefore described in the methods section of Chapter 6 and 7 respectively.

5.2.2 Statistical Analyses

For both studies, data from student and teacher tests and questionnaires were transformed into an appropriate scale for the subsequent analyses. Methods that were used in this dissertation include multi-level randon intercept and random slope regression, Shannon-Wiener diversity index and related modified t tests, configural frequency analysis and related χ^2 tests, latent class analysis, paired-sample and independent sample t tests, and multi-level analysis of variance. Analyses were performed using R (R Core Team, 2013), Mplus (L. K. Muthén & Muthén, 2010), SPSS Version 22, and

Microsoft Excel 2013. Details on the models and software implementation (including R packages used) are given in the methods sections of Chapter 6 and 7.

Multi-Level Analyses

In educational research, data is often structured in a so-called nested way, which means that groups within the data can be related more closely within the group than between groups. In educational settings, students are nested in classes, which can also be nested in schools. It makes sense that, for instance, ratings on perceived learning processes are likely to be more closely related for two students who have had the same instructor, have a similar family background, and who frequently interact with each other than for two students from entirely different settings that have never met.

To account for the multi-level structure of the data, regressions and analyses of variance of this thesis are modeled as multi-level random effects models. This means that an additional error term is introduced to account for the variance that can be explained by group membership. Which portion of the overall variance can be explained by group membership and how much remains random variation, is determined within these models. By accounting for the structure of the data, standard errors and statistical significances are determined more accurately which allows for more precise inferences (Lüdtke, 2009).

Person-Centered Methodology

A noteworthy methodological consideration of this dissertation is the role of person-centered methodology for the exploration of individual students' perspectives in educational research. Several different person-centered methods are employed to serve the different purposes of investigation.

Person-centered methods do not analyze aggregated variable values of a population, but persons or objects with their set of variables values. Instead of assuming a homogeneous population, person-centered methods allow for identifying distinct subgroups (von Eye & Bogat, 2006). In this property, they seem ideal to explore the within-student characteristics diversity and individual differences in student dispositions.

Diversity Indices To date, there had not been a satisfactory method in educational research to explore the diversity or heterogeneity of a sample (and to compare it).

To achieve these goal, this dissertation startet with conceptual consideration. The first question was: How is diversity understood? To answer this question, the thesis disentangled the term from its use in educational science and looked at other fields and context that use it. In a more abstract understanding, diversity is a notion describing an group entity consisting of two or more individual entities in terms of the differences in the individual entities' characteristics. In forestry, for instance, a forest consisting of many different tree species is considered to be more diverse than a forest with only two or three. At the same time, a forest with three species in total but 95% pines is regarded less diverse than one where the three species have a more equal share. From considerations like this, theoretical biology has derived a number of diversity indices (Magurran, 2004).

The Shannon-Wiener diversity index is used in this dissertation. It is a way to summarize observed frequencies that increases when there are more different patterns and when they appear more equally distributed (as described in the forestry example above). The Shannon-Wiener diversity originates from the Shannon entropy, which was initially developed in information theory by C. E. Shannon in 1948 (Shannon, 1948). As this study's application also refers to diversity measurement, it refers to the Shannon-Wiener diversity index instead of the more general Shannon entropy. While there are other measures of diversity (e.g. Simpson, 1920; an overview can be found in Magurran, 2004), Shannon's formula holds a central position when compared to other diversity measures (Laxton, 1978).

In Study I, the Shannon-Wiener diversity index was used as a measurement for within-student characteristics diversity. In this consideration, each distinct configuration of student characteristics scaled on a narrow 3 point scale ranging from 1 (low) to 3 (high) was considered to be its own species. The diversity index regarded how many different species exist (according to student data and according to teacher perceptions) and how they are distributed respectively. Shannon-Wiener diversity indices regarding different groups can be compared using modified t test. Formulas and other details on the index and related t tests are given in the methods section of Chapter 6.

Configural Frequency Analysis For a different purpose of investigation, other person-centered methods are useful. For instance, when interested in identifying

(the existence of) special small subgroups, configural frequency analysis can be used. This is possible when looking at a set or pattern of values for each individual entity. Based on the distribution of each single value across individuals, this method can identify patterns that appear more frequently than expected based on their marginal distributions by employing local χ^2 tests(von Eye, Mun, & Mair, 2010). Patterns that appear significantly more often than expected are called *types*. Reciprocally, patterns that appear significantly less often than expected are correspondingly called *anti-types*. For the identification of anti-types a large number of observations is necessary. This could not be done in this thesis due to sample size.

In Study I of this dissertation, configural frequency analysis provided additional insights into the dominance of coherent vs. incoherent student dispositions. By identifying which dispositions (if any) appeared more frequently than expected, the study found if coherent (or incoherent dispositions) dominate the group. It is important to consider that due to the marginal distributions of roughly 25% high (3) and low (1) values and 50% medium (2) values, the expected occurence is not equal over dispositions. Also, if no types can be found, this means there is a rich diversity of patterns.

Latent Class Analysis A third person-centered method employed in this thesis is latent class analysis. It works by assuming the connection between different measures, the student characteristics in this case, are only through a latent grouping variable. In this method, all students are assorted into a given number of groups based on making the similarities within groups and the differences between groups large. While the number of groups must be given, their sizes can vary. Model fit comparisons can help to determine the number of groups best describing the differences (and similarities) within the data. Hence, this method can provide insight into the question: If I had to divide the students into groups based on their characteristics, how would those groups look, i.e. what share does each one have and how are the average values of each characteristic in the group. Note that considerable variation may still exist within groups with regard to the characteristics. This variation might also not be distributed equally across groups or characteristics. However, the grouping provides a more graspable viewpoint onto within-student characteristics interplay and might be most useful for certain practical considerations.

Study II of this thesis employed latent class analysis to determine how students from a similar incoherent dipositional starting point at the beginninng of the school year had developed their dispositions at the end of the year.

5.3 Relevant Publications

The results presented in the following empirical studies of this dissertation have been published or submitted for publication in the following way:

Study I: Teacher and Student Perspectives on Incoherences and Within-Student Characteristics Diversity

- Huber, S. A., & Seidel, T. (submitted). Comparing Teacher and Student Perspectives on the Interplay of Cognitive and Motivational-Affective Student Characteristics. *Journal for Learning and Individual Differences.*

The manuscript was submitted for publication in October 2016 to this journal.

Study II: Students with Incoherent Dispositions: Development and Internal Learning Processes

- Huber, S. A., Häusler, J., Jurik, V., & Seidel, T. (2015). Self-underestimating students in physics instruction: Development over a school year and its connection to internal learning processes. *Journal for Learning and Individual Differences, 43*, 83–91. doi:10.1016/j.lindif.2015.08.021

The manuscript was submitted for publication in October 2014 to this journal. After a revision, it was accepted for publication in August 2015.

Conception, preparation, analyses, and presentation for both manuscripts were performed in the context of this dissertation. This process was supported by the co-authors (see Appendix B.4).

Chapter 6

Study I: Comparing Teacher and Student Perspectives on Incoherences and Characteristics Diversity

General principles of teaching and learning must be adapted to suit the way these principles operate with different students (Shuell, 1996).

The first part of this study's rational originates in the fact, that educational research does not yet agree on how to best describe these individual differences in students. While ample research considers differences in students' background like gender, race, or socio-economic background (e.g. Birenbaum & Nasser, 2006), this dissertation argues that differences in students' cognitive and motivational-affective characteristics should be focused on. It claims that students' backgrounds play an important role in the formation and development of these characteristics, but learning processes are more directly effected by the latter (Cohen et al., 2009; Seidel & Reiss, 2014). Additionally, it argues that even though background influences characteristics, there is still considerable variations within student groups of the same background (Hope et al., 2013), so that a focus on student characteristics directly, can provide a better picture of individual differences relevant for teaching and learning processes. This dissertation draws upon considerations regarding cognitive and motivational-

affective competences as outcomes of learning and cognitive and motivational-affective characteristics as prerequisites of learning merging them in the concept of student learning dispositions. While the importance of these dispositions in general as well as their single characteristics components have been studied in depth (Deary et al., 2007; Marsh & Martin, 2011), individual differences between students are only starting to move to the focal point of the debate. In studies that do explore differences in the composition of students' learning dispositions, incoherences in the interplay of different cognitive and motivational-affective characteristics are found for a majority of students (Seidel, 2006; Lau & Roeser, 2008; Linnenbrink-Garcia et al., 2012). However, they still look at different groups of students instead of individuals. The aim of this study is to explore the full extent of individual differences among student dispositions by finding a way to measure the differences in their configurations of different cognitive and motivational-affective characteristics, their *within-student characteristics diversity*. In this, it targets the *Individual Characteristics* block of the framework model and focuses on the red double arrow illustrating the interplay of different characteristics (cf. Figure 6.1).

The second part of this study's rational is grounded in the debate of the implementation of the idea of adapting general principles of teaching to different students. On the one hand, the application of this idea is prominent in current educational policy (United Nations Educational Scientific and Cultural Organization, 2009; United States Federal Education Legislation, 2002). At the same time, it often fails in practice (e.g. Schiepe-Tiska et al., 2013). In trying to explain this discrepancy, educational research is currently exploring a prerequisite for this implementation in depth: teachers' perceptions of their students' dispositions. Studies have examined how accurately teachers judge single or multiple student characteristics (Südkamp et al., 2012; Spinath, 2005) and which biases play a role in teacher judgment processes (Fiedler et al., 2002). Nevertheless, the knowledge on teachers' perception of students' individual differences with regards to their dispositions is still incomplete. This study aims at supplementing this knowledge with an additional perspective: Examining how teachers' perceive the diversity in the interplay of cognitive and motivational-affective characteristics and finding out if they see the incoherences in student dispositions. Thereby, the study examines the *Diagnostic Competence* block in the framework model that connects

teacher competences to students' individual characteristics (depicted by the blue eye in Figure 6.1).

A third aspect considered in this study concerns the fact that the general principles of teaching and learning also operate differently in different content areas (Shuell, 1996). Therefore, the above investigations are carried out seperately for two subject domains, mathematics and language arts.

6.1 Research Questions and Conjectures

This study investigated the diversity in the within-interplay of four characteristics: general cognitive ability, prior achievement, interest, and self-concept. In a methodological triad, three aspects of this diversity are considered:

(a) Correlation-like pairwise connections between variables were explored from a student and teacher perspective to verify that variable-centered perspectives were in line with existing research. (b) The Shannon-Wiener Diversity indices adapted from diversity measurement in theoretical biology quantified the amount of diversity in the interaction of student characteristics from student and teacher perspective. Related t

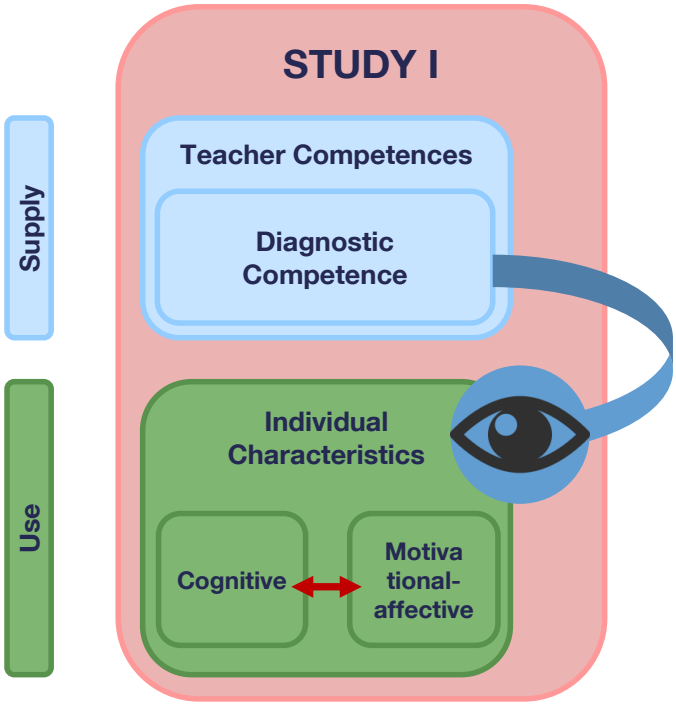

Figure 6.1: Framework for Study 1: Within-student characteristics diversity is regarded from a student perspective (red arrow) and a teacher perspective (blue eye)

tests allowed for statistical tests between both perspectives and between subjects. (c) Configural frequency analyses further examined the distribution of types of students with regard to their sets of characteristics from a student and a teacher point of view.

The following three research questions were studied:

6.1.1 Within-Student Characteristics Diversity

Research Question I. How much within-student diversity is found in the interplay of the four student characteristics?

Conjectures: Following variable-centered research on the relationship of the different student characteristics, the study suspected to find low to moderate positive connections between the different characteristics in the variable-centered approach (a). Considering those low connections on variable level, further person-centered analyses were conjectured to yield high within-student diversity (b) and few over-frequented types (meaning sets of characteristics that appeared more often than statistically expected) (c).

6.1.2 Teacher Perceptions of Within-Student Characteristics Diversity

Research Question II. How much within-student diversity do teachers perceive?

Conjectures: Regarding research on the possible biases in teacher judgment processes and in line with prior findings, the study expected teacher perceptions of the four characteristics to be tied moderately to closely (a). Diversity index comparisons were therefore expected to show significantly less diversity in teacher perceptions compared to student assessment (b) and possibly over-frequented homogeneous student types (meaning within-student characteristics are homogeneously judged as low/medium/high) (c).

6.1.3 Within-Student Characteristics Diversity – Student and Teacher Perspectives in Different Domains

Research Question III. Can within-student characteristics diversity be found differently in two subjects?

Conjectures: In alignment with previous findings regarding the comparison of both subjects, for the student perspective, the study expected a closer relationship of student characteristics in mathematics than in language arts (a) yielding higher measured diversity (b) and fewer or less homogeneous types for language arts (c). Regarding teacher perceptions, the study did not make conjectures for subject differences.

6.2 Method

6.2.1 Sample and Design

This study examined $N_S = 503$ eight-grade students from $N_C = 20$ classrooms of a high teaching track (German Gymnasium) and their $N_T = 41$ mathematics and German language arts teachers. All but three classrooms were coeducational with 51.2% female students. Students' mean age was 13.41 years ($SD = 0.61$). All classrooms were located in middle class urban and suburban areas of southern Germany (Mother's mean ISEI 55.75 ($SD = 19.63$), father's mean ISEI 60.48 ($SD = 20.74$)). The student families had, on average, a high educational background (76.4% of mothers completed at least upper secondary education, 60.0% attained tertiary education; 95.2% of fathers completed at least upper secondary education, 68.3% had tertiary educational degrees). The majority (67.3%) of students was born in Germany with no migration background (29.1% of students were second-generation immigrants, 3.6% were first-generation immigrants). Most students lived with two parents at home (86.6%).

The two groups of teacher participants, $n_{TM} = 20$ mathematics and $n_{TL} = 21$ German language arts teachers, have mean ages of 40.24 ($SD = 10.91$) and 40.70 years ($SD = 10.10$), and averages of teaching experience of 11.26 ($SD = 10.40$) and 11.42 years ($SD = 8.15$), respectively.

Data for the study was collected three months into the academic year of 2013/14 over a period of two weeks. Within this period, teachers and students were asked to answer questionnaires of the research team. Mathematics and language arts teachers also independently filled out teacher questionnaires on their perception of their students' characteristics and sent back their documents in separate, sealed envelopes. At this point of measurement, teachers and students had had three months of teaching and learning together on which their assessments are based. Teachers administered the

student questionnaires and were instructed to follow a strict routine that included a fixed testing time and privacy of students' answers. After assessment, one student of the classroom collected the student questionnaires in a sealed envelope that could not be checked by their teachers.

6.2.2 Instruments

Student questionnaires

The general cognitive ability of students was tested using a subscale of the Kognitiver Fähigkeitstest (KFT, cognitive ability test) (Heller & Perleth, 2000). The subscale comprised 25 items figure analogy item coded dichotomously (0 = incorrect, 1 = correct, $\alpha = .89$). Each item on this test starts with a pair of figures that are related in a specific way. The students are asked to choose a figure (from a sample of five figures) that fits to a third figure in the same way as the second fits to the first. On average, students correctly answered $M = 17.81$ of them correctly ($SD = 5.24$). This subscale was chosen instead of verbal and numerical subscales of the KFT to minimize subject bias for this measure.

Teachers provided the students' mathematics and German language arts grade from the previous school year as a measure of their prior achievement. In Germany, grades range from 1 (best grade) to 6 (worst grade). For this study, the grades were re-coded ranging from 0 to 5 with low values indicating low prior achievement and high values high prior achievement. In mathematics, the average prior achievement was $M = 2.87$ ($SD = 0.99$), in language arts it was $M = 3.00$ ($SD = 0.77$).

Students were administered four items on their interest for mathematics ($\alpha = .88, M = 2.20, SD = 0.78$) and three items on their interest for language arts ($\alpha = .82, M = 2.84, SD = 0.91$). Items were taken from the 2012 and 2009 questionnaires of the Program for International Student Assessment (PISA). An example item was: "I do mathematics because I enjoy it." (Range: 1 = strongly disagree to 4 = strongly agree Baumert et al., 1997). The students' self-concept regarding mathematics and language arts was collected using PISA scales of six items ($\alpha = .92, M = 2.47, SD = 0.84$) and five items ($\alpha = .82, M = 2.85, SD = 0.52$), respectively, from the 2012 and 2009 PISA questionnaires, for example "I learn things quickly in German class" (Range: 1 =

strongly disagree to 4 = strongly agree Marsh, 1990b; O'Neil & Herl, 1998).

Teacher questionnaires

Teachers were asked to rate each individual student's general cognitive ability, achievement, interest and self-concept regarding mathematics on a scale from 1 "low" to 3 "high". Mathematics teachers rated 26.9% of their students as "high" in general cognitive ability and 16.8% as "low". Their students' prior achievement was perceived "high" for 21.5% and "low" for 27.5% by mathematics teachers. For students' interest, mathematics teachers rated 27.7% as "high" and 20.9% as "low". Finally, teachers perceived students' self-concept regarding mathematics to be "high" for 21.7% and "low" for 20.3% of students. Language arts teachers rated 32.0% of their students to have "high" and 16.6% to have "low" general cognitive ability. For achievement, language arts teacher perceived it to be "high" for 22.6% and "low" for 22.2% of students. They rated their students' interest in language arts to be "high" for 30.9% of students and "low" for 23.7% and their student's self-concept regarding language arts to be "high" for 23.5% and "low" for 16.6% of students.

6.2.3 Statistical Analyses

Student characteristics data was recoded for its distribution to match that of teacher data to eliminate scale level effects in the analyses. For each characteristic, the top and bottom fourth of students were considered "high" and "low" in this characteristics, the remaining students received "medium" in this characteristic, the symmetrical distribution which made data most similar to the distribution of teacher perceptions. For each student, student assessment as well as teacher perception on student dispositions consisting of the four student characteristics was displayed as a four-dimensional vector, their diversity pattern, with a total of 81 possible patterns.

Interacting characteristics: A variable-centered approach

Pairwise multi-level regressions To account for the multi-level structure of the data (students within classrooms), multi-level linear regression analyses were performed with each pair of student characteristic variables (Lüdtke, 2009). Appropriate simple, multi-level random intercept, or multi-level random slope regression model were chosen

based on model fit. Since standardized scores were regarded, the results section reports γ values in a correlation-like table leaving full results to the appendix. Analyses were performed using the statistical software R (R Core Team, 2013) and the packages lme4 (Bates, Maechler, Bolker, & Walker S, 2014) and lmerTest (Kuznetsova, Brockhoff, & Christensen, 2015).

For each pair of student characteristics, the study compared model fits of the simple regression model

$$Y_i = \gamma_{00} + \gamma_{10} X_i + r_i, \tag{6.1}$$

with (X_i, Y_i) the pair of student characteristics and $Var(r_i) = \sigma^2$ for student i, the multi-level random intercept regression model

$$Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_{ij}, \tag{6.2}$$

$$\beta_{0j} = \gamma_{00} + u_{0j}, \tag{6.3}$$

$$\beta_{1j} = \gamma_{10}, \tag{6.4}$$

with (X_{ij}, Y_{ij}) the pair of student characteristics, $Var(r_{ij}) = \sigma^2$, and $Var(u_{0j}) = \tau_{00}$ for student i in classroom j, and the multi-level random slope regression model

$$Y_{ij} = \beta_{0j} + \beta_{1j} X_{ij} + r_{ij}, \tag{6.5}$$

$$\beta_{0j} = \gamma_{00} + u_{0j}, \tag{6.6}$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \tag{6.7}$$

with (X_{ij}, Y_{ij}) the pair of student characteristics, $Var(r_{ij}) = \sigma^2$, $Var(u_{0j}) = \tau_{00}$, $Var(u_{1j}) = \tau_{11}$, and $Cov(u_{1j}, u_{0j}) = \tau_{10}$ for student i in classroom j, to find the most appropriate model describing this relationship while considering the multi-level structure of this study's data wherever appropriate. Table A.1 in the appendix gives an overview over the comparative model fit and indicates which model was chosen for each pair. Full regression results of the chosen models are given in Table A.2 in the appendix. For simple regressions, the results section reports the fixed effects with standard error and significance of corresponding t tests as well as the model's results of the F test. For multi-level random intercept and random slope models, the table additionally provides variances of group and residual.

Measuring characteristics diversity: A person-centered approach

For each student, student assessment as well as teacher perception on the four student characteristics was displayed as a four-dimensional vector, their diversity pattern, with a total of 81 possible patterns.

Shannon-Wiener Diversity Index and Modified t Tests The Shannon-Wiener diversity index H is known to measure diversity, for instance, in biology, ecology, and forestry. It is computed as:

$$H = -\sum_{k=1}^{K} p_k \ln(p_k), \tag{6.8}$$

where p_k is the observed proportion of individuals with diversity pattern k and K is the number of total patterns present according to student assessment and teacher perceptions in either subject (Magurran, 2004). The diversity index increases when there are more different species and when they appear more equally distributed. Moreover, the measure of evenness, $J = H/H_{max}$, relating H to its theoretical maximum $H_{max} = ln(K)$, and connected measures were calculated to investigate these diversity patterns. Diversity indices were statistically compared between teachers and student and between mathematics and language arts using Hutcheson's student's t tests (Zar, 2013; Hutcheson, 1970) with the variance

$$var(H) = \frac{\sum_{k=1}^{K}(p_k ln(p_k))^2 - [\sum_{k=1}^{K} p_k ln(p_k)]^2}{N} + \frac{K-1}{2N^2}, \tag{6.9}$$

calculated for both diversity indices H_1 and H_2 to be compared, the test statistic

$$t = \frac{(H_1 - H_2)}{\sqrt{(var(H_1) + var(H_2))}}, \tag{6.10}$$

degrees of freedom

$$df = \frac{[var(H_1) + var(H_2)]^2}{\frac{var(H_1)^2}{N_1} + \frac{var(H_2)^2}{N_2}} \tag{6.11}$$

and the effect size

$$\Delta = |H_1 - H_2| \tag{6.12}$$

of this comparison. All calculations were performed in MS Excel and, where reliable implementation in R was available, results were verified there using the package vegan (Oksanen et al., 2015).

Configural Frequency Analysis Finally, this study compared the observed occurrences of patterns to the expected amounts via configural frequency analysis. Student characteristics patterns that appeared significantly more often than expected, so-called types, were identified for both, the student and the teacher perspective in both subjects. Types in configural frequency analysis can be identified employing local ξ^2 tests relating observed frequencies (n_o) to expected frequencies (n_e) that are based on marginal distributions of the single components of the pattern, in this study's case the single characteristics of the dispositions (von Eye et al., 2010):

$$\chi^2 = \frac{(n_o - n_e)^2}{n_e} \tag{6.13}$$

with $df = 1$. Observed frequencies of diversity patterns and their respective ranking order in configural frequency results based on local χ^2 tests are given in Table A.3 in the appendix. Configural frequency analyzes were performed in R's cfa package (Funke, Mair, von Eye, & Harloff, 2013).

6.3 Results

Exploring the two perspectives on the within-student diversity in characteristics, the study found high diversity from the student perspective and considerable differences between student and teacher perspectives in both subjects as well as small but noticeable differences between subjects.

6.3.1 Interacting Student Characteristics: Variable-Centered Results

An overview of standardized multi-level regression coefficients γ_{ij}^{DS} from pairwise regressions can be found in Table 6.1. Model comparisons resulted in a predominance of multi-level random intercept regression models. Model fit (Table A.1) and full modeling results including tests of significance (Table A.2) can be found in the appendix.

On the students' side, results showed predominantly weak connections between the four student characteristics for both subjects ranging from $\gamma_{GS}^{SL} = \gamma_{SG}^{SL} = 0.12$ to $\gamma_{AI}^{SM} = 0.34$ with only the connection of self-concept with achievement and interest in mathematics at a moderate to strong level ($0.50 \leq \gamma_{ij}^{SM} \leq 0.55$). In mathematics,

the relationship between general cognitive ability and achievement, i.e. the connection within the cognitive domain, was weak at $\gamma_{GA}^{SM} = \gamma_{AG}^{SM} = 0.23$. As opposed to this, relationships within the motivational-affective domain were the strongest over all pairs of characteristics in student assessment ($\gamma_{IS}^{SM} = 0.54, \gamma_{SI}^{SM} = 0.55$). For mathematics, connections between cognitive and motivational-affective domains ranged from a weak $\gamma_{GI}^{SM} = 0.21$ for general cognitive ability and interest to a strong $\gamma_{AS}^{SM} = 0.52$ for achievement and self-concept. For language arts, all pairwise connections were even weaker for student assessments. Overall, the connection within domains was weak for both, the cognitive and the motivational-affective domain ($\gamma_{GA}^{SL} = 0.18, \gamma_{AG}^{SL} = 0.18, \gamma_{IS}^{SL} = 0.18, \gamma_{SI}^{SL} = 0.18$). Additionally, across-domain relationships were also weak ranging from $\gamma_{GS}^{SL} = 0.12$ for general cognitive ability and self-concept to $\gamma_{AS}^{SL} = 0.32$ for achievement and self-concept.

Table 6.1: Relationship between cognitive and motivational-affective student characteristics regarding mathematics and language arts according to student assessment and teacher perception. Table shows standardized regression coefficients γ from pairwise multi-level random slope regressions.

	Mathematics				**Language Arts**			
	GCA	ACH	INT	SC	GCA	ACH	INT	SC
Student Assessment								
GCA	-	0.23***	0.21***	0.24***	-	0.18***	0.13**	0.12**
ACH	0.23***	-	0.34***	0.52***	0.18***	-	0.26***	0.32***
INT	0.21***	0.33***	-	0.54***	0.15*	0.26***	-	0.19***
SC	0.23***	0.50***	0.55***	-	0.12**	0.32***	0.18**	-
Teacher Perception								
GCA	-	0.71***	0.56***	0.51***	-	0.62***	0.43***	0.43***
ACH	0.68***	-	0.56***	0.54***	0.62***	-	0.57***	0.50***
INT	0.57***	0.58***	-	0.41***	0.42***	0.55***	-	0.46***
SC	0.48***	0.53***	0.39***	-	0.40***	0.48***	0.44***	-

Note: Cognitive domain: GCA: general cognitive ability, ACH: achievement; motivational-affective domain: INT: interest, SC: self-concept; * $p < .05$, ** $p < .01$, *** $p < .001$

From the teachers' perspectives, on the other hand, results revealed strong connections between student characteristics ranging between $\gamma_{SI}^{TM} = 0.39$ for self-concept and interest and $\gamma_{GA}^{TM} = 0.71$ for general cognitive ability and achievement, both in mathematics. For both subjects, connections within the cognitive domain were strongest ($\gamma_{GA}^{TM} = 0.71, \gamma_{AG}^{TM} = 0.68$, $\gamma_{GA}^{TL} = \gamma_{AG}^{TL} = 0.62$). In mathematics, connections within the motivational-affective domain were strong but the weakest ($\gamma_{IS}^{TM} = 0.41, \gamma_{SI}^{TM} = 0.39$). Regarding language arts, these were slightly stronger and at the same level as cross-domain connections ($0.40 \leq \gamma_{ij}^{TL} \leq 0.57$).

6.3.2 Measuring Diversity in the Interplay of Student Characteristics: Person-Centered Results

Measuring diversity: The Shannon-Wiener diversity index

The students' perspective showed that 59 different diversity patterns (73%) in mathematics and 74 (91%) in language arts of the $K_{max} = 81$ possible diversity patterns could be observed. Diversity index measures are given in Table 6.2. The Shannon-Wiener diversity index for student assessment was $H = 3.71$ with an evenness of $J = 0.91$ for mathematics and $H = 3.98$ ($J = 0.92$) for language arts. Teachers, on the other hand, perceived only 44 (52%) of the 81 diversity patterns in mathematics and 52 (64%) in language arts. The Shannon-Wiener diversity index was $H = 3.17$ ($J = 0.84$) for mathematics teachers and $H = 3.33$ ($J = 0.84$) for language arts teacher perceptions. When comparing student and teacher perspectives, t test results indicated that teachers perceived significantly less diversity than student assessment revealed in the interaction of student characteristics (mathematics: $t(884) = 8.32, p < .0001, \delta = 0.54$, language arts: $t(785) = 9.82, p < .0001, \delta = 0.65$).

The t test results for subject comparison indicated a significant difference in diversity between mathematics and language arts from a student's point of view (cf. Table 6.3, $t(905) = 4.88, p < .0001, \delta = 0.27$). Furthermore, between-subject comparison on the teachers' side also showed a significant difference between mathematics and language arts teachers ($t(884) = 2.24, p < .05, \delta = 0.16$).

Uncovering types: Frequency analysis of diversity patterns

Observed frequencies of diversity patterns from students and teacher perspectives are compared to their theoretical probability in Figure 6.2. More detail is given in Table A.3 of the appendix. From a student perspective, three diversity patterns where observed significantly more often than expected for mathematics instruction (cf. Table 6.4): Pattern 3333 ($n_o = 19, \xi^2 = 162.70, p < .0001$), the pattern of overall

Table 6.2: Diversity measures based on student assessment and teacher perception for mathematics and language arts.

	N	K	$\frac{K}{K_{max}}$	H	$J = \frac{H}{H_{max}}$	$Var(H)$
Student Assessment						
Mathematics	420	59	0.73	3.71	0.91	0.002
Language Arts	446	74	0.91	3.98	0.92	0.002
Teacher Perception						
Mathematics	472	44	0.54	3.17	0.84	0.003
Language Arts	459	52	0.64	3.33	0.84	0.003

Note: The number of measured / perceived diversity patterns K of $K_{max} = 81$ possible diversity patterns. Diversity index H is compared to its theoretical maximum in $J = H/H_{max}$.

Table 6.3: Diversity measure comparison between student assessment and teacher perception and between subjects in modified t tests.

	t	df	p
Student Assessment vs. Teacher Perception			
Mathematics	8.32	884	****
Language Arts	9.82	785	****
Mathematics vs. Language Arts			
Student Assessment	4.88	905	****
Teacher Perception	2.24	884	*

*Note: Significance levels are marked as follows * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$*

strong students who had high cognitive ability, high achievement, high interest, and high self-concept; Pattern 1111 ($n_o = 16, \xi^2 = 55.00, p < .0001$), overall weak students; and Pattern 2111 ($n_o = 22, \xi^2 = 54.42, p < .0001$). For language arts, no diversity pattern appeared significantly more often than expected on the students' side.

The teachers' perspective showed that mathematics teachers perceived four student diversity patterns significantly more frequently than expected: Patterns 3333 and 1111, the overall strong and the overall weak student ($n_o = 39, \xi^2 = 549.59, p < .0001$ and $n_o = 26, \xi^2 = 427.16, p < .0001$); Pattern 2222, students with overall medium student characteristics ($n_o = 98, \xi^2 = 107.63, p < .0001$); and Pattern 1121 ($n_o = 14, \xi^2 = 43.33, p < .001$). In language arts, teachers perceived only the homogeneous overall strong, weak and average student

Table 6.4: Types of student characteristic patterns in mathematics uncovered by configural frequency analysis.

	Types	n	$exp.(n+1)$	Q	χ^2	p
Student Assessment						
Mathematics	3 3 3 3	19	1.99	0.04	162.70	****
	1 1 1 1	16	3.38	0.03	55.00	****
	2 1 1 1	22	5.58	0.04	54.42	****
Language Arts			—no types—			
Teacher Perception						
Mathematics	3 3 3 3	39	2.55	0.07	549.59	****
	1 1 1 1	26	1.52	0.05	427.16	****
	2 2 2 2	98	36.40	0.12	107.63	****
	1 1 2 1	14	3.21	0.02	43.33	***
Language Arts	3 3 3 3	46	3.27	0.08	585.06	****
	1 1 1 1	19	1.21	0.03	292.31	****
	2 2 2 2	69	33.07	0.07	41.24	***

*Note: Significance levels of local χ^2 tests are marked as follows * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$*

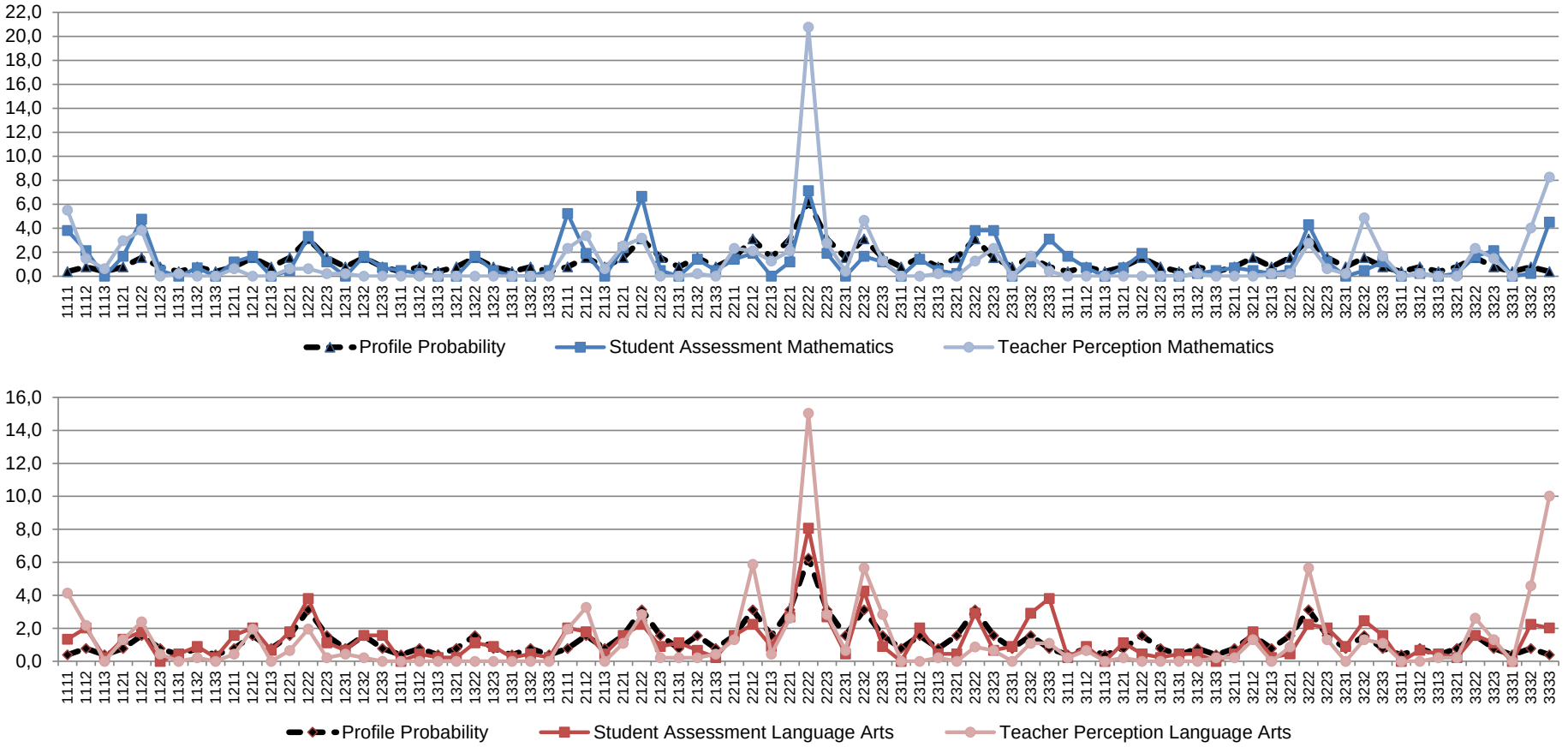

Figure 6.2: Frequencies of diversity patterns of student characteristics. Observed occurrences of 81 diversity patterns according to student assessment (solid dark, square) and teacher perception (solid light, circle) compared to each other and to theoretical profile probabilities (dashed black, diamond) for mathematics (blue, upper image) and language arts (red, lower image).

6.4 Discussion

In comparing students' and teachers' perspectives on the within-student interaction of different cognitive and motivational-affective characteristics, this study had four major findings: First, students' reports revealed high diversity in the way characteristics interacted. Second, teachers did not perceive the same extent of diversity in this interplay. Third, detailed finding on student characteristics diversity must be considered subject-specific. And fourth, the study's person-centered methodology allowed a new look onto this diversity.

6.4.1 The Diversity Within Students' Dispositions

First, looking from a student perspective, all three methodological approaches revealed considerable diversity in within-student characteristics. The medium to low pairwise variable associations agreed with other variable-centered studies finding medium to loose connections between several of the student characteristics (Marsh et al., 2005; Linnenbrink-Garcia et al., 2012). In more detail, with the exception of self-concept regarding mathematics, pairwise multi-level random slope regressions showed that student characteristics only seemed to be loosely tied according to student assessment ($0.18 \leq \gamma \leq 0.32$). Especially the weak connection within the cognitive domain, i.e. the relationship between general cognitive ability and prior achievement (mathematics $\gamma = 0.23$, language arts $\gamma = 0.18$), was noticeable and seemed to differ from other studies' findings of a strong predictive power of general cognitive ability on achievement ($0.61 \leq \gamma \leq 0.77$ for languages and mathematics; Deary et al., 2007). However, interpretations must consider that within this study's sample of high-track students, average cognitive ability was above age-group standard. Hence, on a high level, this strong predictive power seemed to abate. This notion should be kept in mind when considering the teachers' perspective. Overall, however, the agreement of this study's variable-centered approach with prior research makes its subsequent findings especially interesting: They reveal what low variable connections like these might mean for individual students.

Again from a student perspective, overall results from both person-centered approaches (the high diversity index and few dominant student patterns) supported

the notion of incoherences in the interplay of student characteristics. This was in line with this study's first hypothesis and with those findings indicating that cognitive and motivational-affective student characteristics do not have to be parallel (cf. Linnenbrink-Garcia et al., 2012; Seidel, 2006; Lau & Roeser, 2008). In more detail, diversity index results showed that there was a high variability of how cognitive ability, achievement, interest, and self-concept interacted for individual students. Up to 91% of the 81 possible configurations of the four characteristics existed (in language arts) and diversity indices for both subjects were in the top decile compared to their theoretical maximum ($0.91 \leq J \leq 0.92$). Beyond other person-centered studies' findings that groups of heterogeneous students exist alongside groups of more homogeneous students (Lau & Roeser, 2008; Seidel, 2006), the diversity index illustrated the large extent of diversity when not focusing on grouping students. Still, this study's findings agreed with this line of research in that many students exhibit incoherences in the interplay of their characteristics. This further highlights the significance of studying individual differences – and especially incoherences – within students' sets of characteristics. We need to get a better understanding of how they have developed and how this development is connected to student learning. Moreover, it is still unclear if and under which conditions incoherent profiles can be temporary phenomena. We need to know whether incoherences are due to developmental delays where certain characteristics are still forming while others are already fully developed. Considering Vygotsky's theory of proximal development (Vygotsky, 1978), future research ought to identify paths of development for different characteristics configurations guided by teacher scaffolding. Further research that tracks the development of student characteristics over several school years is needed to shed more light onto this issue. Furthermore, it would be enlightening to study students' perspective on student characteristics diversity in different educational settings. For this study, only students of one academic track (Gymnasium) were considered since cross-track level comparisons might have introduced bias in both, student assessment and teacher perception (Trautwein et al., 2006). Other educational settings with more heterogeneous placement might uncover even more characteristics diversity. It is remarkable, however, how much individual difference and diversity is already found within one track of theoretically more homogeneous students.

6.4.2 Teacher Perception of Within-Student Characteristics Diversity

This study's second finding was that teachers did not perceive the same amount of within-student diversity in the interaction of characteristics as found in student assessment. This was indicated by all three methodological approaches – highlighting different aspects. First, on a variable level, teachers in both subjects perceived predominantly strong connections between general cognitive ability, prior achievement, interest, and self-concept ($0.39 \leq \gamma \leq 0.71$). This was in line with this study's hypothesis and agreed with other studies' findings that teachers' perception of one student characteristic was influenced by their view of another (Urhahne et al., 2011; Kaiser et al., 2013) and the more general tendency to overgeneralize as described by the halo effect (Fiedler et al., 2002; Thorndike, 1920). Again, the person-centered methodology gave more detail on these findings.

The juxtaposition of the teacher and student perspectives was studied in depth – and by statistical comparisons. Diversity index comparisons found that teachers perceive significantly less diversity than student assessment data exhibited ($p < .0001$ for both subjects). The profound gap between these two perspectives has to be discussed since concepts such as individualized instruction and adaptive teaching build on the idea that teacher and student perceptions of learning characteristics align (Corno & Snow, 1986). This study's findings add weight to the conception that judgment of individual differences in the interplay of student characteristics is, indeed, difficult for teachers as research on the complexity of those judgment processes indicates (Fiedler et al., 2002). This means that addressing the difficulty of teacher judgment as a central theme in teacher education and professional development is crucial. As this study was one of the few regarding teacher perceptions on the within-student interaction of characteristics, the gap found between teacher and student perspectives especially calls for education and professional development to highlight possible incoherences of within-student characteristics interplay. In addition, in-depth discussion on the role of each single cognitive and motivational-affective student characteristics on learning might help teachers recognize and diagnose with more differentiation. Additionally, this study's findings reveal what other studies on teacher judgments have called for: Addressing

student background diversity and its connection to many possible biases in judgment in teacher education (Ready & Wright, 2011). Knowledge and beliefs of teachers on student characteristics and their interaction must be substantiated in educational programs. While this study did not directly assess teacher knowledge and beliefs, some of its findings gave hints to how ambiguous their role might be in perceiving the interaction of student characteristics. Variable connections within the cognitive domain were strongest for both groups of teachers ($0.62 \leq \gamma \leq 0.71$) which did not correspond to findings from student assessment ($0.18 \leq \gamma \leq 0.23$). Since the strong connection between general cognitive ability and achievement is also established in educational research (Deary et al., 2007, cf.), we might conjecture that teachers knew about this strong relationship. But without also factoring in knowledge of pseudocontingencies (Fiedler et al., 2007) and neglecting the special case of overall above average levels of general cognitive ability in the highest school track, this knowledge might mislead teachers' perceptions. Hence, it is the difficult job of teacher education and professional development to provide not only current research on the interplay of student characteristics, but also raise awareness for their limitations when applying to individual students as cases and discuss how they apply to teachers' practice.

This study's analyses also revealed that teachers predominantly perceived homogeneous types of student characteristics patterns: overall strong and overall weak students as well as an overall average type. Hence, teachers' internal categorization seemed to view many students as uniform within their dispositions – on different levels. Especially interesting is the predominance of the overall average student (over 20% of students were assigned to this pattern by mathematics teachers) which was not found to be over-frequented in student data for either subject. Its high recurrence in teacher perception seems to give first empirical substantiation to the general observation that in discourses about students "terms like 'normal,' 'typical,' and 'average' are abundant" (Perry & Winne, 2001). This study's findings show that this averaging of individual differences seems to not only happen for single characteristics between students but also for within-student characteristics. As a special form of overgeneralization, it would be interesting to consider contextual factors next as critical research on the halo effect suggests (Murphy, Jako, & Anhalt, 1993). An interesting step would be to study how teachers interact with those different groups of students – and with the students whose

characteristics they perceive more distinctly.

Further research is also needed in linking the established approach of teacher perception accuracy to the concept of diversity perception introduced in this study: Are teachers who perceive less diversity in the patterns of their students' characteristics also less accurate in their judgment of all single characteristics? Or do they accurately judge one characteristics, like prior achievement, and generalize this perception to others, like interest or cognitive ability (Urhahne et al., 2011; Kaiser et al., 2013)? Furthermore, large variations in meta-analysis studies indicate that teachers vary in their ability to accurately assess single student characteristics (Südkamp et al., 2012). Hence, further research must also examine the variance in teachers' diversity perception and study its conditions. For example, do expert teachers perceive more diversity than novice teachers? Furthermore, studies must regard the consequences of potential differences in teacher diversity perception. Teacher expectations are long known to influence how teachers interact with their students in the classroom (Brophy & Good, 1970). Since diversity indices provide are a way to quantify teacher's perception of their body of students, further research ought to explore the link between variation in diversity perception and classroom activities. Do teachers who perceive more diversity also engage more students or students more equally in classroom discussions? Do they use a wider range of different activities? Both of which are seen as aspects in adaptive teaching (Corno, 2008). On the other hand, which in-class situations shape teacher perceptions? One of the most interesting directions in this line of further research is the look for proximal indicators that might trigger teacher judgments, such as student behavior and teacher-student interactions. Research has identified that classroom activities play an important role in teacher judgments (Kaiser et al., 2013; Martínez, Stecher, & Borko, 2009). First studies have considered this issue using innovative measurement methods, such as eye-tracking (van den Bogert et al., 2014). They found that it takes experience for teachers to be able to attend to all students' input and behavior in class. Correspondingly, research finds, that especially novice teachers struggle when having to attend to complex and dynamic visual stimuli (Jarodzka, Scheiter, Gerjets, & van Gog, 2010). These findings provide first insights into aspects of the judgment process of teachers. Yet, more research needs to be done.

6.4.3 Domain-Specificity in Within-Student Characteristics Diversity and Teacher Perceptions

This study's third finding supported the idea of subject-specificity of student characteristics diversity. While main findings are similar for the two different subjects, the study also uncovered important differences. First, it found overall weaker connections between characteristics, significantly more diversity, and no dominant student pattern types when regarding student assessment in language arts. On a variable level, this was in line with this study's hypotheses and other studies' findings of a closer tie between characteristics for mathematics compared to language arts (Deary et al., 2007; Schiefele et al., 1992; Marsh & Craven, 2006). However, it was remarkable that the study was able to show that differences in diversity where statistically highly significant ($p < .0001$). A possible conjecture would be the role of a broader scope of language arts as a subject (Lapp & Fisher, 2011) where interest or self-concept of students might vary depending on the aspects considered. Another difference was self-concept regarding mathematics, which was the one exception to the otherwise loose connections of student characteristics ($0.50 \leq \gamma \leq 0.55$ to achievement and interest). These strong connections were not the case for language arts ($0.12 \leq \gamma \leq 0.32$). Even though subject differences are known (Marsh & Craven, 2006), such clear between-subject differences call for more subject-specific research. Furthermore, the lack of over-frequented diversity patterns in language arts affirms that here, student characteristics diversity was higher in the extremes. An awareness of this can be a challenge and a chance for language arts teachers.

Overall, teacher data did not show subject differences as clearly. This encourages the understanding of the complex interplay in teacher judgment decisions regarding student characteristics diversity being not (as) subject-specific. A reason for this might lie in frame of reference effects. While teachers see many students in one subject, students see themselves in many subjects. This might lead to incoherences in the interplay of student characteristics that teachers do not see. Research has found that these frame of reference issues can lead to bias in students' self-judgment (Marsh, 1986). Future research should identify if this bias plays a role in within-student characteristics diversity. Regarding the gender-specific connotation of the two respective subjects

(Hannover & Kessels, 2004), a possible gender effect in teacher perceptions and student's self-perceptions seems possible. Hence, further research studying the role of gender in the interplay of student characteristics could provide additional insights.

6.4.4 Person-Centered Methodology in Educational Research

Finally, reflecting on the methodology of this study which considered the interplay of student characteristics in a novel way, its findings did not only largely support current research, but uncovered important additional aspects of students' and teachers' perspective on the within-student interaction of characteristics. Complementing the analysis of student characteristics interaction on a variable level (e.g. Marsh et al., 2005), this study's person-centered approaches uncovered what is behind loose pairwise connections. Configural frequency analyses identified which configurations where dominant despite overall low associations (e.g. the overall strong and weak students in mathematics). This can help researchers to understand the variable connections better and to identify groups of students interesting for further investigation. With a greater number of participants, configural frequency analyses could uncover anti-types, patterns that occur less frequently than expected, enhancing our understanding even further. This study's approach also complemented research grouping students (e.g. Seidel, 2006), since it uncovered the entire diversity in interacting characteristics. The study's methodological expedition to diversity measurement of other disciplines yielded a methodological advance for educational science. The study was able to measure the amount of diversity with regard to a set of characteristics in a student population. This provides educational researchers with a new methodological tool to examine and account for student characteristics diversity. Foremost, using diversity index comparisons allows for statistically sound comparisons of diversity in different settings, populations, or perspectives. Furthermore, apart from student diversity indicators that focus on student background information, diversity indices can give other important context information when studying differences between groups of students. Overall, this study showed that educational research must look beyond variable-centered methodology when regarding student characteristics diversity. After all, it is research's task to provide empirical evidence for the individual differences in students that teachers face in their teaching in order to aid in striving towards individual learning success.

Chapter 7

Study II: Students with Incoherent Dispositions: Development Over a School Year and Its Connection to Internal Learning Processes

Study I of this dissertation found out more about how different students can be with regards to their learning dispositions. Its findings endorsed and added to studies like Seidel (2006), Lau & Roeser (2008), and Linnenbrink-Garcia et al. (2012), which found that incoherences are common in the interplay of cognitive and motivational-affective characteristics. All of these findings, however, are only a small step towards empirically exploring Shuell (1996)'s concept that general principles of teaching and learning "operate in substantially different ways with different students." We still do not know if these incoherences in students' dispositions are temporary phenomena. Research has shown that single characteristics develop over time (e.g. Renninger, 1992) and we also see that different cognitive and motivational-affective characteristics affect each other over time (Marsh & Craven, 2006; Köller & Baumert, 2001). Therefore, this dissertation conjectures development in these dispositions. However, focusing on individual differences again, the thesis is interested in exploring the differences in this development. This is where this second study enters. It investigates the development of the self-underestimating student, a specific incoherent student disposition that exhibits

high cognitive abilities and low motivational-affective characteristics and was found in Seidel (2006). Via latent-class analysis, the study examines into which groups students who were characterizes as self-underestimating at the beginning of the school year can be separated at the end of the school year. Therewith, the study aims at the connection between *Individual Characteristics* and *Learning Outcomes* in the framework model depicted in Figure 7.1 for this study.

Subsequently, this study digs deaper into the ways in which general principles of teaching and learning operate differently with different students. Research on competences and characteristics, the concepts merged in this thesis' understanding of student dispositions, highlight that they are affected by students' learning (e.g. McClelland, 1973; Renninger, Hidi, & Krapp, 1992). At the same time, research on different motivational and cognitive learning activities and teaching targeting these learning activities have examined their effect on different components of students' dispositions (Diseth et al., 2012; Baumert et al., 2010). However, as described above, this connection is only regarded on average over students. Hence, Study II adds an individual viewpoint to these findings by examining which cognitive and motivational-affective learning activities are connected to the different groups of development of self-underestimating students. With this consideration, the dissertation framework's *Individual Learning Activities* block (see Figure 7.1) is incorporated into the connection of *Individual Characteristics* and *Learning Outcomes*.

7.1 Research Questions and Conjectures

This study investigates the development of self-underestimating students' characteristics and its connection to their internal learning processes in physics instruction. This study attempts to answer the following research questions:

7.1.1 Development of Self-Underestimating Students

Research Question I. How do self-underestimating students develop over the course of one academic year?

Conjectures: As the self-underestimating group of students is defined especially by two characteristics, high knowledge and low self-concept, that are heavily interdependent,

the study expects three possibilities for development of this group: First, a group that does not change remarkably with respect to their combination of those characteristics. They gain knowledge over the school year solely due to their high prior knowledge without adjusting their self-concept. Second, the study expects a group that develops their self-concept over the school year to match their high cognitive abilities. Third, the study presumes to find a group that suffers cognitively and fails to considerably advance in their knowledge due to their low self-concept. Regarding the distribution of self-underestimating students among those three groups and the amount of motivational increase or cognitive decline of the respective groups, the study cannot make any assumptions based on the theory.

7.1.2 Internal Learning Processes Connected to This Development

Research Question II. Which internal learning processes of students in physics instruction are connected with self-underestimating students' development?

Conjectures: As measures of internal learning are connected with both, cognitive and motivational-affective development, the study expects the development of the cognitive and motivational-affective components of students' dispositions to be connected

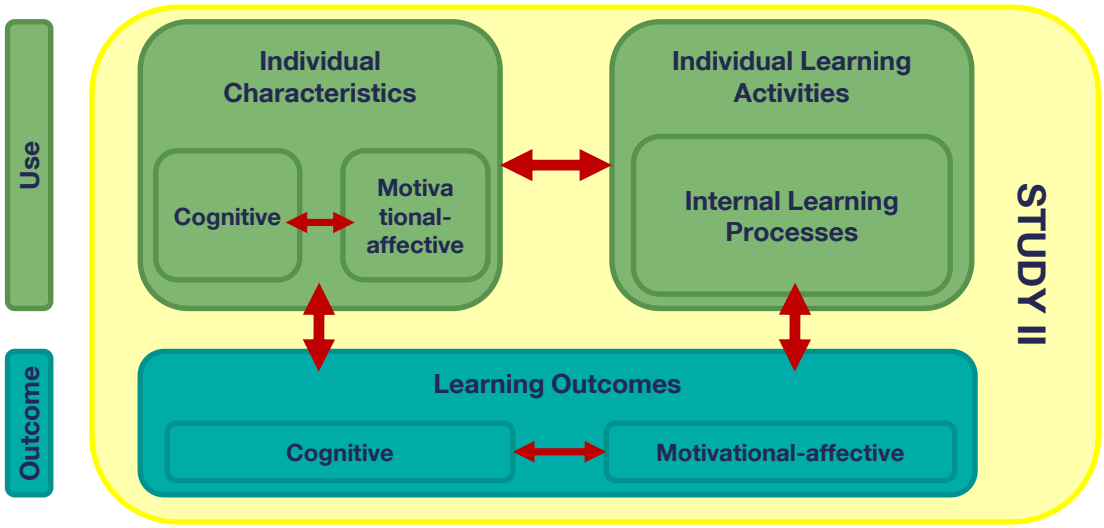

Figure 7.1: Framework for Study 2: Development of specific student disposition – from individual set of characteristics to set of learning outcomes and its connection to individual learning activities (specifically internal learning processes)

with those learning processes. In particular, the group that is to advance their knowledge and positively develop their motivational-affective characteristics, especially their self-concept is expected to have higher ratings for all internal learning processes. Especially their levels of intrinsic motivation and support of autonomy and social relatedness are expected to be higher for this group as they play a crucial role for motivational development. Furthermore, the group that falls behind cognitively and retains their low self-concept is expected to report the lowest level for all internal learning processes. This study expects especially their level of cognitive learning activity to be lower than the other groups' as they do not develop cognitively. The group that, after the school year, still has high knowledge but a low self-concept is expected to report lower internal learning processes than the first group, but higher than the second.

7.2 Method

7.2.1 Sample and Design

In the present study, student questionnaire and test data of the IPN Video Study in Physics instruction are analyzed (for details see Seidel, Prenzel, & Kobarg 2005. The study's focus group of self-underestimating students included $N = 360$ students (29%) of a randomly selected sample of $N_C = 50$ ninth grade physics classrooms of highest and intermediate secondary school level with a total of $N_T = 1235$ students (49% girls, 51% boys).

Additionally, as two meaningful reference groups of the Seidel (2006) study, the study considers the students that were classified in the overall favorable student profile at the beginning of the school year, the *strong* students (24% of all students), and the the *struggling* students (23%), with low values for all four cognitive and motivational–affective characteristics, in appropriate analyses.

All students were tested and asked about their content pre-knowledge, interest, and self-concept of ability at the beginning (Measurement Point (MP) 1) and the end (MP 3) of the school year. Between these measurement points, four months after MP 1, students were asked about their internal learning processes after a 90-min physics lesson that was also videotaped for the study. As Praetorius, Pauli, Reusser, Rakoczy, & Klieme (2014) highlight, measures related to individual student support can be reliably

measured by a single measurement point. After the lesson, all students were also tested on their general cognitive abilities (MP 2).

7.2.2 Instruments

All instruments used in the video study are described in depth by Seidel et al. (2005). This study is focused on student characteristics and internal learning processes. The relevant instruments are described in the following.

Student characteristics

Student profiles were identified according to four characteristics (Seidel, 2006). Cognitive characteristics comprised general cognitive abilities and the content pre-knowledge in physics. Motivational–affective characteristics included interest and self-concept of ability in physics.

To assess cognitive ability, a subtest on reasoning of the cognitive ability test (Heller & Perleth, 2000). The items were coded dichotomously (0 = incorrect, 1 = correct; $M = 0.75, SD = 0.10, \alpha = 0.84$). As general cognitive ability was assumed not to vary profoundly over one school year, it was only measured once, at MP 2. Physics knowledge was assessed with a selection of 33 standardized national and international test items from various sources including the Trends in International Mathematics and Science Study (TIMSS; Baumert et al., 1998) adapted for the IPN Video Study (for details see (Seidel et al., 2005), e.g. "When scientists measure any quantity accurately several times, they expect that..." with four answering options of which one was correct. The items were coded dichotomously (0= incorrect, 1= correct; $M = 0.36, SD = 0.12, \alpha = 0.67$)

The scale for students' free-time interest (Hoffmann et al., 1998) consisted of five items rated on a five-point Likert scale (from 1= never to 5= very often; $M = 2.32, SD = 0.74, \alpha = 0.77$) including e.g. "I read books that treat physic-related topics." Furthermore, the students self-concept regarding physics was measured by a scale developed for the video study including four items scored on a four-point Likert scale (Hoffmann et al., 1997, with the categories from 1= absolutely not correct to 4= absolutely correct; $M = 2.60, SD = 0.69, \alpha = 0.86$;), like, for instance, "I have a talent for physics."

Students' internal learning processes

All scales on students' internal learning processes referred to the videotaped lesson ("During the past lesson..."). The fulfillment of basic psychological needs was measured by five items on perceived social relatedness ($\alpha = .67$) including, e.g. "...I had the feeling that I am important to the teacher," four items on the perceived support of competence ($\alpha = .65$) including, e.g. "...the teacher was confident that we could understand the experiments," and four items on perceived support of autonomy ($\alpha = .65$) including, e.g. "...the teacher was open for different student answers" (Prenzel, Kristen, Dengler, Ettle, & Beer, 1996, in accordance with) all rated on a four-point Likert Scale (from 1 = I do not agree to 4 = I do agree). Intrinsic learning motivation in the lesson was measured by an adapted scale for the video study (Prenzel et al., 1996, in accordance with) consisting of three items rated on a four-point Likert Scale (from 1 = I do not agree to 4 = I do agree; $\alpha = .87$) including, for instance, "...I thought the covered contents were really exciting." Basic cognitive learning activity of students were measured by a scale developed for the video study (in accordance with Seidel 2003). The scale included by four items rated on a four-point Likert Scale (from 1 = I do not agree to 4 = I do agree; $\alpha = .81$) including item endings like "...I was able to follow the lesson well."

7.2.3 Statistical Analyses

Profiles identified by Seidel (2006) for students at the beginning of the school year were replicated via latent class analysis using the software Mplus (L. K. Muthén & Muthén, 2010). This analysis operated on items of the instruments measuring the four student characteristics. For each characteristic, items were bundled according to their relative position (first, fourth, eighth, etc.) in the instrument. For general cognitive ability and content knowledge, four bundles of four to six items per characteristic were generated. Interest and self-concept of ability items were each represented in two bundles. Strong, struggling, and self-underestimating profiles served as reference groups for self-underestimator development. For the first research question, data of self-underestimating students was analyzed building latent classes at the end of the school year. The latent class analysis was performed analog to the analysis at the

beginning of the school year using the software Mplus (L. K. Muthén & Muthén, 2010), but regarding measurements at the end of the school year. The optimal class solution in both latent class analyses was chosen based on consideration of the Bayesian and the Akaike information criterion. The development of characteristics was tested for significant changes of the school year by paired sample t tests and the differences in the level of each characteristic at the end of the school year for the development groups by independent sample t tests in SPSS version 22. For significant results, Cohen's d was given as an effect size.

To answer the second research question, data on students' internal learning processes was compared using nested (multi-level) analysis of variance (nested ANOVA) performed in R (R Core Team, 2013). This mode of analysis was chosen as the focus of analysis was investigating group differences. Moreover, the interplay of variables could be better taken into account than in the alternative, regression analyses. Furthermore, the nested (multi-level) structure of the data was taken into account including the interaction of grouping and school membership of students in the model. For all variables considered, means differed significantly between schools. However, the interaction effect of school and development group was not significant. Hence, these findings are not reported in detail. Due to the structure of the ANOVA model, partial eta-squared (η_p^2) values are reported for effect sizes (cf. Pierce, Block, & Aguinis, 2004). Additionally, for the comparison of one development group to the rest of students, Cohen's d is provided for selected variables.

7.3 Results

7.3.1 Self-Underestimator Development Groups

The latent class analysis for student characteristics data of self-underestimating students measured at the end of the school year revealed a tripartite development. One group of self-underestimating students showed an improvement over the academic year by evolving especially their self-concept dramatically and staying advanced in their level of knowledge, one group remained self-underestimating with high knowledge but a low self-concept, and the third group exhibited a declining development of characteristics by not only maintaining their low self-concept but also forfeiting their knowledge advance.

Of the $N = 360$ students, $n_L = 349$ were assigned to a class membership (97%). To answer the first research question, this section reports each group's size and development of characteristics. Afterwards, it regards the differences between the three groups at the beginning and at the end of the school year. Table 7.1 as well as Figure 7.2 corresponds to these results.

The first group was characterized by a considerable increase in physics knowledge of twelve percentage points from 0.44 to 0.56, $t(85) = 9.56, p < .001, d = 1.11$. Furthermore, interest of this group increased by 0.20 from 2.18 to 2.38, $t(85) = 3.42, p = .001, d = 0.31$. The most outstanding development, self-concept of physics ability of this group rose by 0.59 from 2.44 to 3.03, $t(85) = 11.03, p < .001, d = 1.67$. This group of *improving self-underestimators*, consisting of 26% of the self-underestimators ($n_I = 91$), had, on average, a level of cognitive ability, physics knowledge, interest, and self-concept that was not significantly different from an average strong student at the end of the school year ($p > .05$ for all comparisons). In conclusion, the improving self-underestimator exhibited overall similar characteristics to a strong student at the end of the school year.

The second student group also gained physics knowledge over the school year with an average score on the knowledge test also rising by 12% from 0.43 to 0.55, $t(121) = 13.16, p < .001, d = 1.35$. However, the motivational-affective features of this group of students differed considerably from the first group. The interest for physics of this group of students declined by 0.11 from 1.92 to 1.81, $t(121) = 1.87, p = .06, n.s.$. Moreover, the self-concept of physics ability remained unchanged and low (2.16 to 2.12), $t(121) = 0.68, p = .50, n.s.$. Hence, this group was labeled *remaining self-underestimators* as their knowledge at the end of the school year was still as high as the strong students, however, their self-concept does not match their high cognitive characteristics. 41% of the self-underestimators were in this development group ($n_R = 144$). It was, thus, the largest of the three development groups.

Finally, the third group of self-underestimating students developed yet differently. Their motivational-affective characteristics did not change considerably over the school year (interest: $t(99) = 1.28, p = .20, n.s.$, self-concept: $t(99) = 0.90, p = .37, n.s.$). The defining characteristic of this group of development was the development of physics

knowledge. The average knowledge level of this group of students remained unchanged over the school year at 0.37, $t(99) = 0.70, p = .49, n.s.$. This stagnation meant that these students had not gained considerable knowledge on physics over the entire year of learning while an average student had gained ten percent points in the knowledge test over the school year. The level of knowledge, interest, and self-concept of this group was now at a similar level as the one of struggling students at the end of the school year ($p > .05$ for all comparisons). Thus, these *declining self-underestimators*, who made up 33% of students who were characterized as self-underestimating at the beginning of the school year ($n_D = 114$), did not show overall strong cognitive characteristics anymore, but resembled struggling students in many ways.

A comparison of the characteristics of these three groups at the beginning of the school year was made to examine whether the tripartite structure has been prevalent at the beginning of the school year. The latent class analysis of self-underestimating student characteristics at the beginning of the school year was performed to uncover differences in this group of students at this point in time. This, however, was not the case. Two classes were differentiated at MP 1 differing only in their level of interest. They were equally distributed over all three classes found at MP 3 and were thus, not connected to the development of the three groups. The comparison of the three characteristics of the three groups at the beginning of the school year, however, uncovered differences as depicted on the left side of Figure 7.2. Independent-sample t-tests verified their significance. Improving self-underestimators and remaining self-underestimators already differed in their interest ($M_I = 2.18$ vs. $M_R = 1.94$; $t(227) = 2.84, p = .005, d = 0.39$) and self-concept ($M_I = 2.44$ vs. $M_R = 2.15$; $t(205) = 5.38, p < .001, d = 0.70$). Improving self-underestimators and declining self-underestimators showed differences in cognitive ability ($M_I = 0.86$ vs. $M_D = 0.79$; $t(190) = 5.04, p < .001, d = 0.73$), pre-knowledge ($M_I = 0.44$ vs. $M_D = 0.37$; $t(160) = 5.24, p < .001, d = 0.78$), and self-concept ($M_I = 2.44$ vs. $M_D = 2.10$; $t(193) = 6.02, p < .001, d = 0.85$). Remaining self-underestimators were unlike declining self-underestimators regarding cognitive ability ($M_R = 0.85$ vs. $M_D = 0.79$; $t(239) = 5.56, p < .001, d = 0.70$), pre-knowledge ($M_R = 0.43$ vs. $M_D = 0.37$; $t(244) = 5.71, p < .001, d = 0.71$), and interest ($M_R = 1.94$ vs. $M_D = 2.14$; $t(243) = 2.69, p = .008, d = 0.34$). As the left side of Figure 7.2 depicts, the three groups were nevertheless rather similar in their characteristics.

Table 7.1: Student characteristics at the beginning and the end of the school year of three self-underestimator development groups uncovered by latent class analysis at the end of the school year (values of reference groups included for reference only)

			Beginning of school year (MP 1)								**End of school year (MP 3)**					
			Cognitive ability		Physics knowledge		Interest		Self-concept		Physics knowledge		Interest		Self-concept	
			M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)	M	(SD)
Self-underestimator development groups identified at the end of the school year																
Improving self-underestimators	26%	91	.86	(.10)	.44	(.10)	2.18	(.62)	2.44	(.37)	.56 ***	(.12)	2.38 **	(.68)	3.03 ***	(.32)
Remaining self-underestimators	41%	144	.85	(.10)	.43	(.09)	1.94	(.64)	2.15	(.45)	.55 ***	(.09)	1.81 **	(.57)	2.12	(.43)
Declining self-underestimators	33%	114	.79	(.08)	.37	(.08)	2.14	(.59)	2.10	(.44)	.36	(.07)	2.07	(.70)	2.15	(.52)
All students																
Total		1222	.74	(.20)	.37	(.12)	2.24	(.73)	2.50	(.69)	.45	(.15)	2.19	(.77)	2.51	(.68)
reference groups identified at the beginning of the school year																
Self-under-estimating	29%	360	.83	(.10)	.41	(.09)	2.06	(.63)	2.20	(.46)	.49	(.13)	2.05	(.68)	2.39	(.59)
Strong	24%	295	.88	(.08)	.46	(.10)	2.69	(.75)	3.26	(.38)	.55	(.14)	2.52	(.75)	3.03	(.60)
Struggling	23%	280	.52	(.17)	.28	(.09)	1.96	(.63)	1.96	(.46)	.35	(.12)	1.97	(.76)	2.11	(.56)

Note: All students assigned to groups at MP 1: $n_{TL} = 1222$; all self-underestimating students assigned to groups at MP 3: $n_L = 349$; Significant changes in student characteristics for the self-underestimator development groups indicated by * $p < .05$, ** $p < .01$, *** $p < .001$ (this value at the end of the school year (MP 3) significantly differs from the value at the beginning of the school year (MP 1)).

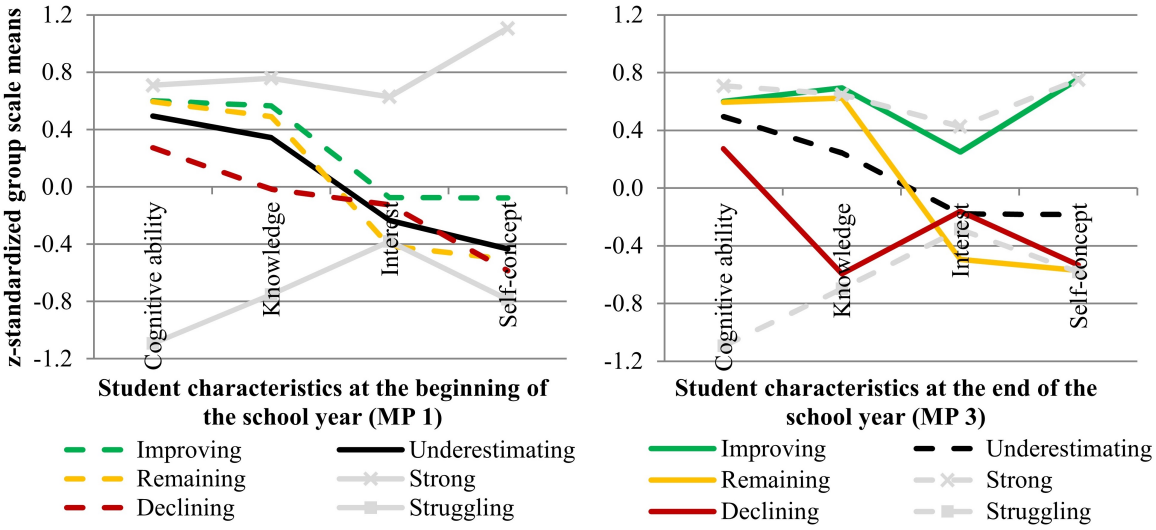

Figure 7.2: Student characteristics (z-standardized group scale means) of the three self-underestimator development groups at the beginning of the school year (MP 1) and the end of the school year (MP 3). The self-underestimator development groups detected by latent class analysis at the end of the school year are shown in green, yellow, and red. For reference, values of reference groups (detected by latent class analysis at the beginning of the school year) are added as grey and black lines. Lines are solid for the point in time where the grouping is determined and dashed for the respective other measurement point. All students assigned to groups at MP 1: $n_{TL} = 1222$; self-underestimating students assigned to development groups at MP 3: $n_L = 349$.

After a school year, the three groups differed considerably. This can be seen on the right side of Figure 7.2. Independent-sample t-tests verified this in effect size and significance. At the end of the school year, improving self-underestimators had a higher interest ($M_I = 2.38$ vs. $M_R = 1.81$; $t(209) = 6.59, p < .001, d = 0.92$) and, even more clearly, a higher self-concept ($M_I = 3.03$ vs. $M_R = 2.12$; $t(208) = 17.66, p < .001, d = 2.35$) than remaining self-underestimators. Furthermore, improving self-underestimators had much higher physics knowledge ($M_I = 0.56$ vs. $M_D = 0.36$; $t(133) = 14.00, p < .001, d = 2.12$), higher interest ($M_I = 2.38$ vs. $M_D = 2.07$; $t(189) = 3.13, p = .002, d = 0.45$), and a much higher self-concept ($M_I = 3.03$ vs. $M_D = 2.15$; $t(173) = 14.35, p < .001, d = 2.01$) than declining self-underestimators. Finally, remaining self-underestimators had a considerably higher level of knowledge ($M_R = 0.55$ vs. $M_D = 0.36$; $t(219) = 17.54, p < .001, d = 2.28$), a slightly lower interest ($M_R = 1.81$ vs. $M_D = 2.07$; $t(196) = 2.96, p = .004, d = 0.40$) than declining self-underestimators, but showed no significant differences in their respective self-concepts ($M_R = 2.12$ vs. $M_D = 2.15$; $t(224) = 0.42, p = .68, n.s.$).

7.3.2 Students' Internal Learning Processes

An overview of group differences in the internal learning processes is given in Table 7.2. Considerable differences between the three development groups of self-underestimating students were evident in the perception of their fulfillment of basic psychological needs. First, concerning social relatedness, the three groups differed significantly, $F(2, 205) = 9.25, p < .001, \eta_p^2 = .08$. Post-hoc comparisons revealed that the improving group felt significantly more socially related than the remaining ($p < .001$) and the declining self-underestimating students ($p = .004$) who were not significantly different from each other ($p = .70, n.s.$). Support of competence was also rated differently by the three development groups, $F(2, 202) = 4.84, p = .009, \eta_p^2 = .05$. Post-hoc comparisons exposed that improving self-underestimators perceived significantly more support of competence than the remaining development group ($p = .006$). An even clearer picture was found when investigating the significant difference between development groups in their perceived support of autonomy, $F(2, 200) = 15.48, p < .001, \eta_p^2 = .13$. It was the remaining student group that reported significantly lower values than the two other groups (both $p < .001$). In comparison with all other students, the improving self-underestimators rated their support of autonomy significantly higher, $F(1, 1014) = 4.18, p = .04, \eta_p^2 = .00, d = 0.21$ whereas this tendency was not significant for declining students, $F(1, 1009) = 2.39, p = .12 (n.s.)$.

The three development groups of self-underestimating students differed in their experience of intrinsic motivation, $F(2, 205) = 18.26, p < .001, \eta_p^2 = .15$. Tukey's HSD post-hoc comparisons showed that the improving group of self-underestimating students experienced significantly higher levels of intrinsic motivation than the other two development groups (both $p < .001$) who were not significantly different from each other ($p = .56, n.s.$).

The reported cognitive learning activity of the three development groups differed considerably, $F(2, 205) = 11.26, p < .001, \eta_p^2 = .10$. Post-hoc comparisons using the Tukey HSD test indicated that the group of improving self-underestimators reported noticeably higher levels than remaining and declining self-underestimators ($p < .001$ for both comparisons), who did not differ significantly from each other ($p = .45, n.s.$). Still, when comparing development groups to all other students, it turned out that declining

self-underestimators reported significantly lower cognitive learning activity than the average student, $F(1, 1030) = 8.94, p = .003, \eta_p^2 = .03, d = 0.21$, while remaining students did not, $F(1, 1030) = 2.79, p = .09 (n.s.)$. For all analyses, interaction effects of school and development group were not significant.

Table 7.2: Internal learning processes of three self-underestimator development groups (values of all students and reference groups included for reference only)

	Self-underestimator development groups (SUDG) identified at the end of the school year								**Reference groups identified at the beginning of the school year**					
	Impr SUDG		Rem SUDG		Decl SUDG		All students		Self-under.		Strong		Strugg-ling	
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
Perceived social relatedness ***	**3.08**	(.52)	**2.78**	(.60)	**2.84**	(.60)	2.93	(.60)	2.88	(.59)	3.05	(.60)	2.84	(.63)
Perceived support of competence **	**3.46**	(.48)	**3.26**	(.51)	**3.34**	(.49)	3.38	(.52)	3.34	(.50)	3.43	(.45)	3.30	(.59)
Perceived support of autonomy ***	**3.18**	(.51)	**2.82**	(.64)	**3.14**	(.61)	3.06	(.64)	3.01	(.62)	3.05	(.63)	3.07	(.65)
Intrinsic motivation ***	**2.64**	(.81)	**2.07**	(.78)	**2.17**	(.76)	2.35	(.86)	2.25	(.82)	2.61	(.85)	2.07	(.83)
Basic elaborations ***	**3.36**	(.47)	**3.12**	(.55)	**3.04**	(.54)	3.19	(.56)	3.16	(.54)	3.41	(.48)	2.93	(.56)

Note: All students assigned to groups at MP 1: $n_{TL} = 1222$; all self-underestimating students assigned to groups at MP 3: $n_L = 349$; Significant differences: * $p < .05$, ** $p < .01$, *** $p < .001$ (values for this variable differ significantly between self-underestimator development groups (improving, remaining, declining); post-hoc test results, test statistics and significance levels of the nested ANOVAs are given in the results section.).

7.4 Discussion

This study investigated the development of self-underestimating students. The first research question was concerned with the change in their student characteristics, especially their physics knowledge and their self-concept. The study's hypotheses supposed one group with an increase in self-concept along with a remaining high level of content knowledge, a group of students that maintained both, high knowledge and low self-concept, as well as a group with a drop in relative knowledge along with a remaining low self-concept. The second research question covered a possible connection of these development paths with internal learning processes. Hypotheses suggested overall higher internal learning processes for students with a positive development of knowledge level and self-concept, lower internal learning processes for students that did not improve their self-concept and, additionally lose their knowledge advance (especially regarding cognitive learning activity), and a medium level of internal learning processes for the group that kept knowledge advance and low self-concept.

Overall, the hypotheses connected with the first research question about the possible groups of development of self-underestimating students were supported by this study's findings. The latent class analysis uncovered a tripartite development of the characteristics profile of students who were at risk of underestimating their abilities at the beginning of the school year. As hypothesized, one group showed a noteworthy development of motivational-affective characteristics, especially of the self-concept of ability, while maintaining a comparatively high level of physics knowledge. Furthermore, one group remained self-underestimating and one group forfeited their cognitive advantage and did not gain physics knowledge over the entire school year retaining their low self-concept.

Concerning the research questions on differences in internal learning processes, the results of this study support the study's hypotheses in parts. Overall, the improving group of self-underestimating students clearly report higher internal learning processes. Furthermore, concerning the level of basic cognitive involvement, a digression of the declining self-underestimator group can be observed. In many aspects, however, the discernment between the remaining and the declining group was not clearly obvious and not evidently in favor of the remaining group who, at least, did not suffer cognitively.

In the following, results are discussed in more detail.

7.4.1 Self-Underestimator Development Groups

The tripartite development of self-underestimating students' characteristics over the course of the school year as found in this study is remarkable for two reasons. First, these groupings were found by latent class analysis without any theoretical input to calculation. Yet, they back theoretical considerations that three directions of development are possible for self-underestimating students: besides remaining self-underestimating, those students can experience, on the one hand, an alignment of self-concept with high pre-knowledge, on the other, a seeming interference of cognitive development by low motivational-affective characteristics. Second, the results indicate for practice that, indeed, positive development of self-underestimating students is possible. However, the majority of these students (nearly 75%) do not develop in this direction. This makes the following analyses on differences in internal learning processes relevant for practice since they might yield indications as of how support of this positive development could look like in classrooms.

7.4.2 Students' Internal Learning Processes

The results indicate a possible positive and a negative development route for self-underestimating students as well as a substantial group largely unaffected in the incoherence of their cognitive and motivational-affective characteristics. This result calls for a more detailed look on the learning of these distinct groups. This study considers students' motivational internal learning processes regarding the quality of experienced learning motivation and the fulfillment of basic psychological needs that have both been shown as highly relevant for student learning (Reeve, 2002). The findings indicate systematic differences in internal learning processes for the group of improving self-underestimators and the other two groups. This is remarkable for practice, as positive development seems, hence, to be susceptible to internal learning processes. Even though teacher activity was not measured in this study, this gives reason for optimism that teachers might be able to advance self-underestimating students' development by providing learning support.

Differences between remaining and declining self-underestimators do not turn out to be as clear. On the one hand, both their developments are not favorable. Hence, the variables indicating low internal learning processes for both groups indicate that positive development is more evidently distinguishable than different kinds of development that is non-positive. On the other hand, however, given the considerable difference in gain of physics knowledge, the indifference in many of the internal learning processes variables is noteworthy. It suggests that internal learning processes for self-underestimating students are not related to their cognitive advance but more strongly to the development of their motivational-affective characteristics. This conjecture is further supported by the fact that declining students actually show higher levels of motivational internal learning processes than remaining self-underestimators for some variables. Even though their interest and self-concept is similarly low than for the remaining group, the declining nature of their development refers only to the forfeit of their physics knowledge advance. Regarding the motivational-affective characteristics, this group does not suffer as much as the remaining self-underestimators. A look at the level of cognitive learning activity gives a hint at the difference between remaining and declining self-underestimators. While the remaining group reported to have followed the lesson cognitively invovled approximately as well as the average student, the declining group did, indeed, not seem to be cognitively as involved in instruction. This finding is in line with theory that cognitive learning activity is related to knowledge acquisition (Bransford et al., 1999). At the same time, a higher level of cognitive learning activity is, again, connected with an improving development, which hints at the hypothesized connection of cognitive engagement to both, knowledge and self-concept.

As this study has investigated, the three groups uncovered by latent class analysis at the end of the school year already showed minor differences in their characteristics at the beginning of the school year. Hence, the possibility of an influence of the minor deviances on the development over the school year cannot be precluded. Especially, the defining characteristics of lower cognitive ability for the declining group and higher self-concept for the improving group might have already been foreshadowed at the beginning of the school year. However, the amplification of these defining characteristics suggests an outside influence to play a role. Moreover, as the interaction of development group and school was not significant, this seems to be true throughout classrooms.

Furthermore, the study's analyses have cautiously not investigated influence, but connection between the development and internal learning processes. Therefore, the considerable differences found between the three development groups at the end of the school year give supplementary indication that the initial differences did not (alone) determine student development.

Even though research indicates that one-time measurements related to individual student support during instruction, and hence, to student internal learning processes, is reliable (Praetorius et al., 2014), further studies on student characteristic development over a school year could gain even deeper insight into what happens to students during the year by including additional measurements and measures.

This study refers to physics classrooms in Germany. As Ahmed & Bruinsma (2006) highlight, cross-cultural generalization of notions related to self-concept beyond the western culture might be difficult. Thus, results should be interpreted within the western educational system. However, a generalization to other domains, like mathematics or language arts, could be an interesting direction of further research.

Furthermore, research especially in two directions seems interesting. First, the detailed development of other profile groups over the course of the school year might give additional information on which kind of internal learning process is connected with positive development of which characteristics – and interaction of characteristics. The second possible direction for further research is the consideration of teacher interaction with the three development groups of self-underestimating students. The study found out that the groups exhibit very different internal learning processes without investigating possibilities of teacher support. Therefore, further research should take into account if those learning processes are backed by observable teacher action such as teacher questions or feedback (Hattie, 2009).

Overall, the findings of this study showed that, over the course of one school year, positive development was possible for students who were at risk of underestimating their abilities. With almost three fourths of self-underestimating students still having a low self-concept (and low interest), however, it was not the majority of those students who exhibited a favorable development of their characteristics. Over 30% forfeited their cognitive advance by not gaining considerable content knowledge over the school

year. This development is as relevant as the development of a quite large group of students who remain in their self-underestimating profile. Regarding the connection of development and internal learning processes, this study's findings give reason for educational intervention. Higher internal learning processes of the improving group indicate that this favorable development can be furthered by teachers' actions in supporting student learning.

Chapter 8

Discussion

8.1 Overview and General Discussion of Central Findings

The research of this dissertation was guided by five central research question examined in two empirical studies. Overall, the findings of this dissertation were in large parts in line with the conjectures derived from current research. Additionally, they provided further novel insights and raised interesting questions for future research. This section gives an overview over the central answers found to each research question and discusses them in light of the conjectures and current research.

Firstly, the dissertation was interested in exploring how diverse is the interplay of cognitive and motivational-affective characteristics was in students‘ dispositions and how common incoherences were. First variable-centered results of Study I showed that different characteristics were weakly to moderately related ($0.12 \leq \gamma \leq 0.55$), which was in line with other variable-centered studies (e.g. $0.17 \leq r_{lat} \leq 0.58$ for the interactions of academic self-concept, interest, grades, and standardized test scores in Marsh et al. 2005). However, the findings of this thesis investigated these interactions further and uncovered their high diversity within students' dispositions. This explains not only the variable-centered findings – it also gives more information on why a relation of different characteristics to learning processes sometimes fails to show large results from a variable-centered point of view (Linnenbrink-Garcia et al., 2012). Further, it backs research that investigates individual differences in the interplay of cognitive and

motivational-affective characteristics like Seidel (2006), Lau & Roeser (2008), or Hope et al. (2013). It supports their findings that incoherences are common in the interplay of these characteristics (85-89% of observed dispositions were incoherent in this way) and supplements this with measuring the full extent of within-student characteristics diversity (73-91% of theoretically possible combinations were observed in students). Furthermore, the finding that no single disposition stood out as dominant regarding language arts gave further evidence how diverse the interplay of characteristics is when the configuration in every individual is considered. This adds new momentum to the discussion around the individuality of students' learning dispositions.

Secondly, this thesis sought to shed light onto the teachers' perspective onto this within-student characteristics diversity. It was interested in examining if teachers saw this diversity and, especially, if they recognized (the commonness of) incoherences. Study I found that, from a teacher's perspective, different cognitive and motivational-affective characteristics were moderately to strongly related. This had been conjectured from studies that looked at teacher judgments of more than one characteristic where judgment on one characteristic predicted judgment tendencies on the other (Urhahne et al., 2011; Kaiser et al., 2013). The study supplemented this view with the statistical comparison of teacher and student perspectives to find that diversity measures based on teacher perceptions to be significantly lower than for student assessments. This mismatch in teacher and student perspective agreed with findings from teacher judgment accuracy studies that found that teacher judgment accuracy varied profoundly for achievement (Südkamp et al., 2012) and was altogether weak for other student characteristics (Spinath, 2005). The dissertations additional finding that teachers dominantly perceived the strictly coherent dispositions of the "overall average", the "overall strong", and the "overall weak" student gives empirical evidence to common notions that "terms like 'normal,' 'typical,' and 'average' are abundant" in rhetoric about students (Perry & Winne, 2001). In part, these findings might be explained by the ample sources of bias found in teacher judgment processes (see Fiedler et al. (2002) for an overview). Especially, overgeneralization originally suggested by Thorndike (1920) might play a role. Overall, teachers' struggle in seeing the extent of differences in their students might explain the lack of individualized instruction to date (Nieder & Frühauf, 2012; Schiepe-Tiska et al., 2013) and certainly raises many new questions (see Section 8.3).

Thirdly, this dissertation viewed student and teacher perspectives on within-student characteristics diversity for two different subjects, mathematics and language arts. The fact that subject differences were observed reinforces efforts to spotlight the role of different subjects in empirical educational research (Baumert et al., 2010). Again, the diversity index comparisons allowed direct statistical comparison of within-student characteristics diversity from student and teachers perspectives and the significance of differences further highlighted demands for domain-comparative research. For students, the specific closer ties for mathematics characteristics agreed with other studies who had also found interest and achievement (Schiefele et al., 1992), self-concept and achievement (Marsh & Craven, 2006), and intelligence and achievement (Deary et al., 2007) to be related more closely for mathematics than for language arts. In addition, configural frequency analyses specified this finding by uncovering that for mathematics (but not language arts), the "overall strong" and the "overall weak" student (but not an "overall average" student) were frequently observable in student data. This provides reason to further investigate the development of student characteristics at the upper and lower ends especially for mathematics. Regarding teacher findings, subject differences were less pronouced. However, the fact that language arts teachers saw slightly significantly more diversity than mathematics teachers might indicate that, as Prawat (1980) conjectured, teachers might integrate subject-related attitudes (as opposed to attitudes directed towards "self" or other individuals) into their understanding of student characteristics.

Fourthly, it was an aim of this dissertation to gain insights into the development of an incoherent disposition over a school year to determine if such incoherences can be temporary phenomena. The findings of Study II gave further empirical evidence to the different mechanisms that were conjectured to play a role in the development of self-underestimating students. First, the fact that the majority of students were still cognitively strong at the end of the school year (both, improving and remaining self-underestimators gained high levels of physics knowledge over the year) agreed with notions of the paramount role of prior knowledge for future knowledge construction (Hattie, 2009). Moreover, the positive development of the motivational-affective characteristics in the improving group indicated that along with this knowledge gain some learning process was triggered for parts of these students that led to the adjustment of self-concept. After all, as an example, the most common type of feedback is

related to students knowledge – and feedback has powerful impacts on self-concept (Hattie & Timperley, 2007). However, on the other side, the considerable amount of self-underestimating students who deteriorated over the school year showed that these two mechanisms do not hold in general and for all students. The declining students' lack of knowledge gain over the entire year suggested that low self-concept could yield effects like effort withdrawal or lack of engagement in learning opportunities, which led to cognitive stagnation (Elliot & Church, 2003; Graham & Golan, 1991). All in all, the fact that these considerably different paths of development were all observable for large parts of the student group within one academic year also calls for a further investigation of this complex interplay of especially cognitive learning and self-perceptions (Marsh & Craven, 2006).

Finally, this dissertation set out to investigate the perceived learning processes connected to the development of students' incoherent dispositions. In particular, it was curious to see which internal learning activities were connected to positive (and which to negative) development of the self-underestimating focus group. In Study II, results showed that improving self-underestimators felt significantly more socially related, perceived significantly more support of competence, rated their support of autonomy significantly higher, and experienced significantly higher levels of intrinsic motivation. This was in line with research. On the one hand, motivational learning activities were found to be connected to positive development of motivational-affective characteristics, self-concept (Allen et al., 1994; Diseth et al., 2012) and interest (Tsai et al., 2008). On the other hand, intrinsic motivation and the satisfaction of basic needs is also known to be connected to cognitive development (Vansteenkiste et al., 2004; Jang et al., 2009). These mechanisms seemed to have played out for this group of students. Furthermore, the higher levels of cognitive learning activity of improving underestimators as well as the low levels of cognitive learning activity of declining underestimators agreed with studies that see cognitive internal learning processes mainly connected to cognitive development (Baumert et al., 2010; Bransford et al., 1999) since these two groups' cognitive characteristics developed accordingly. However, the case of the remaining underestimators shows that these separate conceptions of cognitive and motivational-affective terrains are not the entire picture. The fact that their values regarding most internal learning processes lie inbetween the other two groups and even below the

declining groups' for some, implied that important mechanisms might lie within the interaction of both terrains. On the other hand, the general connection of positive development to internal learning processes gives encouraging indications what teachers can already do to support this group of students in the development of their incoherent learning dispositions.

All in all, this dissertation succeeded in gaining new insights into the (in)coherence of student dispositions and their development. These findings are of relevance for research and practice and raise many new interesting questions, which will be traced out in Sections 8.3 and 8.4.

8.2 Methodological Considerations and Contributions

This dissertation, as any empirical study, investigated its research questions in a particular setting, on a specific sample of students (and teachers) with certain research instruments employed in a specific way. Hence, findings must be interpreted within a boundary of what this empirical setup can provide. This is discussed in the following sections. Insights for future research are given. Furthermore, any analyses reveals results only within the limits of its methodology. Hence, the quantitative answers found always depend on the statistical questions asked. This is picked up in this section as well. Furthermore, the methodological contributions of this dissertation as well as ideas arising from the use of methodology in this thesis for future research are discussed.

8.2.1 Samples, Designs, and Instruments

For both studies of this thesis, only students of onr or two academic tracks (Gymnasium for Study I, Gymnasium and Realschule for Study II). This choice was made to avoid cross-track level comparisons that might have introduced bias in both, student assessment and teacher perception (Trautwein et al., 2006). For the interplay of characteristics (e.g. general cognitive ability and achievement), this must be kept in mind. Furthermore, other educational settings with more heterogeneous placement might uncover even more characteristics diversity. It is remarkable, however, how much

individual difference and diversity is already found within one track of theoretically more homogeneous students.

In studying the interplay of student characteristics, the choice of measurement can make a difference (Guo et al., 2017). Therefore, the instruments and design used in the two empirical studies of this thesis must be considered when interpreting results. Five aspects shall be mentioned here in particular. Firstly, the conceptualization and measurement within the cognitive domain was not parallel in the two studies. Prior knowledge was tested in Study II, whereas prior achievement was measured by prior grades in Study I. This must be kept in mind in terms of the comparability between the two studies – apart from the differences in statistical approach. Regarding measurement through grades in Study I, the reader must keep their connections to self-concept and teacher judgments in mind (e.g. Brookhart et al., 2016). However, since the role of self-concept differed considerably between subjects, a systematic effect appears unlikely and since no direct accuracy of teacher judgments was measured in this study, this connection is not directly relevant for the study's findings. Yet, it must be kept in mind.

Secondly, the assumption in both studies that general cognitive ability will remain stable over time might be challenged in light of implicit theories of intelligence around ideas of a growth mindset, i.e. the idea that engaging in challenging learning activities can make you smarter (Dweck, 1986), consideration of general cognitive maturing, and light of findings that schooling can shape the development of intelligence (Cahan & Cohen, 1989). Future studies migh consider measuring general cognitive ability multiple times along with the other student characteristics to shed more light onto this issue. However, studies employing the ideas of growth mindset focus mainly on effects on achievement and motivational characteristics (Blackwell et al., 2007, e.g.) indicating that they expect (short-term) outcomes to lie in these characteristics.

Thirdly, student's motivational-affective characteristics measured by self-description items whose reliability and stability have been questioned (Spinath, 2005). However, since this dissertation is explicitely contrasting teacher and student *perspectives*, self-descriptions using widely used scales (e.g. scales from PISA, see methods sections) seems appropriate in this case. Fourthly, teacher judgments in Study I were measured on a narrow scale (high/medium/low), which pulls teacher judgments apart. However,

student data was brought to the same level of measurement and a distribution matching the overall distribution of teacher perceptions. Hence effects of measurement and instructions are expected to be low. Finally, even though the measurement of internal learning processes at only one measurement point can be seen as reliable as they are connected to measuring individual student support (Praetorius et al., 2014), additional measurements throughout the school year might yield additional insights. The use of further indicators for students' learning is also discussed in Section 8.3.

8.2.2 Statistical Analyses

This dissertation shows that educational research must look beyond variable-centered methodology when regarding student dispositions. The research of this dissertation shows three possibilities of person-centered analyses, which each come with distinct allowances and limitations. First, the consideration of each individual configuration of characteristics within student dispositions for Shannon-Wiener diversity index calculations might not seem practical, since it is not possible to grant thirty different perspectives the same space in a classroom at all time. However, the index measures make it possible to explore and quantify the diversity of a sample. This and its related modified t tests allow comparing diversity between different samples, groups, or perspectives (teacher and student perspective in the case of Study I of this thesis). Furthermore, quantification makes it possible to incorporate diversity or diversity perception – or, by relating teacher and student data in this measure, a diversity accuracy – into other empirical research questions, which can serve as dependent or independent variable, control, mediator, or moderator. This opens a variety of new research questions that can now be tackled statistically.

Furthermore, diversity indices should only be seen as an additional way to examine individual differences. Other person-centered methods can enrich the picture. For instance, configural frequency analysis can be used to identify special small subgroups that appear more frequently than expected in student or teacher data, since it reveals which student dispositions stand out in a sample. Even thought this old method is known in psychological research (von Eye et al., 2008), its revival in this context might inspire future research.

Nevertheless, configural frequency analysis alone also fails to provide a full and practical overview of individual differences in student dispositions. Contrarily, latent class analysis, as an established method in educational research, allows grouping all students of a given sample, yet considers broad group differences. As such, it gives the most practical insight into differences in student dispositions. In its particular use in Study II of this thesis, considerations of investigating development over time, other approaches might also appear suitable. However, latent growth model or similar more complex approaches (B. O. Muthén & Muthén, 2000) did not offer the benefit of directly tying into existing research and adding to findings by working with the same grouping found in Seidel (2006).

Overall, methodologically, this dissertation followed the call of "rediscovering and applying old, useful methods as well as inventing new ones" (Shuell, 1996). In the end, it is research's task to provide empirical evidence for the individual differences in students that teachers face in their teaching. Only then can it aid in striving towards individual learning success.

8.3 Limitations and Directions for Future Research

This dissertation's findings raise many new ideas and questions that can be addressed in future studies. To integrate these considerations into the current research fields, this section refers back to the framework model of this thesis depicted in Figure 1.1 of Chapter 1 and the structure of the theoretical background in Chapters 2, 3, and 4. To begin with, the field working on *Individual Characteristics* and their development to learning *Outcomes* is adressed. Afterwards, research on *Teacher Competences*, specifically *Diagnostic Competence* including teacher perceptions and judgments, is considered. Then, the field regarding *Individual Learning Activities* is attended to. Finally, thoughts on acknowledging the respective subject domains in all of these deliberations are noted.

8.3.1 Within-Student Characteristics Diversity: Incoherences and Development

This dissertation provided an additional perspective onto individual differences in student learning dispositions by employing person-centered methods as described above. However, this new perspective needs to be tied in with advances from variable-centered studies. An interesting approach for this would be regarding the interaction of individual student characteristics with student characteristics of the class, school, or track (e.g. the big-fish-little-pond effect; Marsh & Hau 2003; Liem, Marsh, Martin, McInerney, & Yeung 2013). Also, the consideration of development over time that includes mutual influence of characteristics on each other over time, like the reciprocal effects model (Marsh et al., 2005), should be tied in more specifically. The latter study shows how much of the interaction between characteristics can be explained over time. In this, methods like growth mixture modeling with latent trajectory classes (B. O. Muthén & Muthén, 2000) promise allowing a direct combination of variable-centered and person-centered perspectives.

Future research should also include aspects of students' beliefs into the considerations of the interplay and development of cognitive and motivational-affective characteristics. For instance, in STEM domains, it has been studied that student beliefs shape the interaction of self-perceptions and achievement (Nosek & Smyth, 2011; Y.-L. Wang, Liang, Lin, & Tsai, 2017) or cognitive ability and achievement (Stipek & Gralinski, 1996).

Moreover, this dissertation's understanding of individual differences in terms of within-student characteristics diversity should be connected to other notions of individual differences. On the one hand, addressing background diversity of gender, race, disability, migration or socio-economic background at the same time as differences with regard to student characteristics, might yield an even more complex picture of diversity. Jurik et al. (2013), for instance, found that only the consideration of student disposition and gender uncovered the special role overall strong girls played in teacher-student interactions in physics instruction. On the other hand, other differences in students might further enhance the understanding of individual students' learning. Even though the characteristics studied in this thesis were deliberately chosen for their

profound importance in learning (see Chapter 2), other characteristics, like personality traits (Sorić, Penezić, & Burić, 2017) or creativity (Gajda, Karwowski, & Beghetto, 2017) might form meaningful interactions with students dispositions as considered in this dissertation.

8.3.2 Teachers Perceptions of Diversity and Incoherences

This thesis provided further indication that teachers struggle in the perceptions of their students' individual differences. However, to gain a fuller picture, these findings also need to be integrated into the existing scientific advancements of the various directions. Foremost, a synthesis with the concept of teacher judgment accuracy (see Südkamp et al., 2012; Spinath, 2005) seems desirable. Future studies should not only consider the extent of within-characteristics diversity perceived by teachers but also how accurately they perceive their students' individual dispositions. Following this notion, the approach of this dissertation might also be able to establish a connection between the latter resesarch on teacher judgment accuracy and findings on teacher biases in judgments, especially the halo effect (Thorndike, 1920; Fiedler et al., 2002). It is possible that teachers accurately assess their students' achievement or level or prior knowledge (where judgment accuracy is known to be higher, Hoge & Coladarci, 1989; Südkamp et al., 2012), which subsequently overshines the judgment of general cognitive ability or motivational characteristics (where judgment accuracy is found to be lower, Spinath, 2005).

Furthermore, knowing the important role that teacher knowledge (Campbell et al., 2014) as well as beliefs and stereotypes (Pajares, 1992; Tiedemann, 2002; Peterson et al., 2016) play in the judgment process, these variables should be included in further studies on teachers' perception of within-student characteristics diversity. Teacher professional development programs could specifically target knowledge about individual characteristics, their interplay, and importance for learning or specific teacher beliefs and stereotypes if they were found to be connected directly to the extent of individual differences they notice in their students.

Finally, we need to know more about where and how these teacher perception and judgments are formed. On the one hand, research needs to identify which instructional

elements and teacher actions can shape and improve judgments. Up to now, first indications are that cogenerative dialogue within instruction (Beltramo, 2017) and reflective excercises outside the classroom (Newberry, 2013) can be measures to foster diagnostic competence. Studies that test if teacher perceptions of within-student characteristics diversity are affected by such measures can provide a fuller picture on their effects. On the other hand, more specifically, we need to know what teachers notice and how they use this information to form judgments. Research has identified that classroom activities play an important role in teacher judgments (Kaiser et al., 2013; Martínez et al., 2009), however it is still unclear what exactly they notice within these classroom activities and how they infer judgments. Supplementing research on proximal indicators for judgment on cognitive characteristics (Reynolds et al., 1995) with those for motivational-affective – and their interplay is a distant goal in this direction. First studies have considered this issue using innovative measurement methods, such as eye-tracking (van den Bogert et al., 2014). An innovative research program combining this methodology with considerations of teacher perceptions of within-student characteristics diversity, teacher judgment accuracy, and judgment biases would promise novel insights into this field.

8.3.3 Learning Processes Connected to Disposition Development

Findings of this dissertation showed that considerable development was possible over a school year – and this was connected to students' perceived internal learning processes for self-underestimating students. Hence, the thesis supplemented the research on the role of learning processes for incoherent disposition development with indications about one example of individual learning paths. Still, this is not a complete picture. In order to make progress toward individualized instruction, studies need to address these developmental learning paths for other coherent and incoherent students learning dispositions. This should ideally also be regarded over a longer period of time as learning process unfold effects over time (Cordova & Lepper, 1996).

A main suggestion for further research is to examine students learning activities in more depth – trying also to bridge the gap into the connection with teaching actions.

While self-perceptions of internal learning processes as used in Study II of this thesis provide important insights into students' views on their learning, these self-perceptions can be influenced by external sources like parents (Grolnick, 2009) or peers (León & Liew, 2017). New methodology like experience sampling provide additional deeper insights into students' learning processes – also over time (Nett, Goetz, Hall, & Frenzel, 2012; Bolger & Laurenceau, 2013). Additional insights can be gained by supplementing the investigation of internal learning processes with observable indicators for external learning processes. Video analysis provide a suitable tool to examine the dynamics of learning and teaching (Janik & Seidel, 2009). This research environment could also serve the purpose of combining all three of the mentioned fields of future investigations, student characteristics, teacher perceptions, and learning processes, with the teaching processes also observable in the classroom.

8.3.4 Domain Specificity

This dissertation's findings in empirical Study I demonstrated that within-student characteristics diversity should be viewed subject-specific. This yields two main demands to future research. As a limitation to Study I of this thesis, when considering two or more subject domains, the interactions of student characteristics between these domains must be considered. The prominent example of the frame of reference effect between achievement and self-concept in mathematics and language arts (Marsh, 1986) shows that characteristics regarding one subject can have effects on characteristics regarding another. An integration of this notion in future studies on within-student characteristics diversity promise interesting results. Also, from the perspective of teaching and learning processes, actions in one subject domain might have effects on other fields. For instance, interventions to foster motivation for science and mathematics resulted in negative effects for valueing language domains (Gaspard et al., 2016).

In addition, even though the common results of Study I were observed for both subjects, mathematics and language arts, noticeable differences remained. This consideration of different subject domains yields limitations for the findings of Study II. Since the discovery of self-underestimating students as a large group of students (Seidel, 2006) as well as the examination of their development and connected learning processes were performed with respect to a single subject domain, physics instruction, caution

must be held when translating these findings to other domains. Instead, further studies should explore the interaction of different student characteristics regarding different subject domains. An example for generalizing these findings to other domains can be found in established lines of variable-centered research where, for instance, the reciprocal effects model is now tested in physical education (gymnastics, Marsh et al., 2006). In these efforts, educational psychologists should collaborate with experts in the subject didactics and subject domains to be able to fully encompass the subject-specific learning environments.

8.4 Educational Relevance

The findings from this thesis are of relevance for practice and can help in supporting teaching and learning. Findings from both studies give implications for teacher education and professional development as well as every day teaching practice.

8.4.1 Teacher Education and Professional Development

The answers this dissertation has found to the first two research questions, the within-student characteristics diversity and teachers difficulty seeing it, further support calls to strengthen the topic of diagnostics competence and dealing with diversity and individual student characteristics in teacher education.

International teacher survey data has already suggested that teacher education must make the discussion about diversity more effectful in terms of preparation for classroom realities. While the vast majority of teachers (96% of pre-service teachers and 65% of serving teachers) reported that diversity was covered in their education in some form, a large share of them (47% of pre-service teachers and 66% of serving teachers) perceived this preparation as insufficient for practice (Organisation for Economic Co-operation and Development, 2010).

Additionally, policy makers call on teacher professional development measures for a support of “reliable diagnostic judgments of learning prereqisites” and “pedagogically professional dealing with differences” that is “founded on knowledge of differences in states of learning and achievement” (Nieder & Frühauf, 2012). From a standpoint of educational research, experts like (Weinert, 2000) also critisize that diagnostic

competence is rarely taught in teacher education and professional development. Other authors note the lack of learning opportunities for diagnostic tasks (Praetorius et al., 2012) or that those skills are only trained on the job (Lorenz, 2011).

Regarding the actual content of teacher education and professional development courses, the findings of this thesis provide further empirical evidence regarding especially two points. These can be used in research-based teacher professional development courses to challenge teachers and give them the opportunity to concretely revise their own judgment tendencies. Firstly, the thesis contributes additional empirical evidence for the richness of differences among students highlighting especially the commonness of incoherences that can be mentioned along with the findings of Seidel (2006), Lau & Roeser (2008), and Linnenbrink-Garcia et al. (2012). Secondly, it supplies evidence for specific teacher misconceptions. The direct comparison of teacher and student perspectives in diversity index comparisons can be discussed along with findings on judgment accuracy (Südkamp et al., 2012; Spinath, 2005). Moreover, the fact that teachers often speak of 'typical' or 'average' students has been mentioned by scholars (Perry & Winne, 2001), but can now be backed by data that teachers predominantly see homogeneous "overall strong", "overall weak", and most prominently, "overall average" students.

Furthermore, because of the important role stereotypes (Fiedler et al., 2002) and beliefs (Niemiec & Ryan, 2009) play for teacher perceptions and since those beliefs are formed early (Pajares, 1992), it appears most promising to tackle misconceptions early in teacher education programs. However, as other researchers highlight, there is yet more research to be done before all causes of bias in teacher perceptions can be obviated through teacher education (Meissel, Meyer, Yao, & Rubie-Davies, 2017). Nevertheless, the findings of teacher perceptions of within-student characteristics diversity in this thesis can also be brought up along with other aspects of students diversity including students' background. Alongside findings of rich characteristics diversity within a specific background group (Hope et al., 2013) and the importance of characteristics development in closing achievement gaps for minority groups (Cohen et al., 2009), this can offer teachers at least a fuller picture of their students' differences and starting points for coping with them by focusing on their learning dispositions.

8.4.2 Instructional Planning and Implementation

Despite limited specific guidelines for teacher actions, the findings of the dissertation can inform everyday instructional planning and implementation aiding to incrementally break with current unindividualized practice (Nieder & Frühauf, 2012; Schiepe-Tiska et al., 2013).

In doing so, the finding in Study I of this dissertation that nearly every student is different regarding his or her learning disposition should not discourage teachers. Contrarily, it should be seen as a perspective that yields increased awareness of individual differences in terms of student learning dispositions when planning and implementing instruction.

The findings from Study II give teachers can give teachers first more concrete ideas for student support if connected with other findings from the field. Bolstering both, students' cognitive and motivational internal learning processes promises to stregthen at least the development of students with self-underestimating tendencies. Everyday actions like feedback, for instance, can be shaped in a way to fulfull students' need for competence (Sansone, 1989). Moreover, there are numerous ideas for interventions on student motivation that are generally proven to be effective (Lazowski & Hulleman, 2016). Those can inspire everyday teaching to help teachers spark their students' intrinsic motivation. Furthermore, cognitive learning processes can be evoked, for example, by shaping everyday class discussions in a way that encourages students' critical thinking and the acknowledgement of multiple solution paths (Baumert et al., 2010). What is more, administrators and teachers in educational leadership roles might support teachers in creating such supportive environments by strengthening their self-efficacy, which is found to play a crucial role in how they support students' compentence (Zee & Koomen, 2016; Niemiec & Ryan, 2009).

Certainly, in the successful implementation of all of these elements of instruction, other teachers' pedagogical, content, and pedagogical content knowledge. For instance, in the provision of individual feedback or the choice of individual questions and tasks, especially teachers' awareness of common misconceptions or the familiarity with helpful examples as components of as aspects of pedagocial content knowledge are paramount (Kunter & Pohlmann, 2015; Reiss et al., 2008; Reiss & Hammer, 2013).

More generally, in light of ideas like self-teaching (e.g. A. J. Martin & Steinbeck, 2017) or adaptive learning technology (Walkington, 2013; Forsyth, Kimble, Birch, Deel, & Brauer, 2013), critics might argue that the need for teachers' diagnostic competence might diminish in the future. However, even success of these forms of learning have shown to demand teacher planning, instruction, and decision making (A. J. Martin & Steinbeck, 2017). Additionally, aspects like teacher-student-interactions are not expected to vanish from everyday instruction. They are, on the one side, shaped profoundly by teacher perceptions and judgments (Cornbleth & Korth, 1980) and, on the other side, tremendously impact students' cognitive and motivational-affective development (D. Martin & Rimm-Kaufman, 2015; Cadima, Leal, & Burchinal, 2010). Hence, despite innovative developments in the field of education, teacher judgments will remain at the core of educational quality and students' learning success. Quite to the contrary, due to the current discussion and political implementation of inclusion measures in schools (United Nations Educational Scientific and Cultural Organization, 2009) as well as the integration of immigrant and refugee students into classrooms throughout different educational systems (Blossfeld et al., 2016), the question of diversity will only grow more pressing.

Therefore, both, calls for additional teacher education and professional development and the defacto implementation of individualized instruction demand additional time from teachers – as scholars already note (Schlaaff, 2015). Hence, the role of teachers will continue to grow challenging. Withal, exciting newer developments in practice can serve as role models for coping with these challenges. For instance in Spain, former special education faculty are starting to take on new roles in encouraging teachers as well as other agents in the community to share their role of attending to and supporting student diversity (Gómez-Zepeda, Petreñas, Sabando, & Puigdellívol, 2017).

8.5 Conclusion

This dissertation provided further empirical support for the individual differences between students with regards to their learning dispositions and the diversity and commenness of incoherences within these dispositions. It did so by employing new methodology to investigate, compare, or account for this diversity and highlight incoher-

ences in the interplay of cognitive and non-cognitive components of learning dipositions. Further, this thesis revealed that teachers do not yet fully recognize the diversity of their students – a precondition for providing adequate individual support. Findings suggested that teachers struggle especially in recognizing the incoherences within dispositions. On the other hand, the dissertation gave first hints at what might be possible in the support of students with incoherent dispositions: Considerable positive development of self-underestimating students was observable over only one school year (but not yet the norm) and this positive development was connected to students' perception of their cognitive and motivational internal learning processes. Hence, teachers might be able to support those students by shaping learning environments accordingly. All together, the thesis is a renewed appeal on educational research and practice to focus on the individual students and their learning dispositions.

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Appendix A

Additional Details on Results of Study I

A.1 Model Fit for Multi-Level Regression Models

Table A.1: Model fit of simple, multi-level random intercept, or multi-level random slope regression model for pairs of student characteristics. Chosen model was indicated.

		Simple regression model (df = 3)		**Multi-level random intercept model (df = 4)**			**Multi-level random slope model (df = 6)**		
		χ^2	×	χ^2	p	×	χ^2	p	×
StudentAssessment:Mathematics									
G. Cognitive Ability	ACH	1164.87	×	1162.27	.107		1162.26	.992	
	INT	1268.66	×	1267.07	.208		1265.41	.435	
	SC	1265.33		1262.32	.083	×	1262.11	.902	
Achievement	GCA	1170.03	×	1167.38	.104		1167.21	.919	
	INT	1188.69	×	1188.10	.440		1188.04	.975	
	SC	1105.66	×	1105.66	1.00		1105.66	1.00	
Interest	GCA	1272.27		1257.12	.000	×	1253.87	.197	
	ACH	1182.24		1167.82	.000	×	1167.17	.723	

	SC	1166.05		1161.01	.025	×	1158.37	.267	
Self-concept	GCA	1265.67		1253.29	.000	×	1253.25	.979	
	ACH	1102.33		1095.91	.011	×	1093.37	.281	
	INT	1166.12	×	1164.31	.178		1162.69	.446	
Student Assessment: Language Arts									
G. Cognitive Ability	ACH	1248.93	×	1247.46	.226		1246.17	.523	
	INT	1280.99	×	1279.80	.274		1276.67	.209	
	SC	1283.39	×	1281.74	.199		1280.84	.637	
Achievement	GCA	1244.14		1239.23	.027	×	1238.86	.835	
	INT	1269.06		1261.22	.005	×	1259.63	.452	
	SC	1250.81		1243.92	.009	×	1242.78	.568	
Interest	GCA	1270.06		1269.03	.310		1262.68	.042	×
	ACH	1273.98		1268.99	.026	×	1268.27	.696	
	SC	1315.12		1310.64	.034	×	1310.04	.739	
Self-concept	GCA	1288.61	×	1285.66	.086		1285.32	.841	
	ACH	1255.98		1250.05	.015	×	1249.68	.831	
	INT	1315.43		1309.47	.015		1303.27	.045	×
Teacher Perception: Mathematics									
G. Cognitive Ability	ACH	1054.62		1037.23	.000		1031.46	.056	×
	INT	1164.73		1156.40	.004	×	1153.56	.242	
	SC	1210.38		1199.70	.001	×	1198.68	.600	
Achievement	GCA	1058.68		1020.00	.000	×	1018.46	.463	
	INT	1197.82		1166.72	.000	×	1163.48	.197	
	SC	1190.47		1178.36	.001	×	1185.32	1	
Interest	GCA	1170.62		1158.39	.000	×	1156.85	.464	
	ACH	1197.70		1185.13	.000	×	1185.11	.991	
	SC	1274.75		1266.33	.004	×	1263.46	.237	
Self-concept	GCA	1212.03		1167.29	.000	×	1162.68	.100	
	ACH	1188.58		1164.04	.000		1156.38	.022	×
	INT	1272.23		1233.95	.000		1210.55	.000	×
Teacher Perception: Language Arts									
G. Cognitive Ability	ACH	1080.22		1076.18	.044		1067.91	.016	×

	INT	1207.65	×	1206.95	.402		1205.36	.452	
	SC	1215.59		1209.83	.016		1198.83	.004	×
Achievement	GCA	1082.88	×	1081.18	.193		1077.46	.156	
	INT	1198.89		1197.78	.293		1189.53	.016	×
	SC	1172.59	×	1170.09	.114		1168.31	.411	
Interest	GCA	1210.50		1194.96	.000	×	1194.55	.814	
	ACH	1198.72		1176.66	.000		1167.79	.012	×
	SC	1194.64		1182.44	.000	×	1181.65	.674	
Self-concept	GCA	1215.92		1169.45	.000		1162.17	.026	×
	ACH	1170.27		1125.49	.000	×	1123.24	.324	
	INT	1192.12		1160.69	.000		1153.44	.027	×

Note: Cognitive domain: GCA: general cognitive ability, ACH: achievement; motivational-affective domain: INT: interest, SC: self-concept. p: significance of χ^2-difference for this model compared to the next simpler one. × : The model was chosen for this pair of characteristics.

A.2 Full Model Results of Multi-Level Regressions

Table A.2: Full model results of simple, multi-level random intercept, or multi-level random slope regression models.

		Fixed effects		**Random effects**			
		γ_{00} (SE)	γ_{10} (SE)	τ_{00}	σ^2	$F(df_1, df_2)$	p
Student Assessment: Mathematics							
GCA	ACH	-0.02 (0.05)	0.23*** (0.05)			F(1,418)=24.02	****
	INT	0.00 (0.05)	0.21*** (0.05)			F(1,453)=22.06	****
	SC	0.00 (0.06)	0.24*** (0.05)	0.03	0.92	F(1,450)=26.74	****
ACH	GCA	0.02 (0.05)	0.23*** (0.05)			F(1,418)=24.02	****
	INT	0.01 (0.05)	0.34*** (0.05)			F(1,435)=55.05	****
	SC	0.01 (0.04)	0.52*** (0.04)			F(1,435)=158.41	****

INT	GCA	-0.01 (0.08)	0.21*** (0.05)	0.07	0.89	F(1,451)=21.00	****
	ACH	-0.01 (0.07)	0.33*** (0.04)	0.07	0.81	F(1,431)=55.59	****
	SC	-0.00 (0.05)	0.54*** (0.04)	0.03	0.67	F(1,471)=195.32	****
SC	GCA	-0.01 (0.07)	0.23*** (0.05)	0.06	0.88	F(1,452)=27.20	****
	ACH	-0.00 (0.06)	0.50*** (0.04)	0.03	0.70	F(1,434)=155.11	****
	INT	0.00 (0.04)	0.55*** (0.04)			F(1,470)=207.2	****
Student Assessment: Language Arts							
GCA	ACH	-0.02 (0.05)	0.18*** (0.05)			F(1,444)=14.97	***
	INT	-0.00 (0.05)	0.13** (0.05)			F(1,453)=9.36	**
	SC	0.00 (0.05)	0.12** (0.05)			F(1,453)=6.92	**
ACH	GCA	0.06 (0.06)	0.18*** (0.05)	0.04	0.91	F(1,445)=14.93	***
	INT	0.04 (0.07)	0.26*** (0.04)	0.05	0.88	F(1,460)=34.53	****
	SC	0.03 (0.06)	0.32*** (0.05)	0.04	0.85	F(1,460)=53.32	****
INT	GCA	0.03 (0.05)	0.15* (0.06)	0.01	0.90	F(1,455)=5.40	*
	ACH	-0.01 (0.06)	0.26*** (0.05)	0.04	0.90	F(1,460)=34.13	****
	SC	0.00 (0.06)	0.19*** (0.05)	0.04	0.93	F(1,469)=16.66	***
SC	GCA	0.00 (0.05)	0.12** (0.05)			F(1,453)=6.92	**
	ACH	0.00 (0.06)	0.32*** (0.04)	0.04	0.86	F(1,460)=53.16	****
	INT	-0.00 (0.06)	0.18** (0.05)	0.04	0.91	F(1,469)=11.12	**
Teacher Perception: Mathematics							
GCA	ACH	-0.01 (0.06)	0.71*** (0.05)	0.04	0.48	F(1,475)=213.44	****
	INT	-0.01 (0.06)	0.56*** (0.04)	0.04	0.64	F(1,475)=224.24	****
	SC	-0.01 (0.06)	0.51*** (0.04)	0.04	0.72	F(1,456)=156.1	****
ACH	GCA	0.02 (0.07)	0.68*** (0.03)	0.07	0.47	F(1,469)=429.84	****
	INT	0.01 (0.07)	0.56*** (0.04)	0.08	0.60	F(1,483)=233.15	****
	SC	0.01 (0.06)	0.54*** (0.04)	0.04	0.66	F(1,465)=187.28	****
INT	GCA	0.03 (0.06)	0.57*** (0.04)	0.05	0.64	F(1,474)=224.66	****
	ACH	0.00 (0.06)	0.58*** (0.04)	0.04	0.64	F(1,484)=231.68	****
	SC	0.01 (0.06)	0.41*** (0.04)	0.04	0.80	F(1,456)=92.85	****
SC	GCA	0.01 (0.08)	0.48*** (0.04)	0.11	0.65	F(1,465)=157.85	****
	ACH	-0.01 (0.06)	0.53*** (0.06)	0.05	0.61	F(1,479)=91.14	****
	INT	0.02 (0.09)	0.39*** (0.07)	0.12	0.66	F(1,479)=33.25	****

Teacher Perception: Language Arts

GCA	ACH	-0.01 (0.05)	0.62*** (0.05)	0.03	0.58	F(1,459)=185.98	****
	INT	0.01 (0.04)	0.43*** (0.04)			F(1,457)=103.52	****
	SC	-0.02 (0.06)	0.43*** (0.06)	0.04	0.76	F(1,459)=53.80	****
ACH	GCA	0.00 (0.04)	0.62*** (0.04)			F(1,457)=282.88	****
	INT	0.01 (0.05)	0.57*** (0.05)	0.01	0.66	F(1,486)=136.87	****
	SC	0.00 (0.04)	0.50*** (0.04)			F(1,457)=151.52	****
INT	GCA	-0.02 (0.07)	0.42*** (0.04)	0.06	0.76	F(1,454)=103.05	****
	ACH	0.01 (0.07)	0.55*** (0.04)	0.06	0.61	F(1,486)=156.29	****
	SC	-0.02 (0.06)	0.46*** (0.04)	0.05	0.74	F(1,447)=118.85	****
SC	GCA	0.01 (0.09)	0.40*** (0.06)	0.13	0.67	F(1,459)=52.31	****
	ACH	0.00 (0.09)	0.48*** (0.04)	0.12	0.63	F(1,447)=163.12	****
	INT	-0.00 (0.08)	0.44*** (0.06)	0.11	0.66	F(1,459)=60.83	****

Note: * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

A.3 Observed Frequencies of Diversity Patterns

Table A.3: Observed frequencies of diversity patterns (n_o) and their respective ranking based on local χ^2 tests for student assessment and teacher perception in mathematics and language arts..

		Student Assessment				**Teacher Perception**			
Profile	Theoretical Profile Probability	Mathematics		Language Arts		Mathematics		Language Arts	
	(N=503)	(N=420)		(N=446)		(N=472)		(N=459)	
		n_o	χ^2 rank	n_o	χ^2 rank	n_o	χ^2 rank	n_o	χ^2 rank
1111	1.96	16	2	6	4	26	2	19	2
1112	3.93	9	37	9	5	7	18	10	5
1113	1.96	0	27	1	71	3	26	0	67
1121	3.93	7	62	6	10	14	4	6	7

1122	7.86	20	13	8	58	18	6	11	12
1123	3.93	2	23	0	14	0	46	2	78
1131	1.96	0	40	2	75	1	81	0	70
1132	3.93	3	55	4	63	0	32	1	42
1133	1.96	0	35	1	54	0	67	0	63
1211	3.93	5	21	7	11	3	62	2	74
1212	7.86	7	72	9	72	0	21	9	51
1213	3.93	0	28	3	67	0	55	0	35
1221	7.86	2	34	8	45	3	70	3	77
1222	15.72	14	65	17	44	3	15	9	54
1223	7.86	5	77	5	52	1	36	1	28
1231	3.93	0	42	3	50	1	68	2	80
1232	7.86	7	38	7	30	0	16	1	13
1233	3.93	3	60	7	34	0	44	0	29
1311	1.96	2	76	0	36	0	77	0	75
1312	3.93	1	25	2	32	0	49	0	34
1313	1.96	0	39	1	60	0	76	0	65
1321	3.93	0	17	1	31	0	56	0	58
1322	7.86	7	66	5	38	0	20	0	17
1323	3.93	2	45	4	65	0	53	0	43
1331	1.96	0	57	1	49	0	74	0	69
1332	3.93	0	20	2	19	0	38	0	27
1333	1.96	2	71	1	46	0	73	0	61
2111	3.93	22	3	9	3	11	7	9	6
2112	7.86	8	54	8	64	16	19	15	14
2113	3.93	0	15	2	56	3	80	0	31
2121	7.86	10	79	7	42	12	42	5	72
2122	15.72	28	24	10	53	15	52	13	73
2123	7.86	2	8	4	51	0	11	1	24
2131	3.93	0	18	5	48	0	27	1	50
2132	7.86	6	53	3	9	1	10	1	11
2133	3.93	2	51	1	20	0	24	2	52

2211	7.86	6	56	7	70	11	30	6	79
2212	15.72	8	61	10	24	10	39	27	21
2213	7.86	0	16	4	33	6	79	2	20
2221	15.72	5	33	12	66	10	57	12	64
2222	31.44	30	10	36	6	98	3	69	3
2223	15.72	8	70	12	76	13	75	13	76
2231	7.86	0	19	2	8	2	23	3	33
2232	15.72	7	74	19	73	22	78	26	60
2233	7.86	5	68	4	15	6	63	13	40
2311	3.93	0	22	0	12	0	45	0	36
2312	7.86	6	69	9	61	0	14	0	9
2313	3.93	2	58	2	47	1	59	1	44
2321	7.86	1	14	2	17	0	17	0	22
2322	15.72	16	80	13	77	6	13	4	10
2323	7.86	16	5	3	23	11	41	3	38
2331	3.93	0	29	4	79	0	35	0	32
2332	7.86	5	73	13	35	8	72	5	30
2333	3.93	13	4	17	1	2	64	5	66
3111	1.96	7	6	1	78	0	65	1	81
3112	3.93	3	43	4	69	0	25	3	56
3113	1.96	0	30	0	41	0	61	0	45
3121	3.93	3	59	5	16	0	34	1	57
3122	7.86	8	48	2	13	0	9	0	8
3123	3.93	0	12	1	40	0	31	0	25
3131	1.96	0	47	2	68	0	54	0	47
3132	3.93	1	26	2	28	1	28	0	15
3133	1.96	2	78	0	29	0	51	1	62
3211	3.93	3	64	2	55	0	43	1	37
3212	7.86	2	32	8	74	0	12	6	26
3213	3.93	1	63	1	25	1	58	0	19
3221	7.86	2	41	2	18	1	22	4	48
3222	15.72	18	9	10	43	13	48	26	41

3223	7.86	5	81	9	22	3	37	6	49
3231	3.93	0	50	4	81	1	47	0	23
3232	7.86	2	49	11	57	23	8	6	16
3233	3.93	5	11	7	21	8	33	5	71
3311	1.96	0	52	0	39	0	71	0	59
3312	3.93	1	31	3	59	1	50	0	18
3313	1.96	0	46	2	62	0	69	1	68
3321	3.93	1	36	1	37	0	40	1	55
3322	7.86	7	75	7	80	11	66	12	53
3323	3.93	9	7	5	27	7	29	6	39
3331	1.96	0	67	0	26	0	60	0	46
3332	3.93	1	44	10	7	19	5	21	4
3333	1.96	19	1	9	2	39	1	46	1

Note: χ^2 rank is the rank of this diversity pattern based on a comparison of expected and observed frequency considering local χ^2 tests.

Appendix B

Supplements

B.1 Supplement 1: Study I (Manuscript)

Huber, S. A., & Seidel, T. (submitted). Comparing Teacher and Student Perspectives on the Interplay of Cognitive and Motivational-Affective Student Characteristics. *Journal for Learning and Individual Differences.*

B.2 Supplement 2: Study I (Data in Brief)

Instead of an appendix, the Journal for Learning and Individual Differences requires the submission of a separate data article with additional details on methodology. It is supplemented as

Huber, S. A., & Seidel, T. (submitted). Teacher and Student Data on the Interaction of Student Characteristics: Sample, Design, Shannon-Wiener Indices, and Configural Frequency Analyses. *Journal for Learning and Individual Differences.*

and must be understood as the appendix of the previous manuscript.

B.3 Supplement 3: Study II (Published Manuscript)

Huber, S. A., Häusler, J., Jurik, V., & Seidel, T. (2015). Self-underestimating students in physics instruction: Development over a school year and its connection to internal learning processes. *Journal for Learning and Individual Differences, 43*, 83–91. doi:10.1016/j.lindif.2015.08.021

B.4 Supplement 4: Statement of Distribution of Tasks and Responsibilities