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Where the hidden becomes visible:

Exploring individual differences in student engagement and their utility to teachers as a window into student motivational-affective and cognitive characteristics

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For my parents.

Anfangs wollt ich fast verzagen,
Und ich glaubt ich trüg es nie,
Und ich hab es doch getragen, –
Aber fragt mich nur nicht, wie?
Heinrich Heine

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Included Publications

The present dissertation was written cumulatively and consists of two articles published in international peer-reviewed journals. The author of this dissertation is the first author of both publications and was mainly responsible for conceptualization, data analyses, writing the original and revised drafts, and for pursuing the publication process with the respective journals.

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The first author was primarily responsible for the publication of this article (see Article A in the appendix) including conceptualization, data analyses, and writing (70%). The co-authors, Prof. Dr. Doris Holzberger (20%) and Prof. Dr. Tina Seidel (10%), contributed to the development and publication of the article with critical reviews.

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Abstract

Individual differences in student engagement play a pivotal role in learning and teaching in an everyday classroom setting. For students, behavioral, cognitive, and emotional engagement is a central condition for achievement since it mediates the influence of student motivation on learning outcomes. As a result, differential usage of learning activities can result in different learning outcomes. For teachers, individual differences in student engagement represent an observable student feature that can be used as source of information about their internal experiences, as private student characteristics manifest in students' overt engagement. This is important since teachers are supposed to assess students' learning-relevant characteristics to adapt their teaching. However, it is not only unclear, for the most part, how students' typical engagement patterns appear, even in the context of common classroom learning activities such as whole-class dialogue. How teachers' observation and utilization of student engagement as a component of judgment processes relate to judgment accuracy of student characteristics is also undetermined. It was the aim of the first study to uncover typical engagement patterns—the intra-individual interplay of number of hand raisings as a specific form of behavioral engagement, cognitive and emotional engagement—and their relation with academic self-concept as an antecedent and achievement as a learning outcome. With the second study, judgment accuracy of student teachers regarding combinations of motivational-affective and cognitive student characteristics was linked to eye-movements as an indicator of observation behavior. The use of student engagement as a cognitive aspect of judgment processes also acted as an indicator. A latent profile analysis with eighth-grade high school students (N = 397) revealed five engagement patterns of *disengaged*, *compliant*, *silent*, *engaged*, and *busy,* in which the number of hand raisings was inconsistently related to cognitive and emotional engagement, for the most part. Higher academic self-concept at the beginning of the school year increased the likelihood of displaying patterns of moderate to high engagement. Disengaged students suffered from lower end-of-year grades than their peers. Using a video vignette as stimulus, student teachers (N = 43) showed substantial differences in their judgment accuracy of student characteristics. Participants with a higher accuracy tended to show a pattern of eye movements similar to more experienced teachers with a higher number of fixations and shorter average fixation duration. According to epistemic-network analysis, they utilized combinations of student cues that were conclusive for particular combinations of motivational-affective and cognitive student characteristics, although overall, participants favored diagnostic student cues for their assessments. Together, these studies highlight the role that individual differences in student engagement play in student learning and in teacher assessments.

Zusammenfassung

Individuelle Unterschiede in der Beteiligung von Schülerinnen und Schülern spielen eine zentrale Rolle im Klassenzimmer. Dabei ist die verhaltensbezogene, kognitive und emotionale Beteiligung eine zentrale Bedingung für die Leistung von Schülerinnen und Schülern, da die Beteiligung den Einfluss der Motivation auf die Lernergebnisse mediiert. Eine differenzielle Nutzung von Lernaktivitäten kann demnach zu unterschiedlichen Lernergebnissen führen. Für Lehrpersonen stellen individuelle Unterschiede in der Beteiligung von Schülerinnen und Schülern ein Merkmal dar, das als Informationsquelle über das nicht direkt beobachtbare innere Erleben genutzt werden kann, da sich internale Merkmale in der Beteiligung sichtbar manifestieren. Dies ist wichtig, da Lehrpersonen die lernrelevanten Merkmale der Schülerinnen und Schüler beurteilen müssen, um ihren Unterricht individuell anzupassen. Es ist jedoch bisher nicht nur weitgehend unklar, wie typische Beteiligungsmuster von Schülerinnen und Schülern bei alltäglichen Lernaktivitäten wie beispielsweise Diskussionen im Klassenplenum aussehen, sondern es ist auch offen, wie die Beobachtung und Nutzung der Beteiligung durch die Lehrpersonen als Komponente des Urteilsprozesses mit der Urteilsgenauigkeit bezüglich der Merkmale von Schülerinnen und Schülern zusammenhängt. Ziel der ersten Studie war es demnach, typische Beteiligungsmuster – in Form des intra-individuellen Zusammenspiels von der Anzahl der Meldungen als spezifischem Indikator der verhaltensbezogenen Beteiligung mit der kognitiven und emotionalen Beteiligung – und deren Zusammenhang mit dem akademischen Selbstkonzept als Prädiktor und der Leistung als Ergebnis aufzuklären. In der zweiten Studie wurde die Urteilsgenauigkeit von Lehramtsstudierenden bezüglich der Kombination von motivational-affektiven und kognitiven Merkmalen mit Blickbewegungen als Indikator für das Beobachtungsverhalten und der Nutzung von der Schülerinnen- und Schülerbeteiligung als kognitive Aktivität von Urteilsprozessen in Zusammenhang gebracht. Eine latente Profilanalyse mit Gymnasiastinnen und Gymnasiasten der achten Jahrgangsstufe (N = 397) ergab fünf Beteiligungsmuster von *unbeteiligt*, *konform*, *still*, *beteiligt* und *geschäftig*, bei denen die Anzahl der Meldungen überwiegend auf inkonsistente Art mit der kognitiven und emotionalen Beteiligung kombiniert war. Ein höheres akademisches Selbstkonzept zu Beginn des Schuljahres erhöhte die Wahrscheinlichkeit, ein Muster von mittlerer bis hoher Beteiligung zu zeigen. Unbeteiligte Schülerinnen und Schüler hatten am Ende des Schuljahres schlechtere Noten als ihre Mitschülerinnen und Mitschüler mit anderen Beteiligungsmustern. Unter Verwendung einer Videovignette als Stimulus zeigten Lehramtsstudierende (N = 43) Unterschiede in ihrer Beurteilungsgenauigkeit von Schülerinnen- und Schülermerkmalen. Die Teilnehmenden mit einer höheren Genauigkeit zeigten in der Tendenz ein ähnliches Blickbewegungsmuster

wie erfahrenere Lehrpersonen mit einer höheren Anzahl von Fixationen und einer kürzeren durchschnittlichen Fixationsdauer. Der epistemischen Netzwerkanalyse zufolge verwendeten sie Kombinationen an Schülerinnen- und Schülersignalen, die für ein bestimmtes intra-individuelles Zusammenspiel von motivational-affektiven und kognitiven Merkmalen schlüssig waren, obwohl insgesamt alle Teilnehmenden diagnostische Schülerinnen- und Schülersignale für ihre Einschätzungen heranzogen. Zusammengenommen unterstreichen diese Studienergebnisse die Rolle individueller Unterschiede in der Beteiligung von Schülerinnen und Schülern für deren Lernergebnisse und die Einschätzungen der Lehrpersonen und verdeutlichen die Bedeutsamkei von Schülerinnen- und Schülerbeteiligung.

Contents

1 Introduction

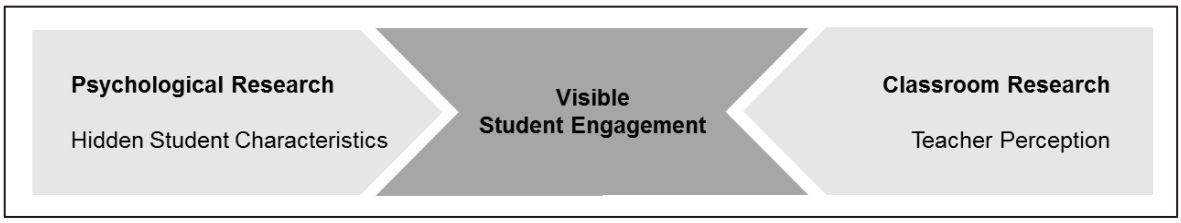
Research on student engagement has significantly increased since its origins in the 1980s (Reschly & Christenson, 2012) when the term first appeared in literature in a review by Mosher and MacGowan (1985). Encouraged by studies that portrayed engagement as an antidote to school dropouts and a prerequisite for learning success, an increasing number of studies have examined the positive effects of engagement. Since then, this relatively young construct has received a lot of hype in the world of research. At times, student engagement has even been regarded as the "holy grail" of teaching and learning research—a means to help all students achieve academic success (Sinatra et al., 2015, p. 1). Amidst this flurry of activity surrounding this construct, it is important to examine the benefits of student engagement and the reasons for which it is so attractive to researchers.

First, engagement offers a multidimensional approach to understanding learning processes (Fredricks & McColskey, 2012). In existing literature, behavior, thinking, and feeling have commonly been grouped under the construct of engagement (Fredricks et al., 2004). Engagement thus integrates fragmented aspects of student learning that are otherwise considered separately in research, thereby synthesizing situational learning processes. In the words of Ainley (1993, p. 396), research "strategies of 'simplification by isolation' need to be supported with strategies of 'simplification by integration'" to gain a more comprehensive, holistic picture of the complexity of everyday student experiences. Second, when viewed in this way, behavior, thinking, and feeling together can be differentiated from student motivation (e.g., academic self-concept or achievement goals) as the underlying driving force of student engagement (Reschly & Christenson, 2012; Skinner et al., 2009). Based on this point, a third can be derived. Student engagement is one of the best observable indicators of student motivation available to teachers in their day-to-day teaching. To be clear, "there is no better telltale signal about student's private motivation than their public engagement" (Reeve, 2012, p. 162). To phrase it for the purposes of this dissertation, student engagement is where the hidden—student characteristic—becomes visible. Fourth, student engagement represents the very object that is considered central to learning outcomes in models of effective teaching (e.g., supply-use model; Helmke, 2012), namely, the individual student's external and internal usage (i.e. engagement) of learning activities offered in class (Decristan et al., 2020). The relevance of student engagement for learning outcomes has been clearly demonstrated in previous research. Study results have consistently shown that engagement is a strong predictor of various academic outcomes (Alrashidi et al., 2016). Thus, by jointly considering the different dimensions of engagement, research can elucidate the extent to which individual differences in engagement are related

to learning outcomes. Fifth, engagement is malleable to situational conditions and personal features, as it represents the processes that occur during learning activities from person-situation interactions. It can therefore be addressed through targeted interventions and offers a starting point for supporting students in their learning success (Renninger & Bachrach, 2015). Together, these five features point to a final, crucial argument in favor of using student engagement as a lens through which to view learning processes and outcomes. It bridges the gap between psychological research, which is primarily concerned with students' personal internal characteristics, and classroom-based educational research, which addresses classroom phenomena (for example, interaction patterns of teachers and students or teachers' classroom perceptions) (see Figure 1; Li & Lerner, 2013).

Figure 1.

Engagement as a Linkage between Psychological and Classroom Research



Building upon these characteristics of student engagement, this dissertation seeks to develop a comprehensive understanding of how student engagement differs among individuals, both from student and teacher perspectives. The first objective was to identify dominant patterns of student engagement—that is, how student behavior, thinking, and feelings are intra-individually combined. In doing so, the ultimate goal was to uncover the extent to which external observable dimensions (i.e. behavior) and internal dimensions of engagement (i.e. cognition and emotion) co-occur intra-individually in consistent and inconsistent ways. Moreover, student academic self-concept was considered as an antecedent to student engagement, and end-of-the year grades a learning outcome of it. Therefore, longitudinal relations between these variables could be investigated, allowing for insights into whether certain engagement patterns are proxies for underlying student motivation and subsequent achievement. The second objective was to examine the utility of individual engagement for teachers as a window into their students' characteristics for the purposes of assessment. This is mostly a novelty as teachers are often viewed as facilitators of student engagement or creators of stimulating learning environments; much less is known about their usage or interpretation of student engagement, what they perceive, and how they process information to gain insight into students' characteristics. Therefore, the present research investigated how teachers—with higher and lower

judgment accuracy of student characteristics—differed in their observation and usage of individual student engagement as components of judgment processes.

To guide the reader through the theory associated with this study and to reveal gaps in research, the theoretical background is structured into three sections. First, the construct of student engagement is narrowed down to a momentary, short-term experience and a typical division of engagement into behavioral, cognitive, and emotional dimensions is introduced. This is followed by an outline of how this division reveals individual differences in the form of engagement patterns. Second, a process model of motivation is shown to serve as a basis for demonstrating the extent to which hidden student characteristics are antecedents of visible student engagement; it also serves to identify the degree to which student engagement subsequently affects learning outcomes. Third, along the notion of the lens model, individual differences in student engagement are emphasized as a source of visible information for teachers that can be utilized to assess underlying student characteristics. These theoretical sections are followed by chapters summarizing the aim of the present research and its two studies, an overview of the methods implemented, and a brief summary of the findings of both studies. A joint discussion with respect to the main findings, methodological reflections, implications, and limitations is then presented. The dissertation closes with concluding comments.

2 Theoretical Background

2.1 Student engagement: Specifying an elusive construct

Engagement research commonly uses a review by Fredricks et al. (2004) as groundwork, which summarized what was understood by the term “school engagement,” how it was measured, and how it seemed to influence students’ academic outcomes (Alrashidi et al., 2016). Nevertheless, researchers did not develop a theory about the formation and structure of student engagement, leaving a theoretical gap that still exists today. In special issue publications, synthesizing reviews (e.g., Azevedo, 2015; Eccles, 2016; Sinatra et al., 2015), and handbooks (Reschly & Christenson, 2012), researchers have regularly pointed out that there is an urgent need for the development of a sound theory and even definition of student engagement. Until then, student engagement remains an elusive construct that is difficult to grasp. Scientists who contribute to the growing stream of engagement research have therefore been asked to clarify their particular understanding of student engagement to remain accessible and transparent for others (Appleton et al., 2008). Therefore, in this first section, the understanding of student engagement that underlies the present research is highlighted.

2.1.1 Definition and classification

Despite the need for a theoretical underpinning, there is already a consensus on some of the features of student engagement, which is adopted here for definitional purposes. Engagement reflects the intensity of student active involvement in an activity or context and can thus be present or absent to varying degrees. Student involvement is multidimensional, comprising several components that are predominantly described as the triad of how students behave, think, and feel (Boekaerts, 2016; Fredricks et al., 2004; Fredricks, Filsecker et al., 2016). Therefore, student engagement covers both overt (behavior) and internal aspects (cognition and emotion) of student involvement (Appleton et al., 2008). As engagement occurs during interaction with an activity or context, its occurrence depends strongly on contextual features. Engagement is, therefore, malleable to differences in students’ learning environments, such as targeted changes through intervention or the nature of different school subjects (Fredricks & McColskey, 2012; Skinner & Pitzer, 2012).

There is also agreement among researchers that student engagement can be differentiated along several criteria. First, engagement varies along different temporal levels ranging from a momentary, short term form (e.g., five minutes to an hour; Symonds et al. 2019) to longer term, prolonged forms (e.g., across several school years; Eccles, 2016; Fredricks, Filsecker

et al., 2016). Second, engagement can occur on different contextual levels ranging from engagement in schools as social institutions to engagement in classrooms or in specific learning activities (Eccles, 2016; Skinner & Pitzer, 2012). Third, different social levels of engagement can be distinguished; a distinction can be made between engagement at the individual level (engagement of individual students) and at the social level (engagement of a group of students, a whole classroom, or an entire school) (Azevedo, 2015; Sinatra et al., 2015).

Based on these distinguishing criteria, the research presented herein took a person-centered perspective and focused on engagement as the momentary process of behavioral, cognitive, and emotional involvement of individual students that occurred during one particular learning activity, essentially assuming a multidimensional approach. The focus of the dissertation is therefore on a very common type of classroom learning activity, in which teachers interacted with their students either in form of whole-class dialogues or when providing content- and task-related instructions (Seidel & Prenzel, 2006; Stigler et al., 1999). In order to elaborate on the notion of engagement as a multidimensional construct, the three dimensions of behavioral, cognitive, and emotional engagement will be presented in more detail in the following section.

2.1.2 Behavioral, cognitive, and emotional dimensions

Behavioral engagement refers to the broad range of students' overt, directly observable behaviors (Alrashidi et al., 2016; Fredricks, Filsecker et al., 2016; Reschly & Christenson, 2012) and is comprised of several distinct but related subcomponents. Fredricks et al. (2004) for example, identified positive conduct, involvement in learning activities, and participation in school-related activities as three subcomponents of behavioral engagement. Hospel et al. (2016), who set out to empirically test the multidimensionality of behavioral engagement, identified five subcomponents ranging from participation and following instructions to withdrawal, disruptive behaviors, and absenteeism. For the present investigation of student engagement in interactions with teachers, the notion of behavioral engagement as a student's voluntary and active participation is emphasized (Appleton et al., 2008; Fredricks et al., 2004). Participation is reflected in several student behaviors, such as nodding of the head, taking notes, collaborating with classmates, making eye contact with the teacher, contributing verbally to whole-class dialogues to share ideas or respond to a teacher's questions, and listening quietly when others are speaking (Hospel et al., 2016; Nguyen et al., 2018; Shi & Tan, 2020). With regard to whole-class dialogues and teacher–student interactions, it is important to note that these activities are typically structured by teachers, in that it is they who ask questions, call upon students, and provide feedback (Burns & Myhill, 2004; Mercer & Dawes, 2014). For students, it is a common rule that they

must raise their hand before they may respond to the teacher. In terms of student voluntary and active participation, then, hand-raising is an important feature, as it is a self-directed behavior reflecting students' intention to contribute verbally (Böheim, Knogler et al., 2020; Decristan et al., 2020).

The dimension of cognitive engagement comprises various aspects of students' covert mental investment in learning (Appleton et al., 2008; Fredricks et al., 2004), such as being thoughtful, being strategic, making an effort to understand complex ideas, preferring challenging tasks, and self-regulating learning (Alrashidi et al., 2016; Sinatra et al., 2015). Among these aspects, the definition of cognitive engagement as the use of learning strategies is the most specific (Chi et al., 2018). Typically, strategies of surface information processing are differentiated from deep information processing (Dinsmore & Alexander, 2012; Greene, 2015). Surface information processing refers to the repetition of information through rehearsal and memorization. Deep information processing involves the active mental manipulation of new information through organization (identifying connections among different pieces of new information) and elaboration (integrating new information with existing knowledge), and leads to transformed knowledge structures (Ainley, 1993; Greene, 2015; Weinstein & Mayer, 1986). Although these processes are internal, they can shine through in student behavior (e.g., when making notes) and language (e.g., verbalization) (Helme & Clarke, 2001). For instance verbalizing ideas and explanations in an exchange with a classmate might mirror students' own processing of the content. In a similar vein, Chi et al. (2018; Chi & Wylie, 2014) suggested a taxonomy of cognitive engagement that connects thinking processes not only to different types of student behavior but also to the content-related information contained in student behaviors. According to the authors, the content of student engagement provides insight into students' cognitive engagement. For example, a student's interaction with a classmate can provide insight into whether they are only reproducing information, connecting information, or generating their own thoughts and ideas that go beyond information that was already present in learning materials. Thus, student behavior and content of engagement can be jointly considered as possible overt proxies of students' cognitive engagement. It is worth noting that whether or not the inferences that a student makes based on existing information are correct does not fall under the dimension of cognitive engagement (Chi & Wylie, 2014).

Student emotional engagement is also used to refer to a variety of internal student experiences, for instance identification with school, feelings of belonging to school, and a positive attitude toward learning and academics (Fredricks et al., 2004; Fredricks, Filsecker et al., 2016). In terms of student momentary situational engagement in classroom learning activities, as it was considered in this research project, emotional engagement is commonly

defined as students' emotional reactions in the classroom (Boekaerts, 2016; Sinatra et al., 2015). These include discrete emotions of interest, enjoyment, boredom, anxiety, or sadness (Ainley & Ainley, 2011; Fredricks et al., 2004; Reeve, 2012). Such emotions are commonly labeled as achievement emotions as they pertain to academic achievement, and have been systematized in an integrative framework by Pekrun (2006; Pekrun et al., 2009). Achievement emotions differ in their object of focus, either relating to a learning activity itself (activity emotions) or to the outcomes of learning activities (outcome emotions). Moreover, they can be of a positive or negative valence (Obergriesser & Stoeger, 2020). For example, enjoyment is a positive activity emotion. Anger, frustration, and boredom are negative activity emotions. Hope and pride are examples for positive outcome emotions, while anxiety and shame are examples of negative outcome emotions (Ainley & Ainley, 2011; Pekrun, 2006). Similar to how student cognitive engagement is reflected in students' behavior and its content, student emotional engagement is likely to be mirrored in external indicators such as language (semantics and voice), body posture, and facial expressions (Helme & Clarke, 2001; Pekrun, 2006).

When considering student engagement as an individual's situational behavioral, cognitive, and emotional involvement, it follows that students show substantial differences along each dimension of engagement (Fredricks et al., 2004; Reeve, 2012). The next section examines this feature of student engagement more closely.

2.1.3 Individual differences

Considering significant variation in the number of verbal contributions by students as a threat to learning outcomes, research has typically considered inter-individual behavioral differences in students' participation in whole-class dialogues. Studies have revealed not only strong variation in students' verbal participation (Black, 2004; Clarke et al., 2016; Kelly, 2007; O'Connor et al., 2017), but also in the number of hand raisings (Böheim, Knogler et al., 2020; Böheim, Urdan et al., 2020; Decristan et al., 2020; Sacher, 1995). With respect to forms of student engagement that are internal, studies that address individual differences have clearly shown that students have different experiences of cognitive (Anderman & Young, 1994; Chi et al., 2018; Jurik et al., 2014; Pintrich et al., 1994) and emotional engagement (Ahmed et al., 2013; Daniels et al., 2008; Ganotice et al., 2016; Park et al., 2012).

Although these results indicate substantial variations in students' response to their learning environment, only the simultaneous consideration of the three engagement dimensions allows for a comprehensive understanding of individual differences in students' daily classroom experiences. Given that behavior, thought, and emotion are interrelated but

separate aspects of the learning process (Ben-Eliyahu et al., 2018; Wang et al., 2019), students may also differ in the intensity with which they are simultaneously behaviorally, cognitively, and emotionally engaged at any given moment. Maintaining this position in investigations would also give credit to the understanding of engagement as a momentary process occurring during a particular learning activity, in which the three dimensions interact dynamically and differentially in a nonlinear way (Eccles, 2016; Symonds et al., 2019). Consequently, many researchers have called for studies that clarify which types of engagement patterns are typical among students for the purpose of moving beyond simplistic distinctions of engaged versus disengaged, or active versus passive, students (e.g., Hospel et al., 2016; Lawson & Lawson, 2013; Skinner et al., 2009).

So far, researchers have mostly summarized the relationships of any two of the three dimensions using traditional variable-centered analysis, which does not consider whether the interplay of dimensions might differ between students (e.g., Chong et al., 2018; Li & Lerner, 2013). Only a few studies have started to examine common patterns of student engagement using person-centered analysis strategies. Some have focused on individual trajectories in the temporal development of the interplay of the three engagement dimensions (e.g., Archambault & Dupéré, 2017; Li & Lerner, 2011). As an example, students that showed high engagement in all three dimensions in the third grade could later be separated into those who upheld high values and those who showed a consistent decrease in their behavioral, cognitive, and emotional engagement during subsequent school years. According to Symonds et al. (2020), studies that dealt with different engagement patterns occurring at a certain time included a few that integrated variables external to student engagement into the patterns, and some that did not define engagement in a multidimensional way. Widlund et al. (2018), for instance, investigated the intra-individual combinations of achievement, engagement, and various features of academic well-being. Salmela-Aro (2016) and Virtanen et al. (2018) defined engagement as energy, dedication, and absorption. Others adopted the prominent multidimensional perspective of engagement (Bae & DeBusk-Lane, 2019; Conner & Pope, 2013; Schmidt et al., 2018; Symonds et al., 2020; Wang & Peck, 2013; Watt et al., 2017). These latter studies have a great heterogeneity in their designs, although they predominantly used self-report measures. Only, Symonds et al. (2020) assessed behavioral engagement through video coding. The studies differ in terms of whether they included students from various or specific grades in their samples, whether they investigated school engagement in general or engagement in specific subjects, and whether they approached engagement as a longer term or momentary experience. Different studies have identified between three and seven engagement patterns. In all studies, however, some form of consistent patterns (similar intensity of behavioral, cognitive, and emotional engagement) and inconsistent patterns

(diverse combinations of low, moderate, and high intensities across the three dimensions) have emerged.

By way of example, the studies by Symonds et al. (2020) and Schmidt et al. (2018) are presented in more detail here. These two studies were most important to the present research project, as they fall closest to the end of the spectrum that views engagement as a momentary process (rather than a long-term one).

Schmidt et al. (2018) identified engagement patterns in science for several learning activities, for instance lectures, laboratory work, group work, or individual work using an experience sampling method. A sample of 244 students from 12 classrooms stemming from one high school participated in the study. Behavioral (effort and concentration), cognitive (personal value), and emotional (interest and enjoyment) engagement were assessed with self-reports. Six engagement patterns occurred. Three of them were consistent with low (22%), moderate (18%), and high (10%) intensity across the three dimensions. The remaining three were inconsistent: One combined low emotional and cognitive engagement with moderate behavioral engagement (18%). Another consisted of moderate emotional and behavioral engagement in combination with low cognitive engagement (19%). And others (13%) reported low emotional, moderate behavioral, and high cognitive engagement.

Symonds et al. (2020) also investigated engagement patterns occurring during a single, standardized, ten-minute long English literacy task. The sample comprised 196 students in their first and second year of secondary school recruited from 16 classes in two schools from a socially disadvantaged area. Students' behavioral engagement was captured by video-coding aspects of their participation while their mental investment as well as their personal value, enjoyment, and interest were assessed by means of self-reports as measures of their cognitive and emotional engagement, respectively. Seven patterns of engagement were identified, including one with consistently high intensity (28%) and one with consistently low intensity (6%). The remaining five patterns were made up of inconsistent combinations. Three had high levels of behavioral engagement that were combined in diverse ways with high, moderate, and low levels of behavioral and cognitive engagement (47% combined), while two displayed combinations of low behavioral engagement with high or moderate cognitive and emotional experiences (19% combined).

These two initial studies on individual differences in student engagement provided strong evidence that a substantial number of students display inconsistent engagement patterns. This suggests that divergent dynamics of behavioral, cognitive, and emotional engagement are the norm rather than the exception (Symonds et al., 2020). However, high heterogeneity in the study design also requires further research to deepen the current understanding of

engagement by differentiating and generalizing the previous results. In terms of differentiating results, the prevalence of certain engagement patterns should be investigated more systematically in light of temporal, contextual, and social levels of engagement. It remains for example unclear how students' typical engagement patterns in whole-class dialogues as a common learning activity look like. It is repeatedly presumed that the group of students that refuse to participate consists of two subgroups: One that at least cognitively follows what is going on, and one that is consistently disengaged from the class and the teacher's questions (Decristan et al., 2020; O'Connor et al., 2017; Shi & Tan, 2020). By observing specific behavioral indicators, such as number of hand-raisings, and combining these with internal experiences of cognitive and emotional engagement dimensions, it would be possible to clarify whether such subgroups can be truly identified. Similarly, it could be assumed that the group of students who raise their hands also differ in their internal experiences and learning outcomes. Ultimately, only such a method would allow for statements to be made about the extent to which observed behaviors correspond to students' internal experience, and could thus serve as a proxy (Chi & Wylie, 2014; Peterson et al., 1984). In terms of generalizing results, the question remains as to whether engagement patterns identified in specific contexts play a similar role across different countries, grades, and school subjects (Bae & DeBusk-Lane, 2019).

2.2 Engagement as a linkage between student characteristics and learning outcomes

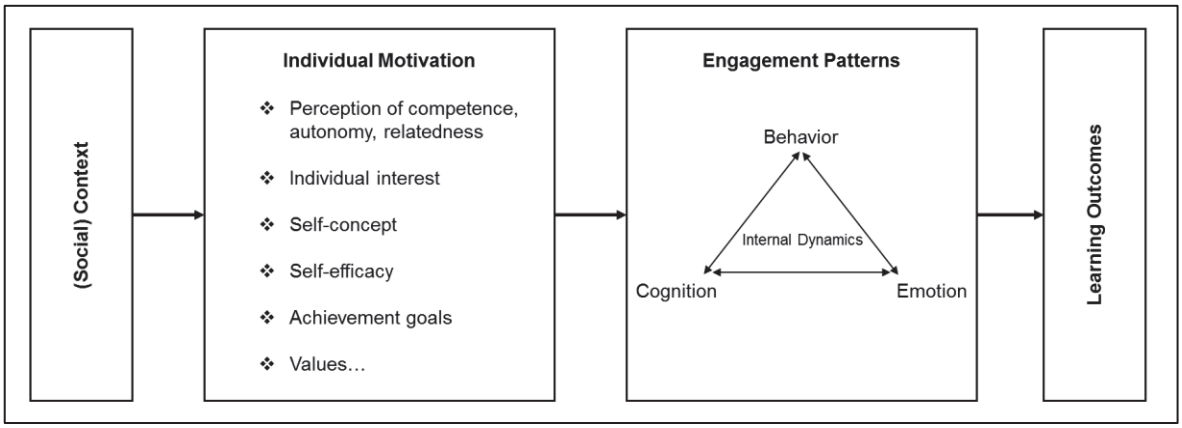
To highlight the central role that student engagement plays in learning, this section examines the processes through which hidden student characteristics become visible during student engagement, as well as the way in which student engagement leads to learning outcomes.

Engagement is a fundamental condition for student learning and related outcomes such as achievement and academic success; it is seen as the proximal and only process through which learning can occur (Reschly & Christenson, 2012). Further, it is most commonly described as the manifestation of students' motivation, which represents the psychological processes underlying the energy, purpose, and durability of one's actions and pertains to the psychological reasons for why students are doing something (Skinner et al., 2009). Hence, student engagement plays a central role in the mechanisms of student learning as a mediator between the psychological process of student motivation and subsequent learning outcomes (Boekaerts, 2016; Skinner & Pitzer, 2012). The self-system model of motivational development, formulated by Connell and Wellborn (1991), captures these

relationships and is common ground for much research on engagement (Fredricks & McColskey, 2012; Skinner et al., 2009). At the heart of this model lies the notion of a process in which social context shapes students' self-system processes: appraisals of the three basic needs (whether students feel competent, autonomous, and socially related) manifest in the intensity of student behavioral, cognitive, and emotional engagement, which in turn influence academic learning outcomes (Appleton et al., 2008; Skinner et al., 2008). As the idea of higher motivation manifesting in more intense student engagement is also part of other prominent motivation theories such as self-efficacy, expectancy-value, or achievement goal, Skinner et al. (2009) created a general process model of student motivation and engagement (see Figure 2). In this model, contextual features and diverse aspects of student motivation manifest in student engagement, which in turn influence learning outcomes. Hence, individual differences in the covert psychological motivational processes are commonly seen to be reflected in overt individual student engagement (i.e. engagement patterns). These relations will be outlined in more detail in the following sections.

Figure 2.

Process Model of Individual Motivation and Engagement Patterns (adapted from Skinner et al., 2009).



2.2.1 Student characteristics as antecedents

It is commonly assumed that students' perceptions of their own abilities and the subjective value of content of an activity jointly shape the intensity of students' behavioral, cognitive, and emotional engagement (Pekrun, 2006; Wigfield et al., 2009). In the present research project, these perceptions were respectively represented by academic self-concept and individual interest as motivational-affective antecedents of student engagement (Durik et al., 2017; Green et al., 2012; Marsh et al., 2005). Academic self-concept refers to students'

perception of their own abilities (Marsh & Martin, 2011; Shavelson et al., 1976) whereas individual interest describes the quality of a relation between a student and specific content. The relation comprises feelings, experiences of meaning, and personal value of the object of interest, where degree of interest correlates to how positive relationship is (Ainley, 2017; Hidi & Renninger, 2006). Consequently, individual interest is seen as an enduring motivational-affective student characteristic that can be differentiated from situational interest, which describes students' in-the-moment emotional experience (triggered through stimuli in the learning activity, introduced as an indicator of student emotional engagement in previous sections) (Schiefele, 2009; Wigfield & Cambria, 2010).

Although the process model of motivation and engagement (Figure 2) describes the key role of motivational-affective student characteristics, student cognitive characteristics, such as their cognitive abilities or pre-knowledge, also matter for learning and cannot be neglected (Snow, 1989; Snow & Swanson, 1992). Cognitive abilities are the degree to which students are able to successfully perform tasks that require mental processing of information to find a solution (Carroll, 1993). Students' pre-knowledge reflects the level of knowledge that students have already acquired. For mathematics, for instance, this comprises a mixture of procedural knowledge about specific, step-by-step solutions for particular tasks and conceptual knowledge about mathematical principals that can be applied to a variety of tasks (Rittle-Johnson et al., 2001).

Similar to engagement patterns in which consistent and inconsistent levels of engagement dimensions are intra-individually combined, students seem to develop individual profiles in which levels of motivational-affective and cognitive characteristics appear in various combinations (Lau & Roeser, 2008; Linnenbrink-Garcia et al., 2012; Seidel et al., 2016; Südkamp et al., 2018). Seidel (2006) and Kosel, Wolter et al. (2021), for instance, identified five distinct profiles for mathematics, in which individual interest and academic self-concept as motivational-affective characteristics and cognitive abilities and pre-knowledge as cognitive characteristics were taken into account. *Strong* students had consistently high motivational-affective and cognitive characteristics while for *struggling* students these characteristics were consistently low. A group of *overestimating* students tended to overestimate their abilities as they reported high self-concept and interest but had lower cognitive abilities and pre-knowledge. On the contrary, *underestimating* students seemed to underestimate their abilities and reported low motivational-affective characteristics although they displayed higher levels of cognitive characteristics. Another group of students was characterized above all by its comparatively low level of interest and was thus labeled as *uninterested*. Other studies have corroborated these findings when looking at other school subjects and using different motivational-affective and cognitive characteristics.

Besides consistent profiles, a significant proportion of students develop various inconsistent combinations (Lau & Roeser, 2008; Linnenbrink-Garcia et al., 2012; Südkamp et al., 2018).

At the empirical level, relationships between motivational-affective characteristics and engagement are well-documented. If students have secure self-concepts, they seem to be willing to compete with their classmates for the opportunity to contribute an answer by raising their hand, and take the risk of saying something wrong in front of the class, thereby making their misunderstandings public (Abdullah et al., 2012; Böheim, Knogler et al., 2020; Sacher, 1995). Similarly, perceiving oneself as competent makes it more likely that one will try hard to understand and master the content of a learning activity through deeper and more flexible cognitive information processing (Greene & Miller, 1996; Liem et al., 2008; Linnenbrink & Pintrich, 2003; Walker et al., 2006); it is also more likely that one will experience positive emotions like enjoyment while doing so (Goetz et al., 2008; Martin & Rimm-Kaufman, 2015; Pinxten et al., 2014). Furthermore, higher ability perceptions were found to relate to patterns of higher engagement (Bae & DeBusk-Lane, 2019; Symonds et al., 2020). Since interest accompanies the goal of enhancing one's understanding of the content one is interested in, it naturally includes an internal desire for repeated and persistent engagement with that content (O'Keefe et al., 2017; Renninger & Bachrach, 2015). Thus, if a learning activity contains content for which students have developed an individual interest, they should be more likely to be behaviorally, cognitively, and emotionally engaged (Ainley, 2017; Durik et al., 2017; Hidi & Renninger, 2006; Schiefele, 2009). Despite a lack of studies that explicitly focus on the relationship between individual interest and multidimensional student engagement (Böheim, 2020), evidence corroborated relations between individual interest and student participation (Böheim, Knogler et al., 2020), deep information processing (Schiefele & Krapp, 1996), and situational interest (Knogler et al., 2015; Linnenbrink-Garcia et al., 2013).

In a similar vein, evidence has shown that students with profiles of higher motivational-affective characteristics display higher behavioral and cognitive engagement, irrespective of the level of their cognitive characteristics in comparison to students with lower motivation profiles (Jurik et al., 2013, 2014; Lau & Roeser, 2008). Hence, the motivational-affective components of student profiles are reflected in the intensity of engagement dimensions while the cognitive components seem to be unrelated to it. However, as outlined above, student behavioral engagement allows high inferential conclusions about the intensity of cognitive engagement, as students' thinking becomes overt in the content of their engagement (Eccles, 2016; Helme & Clarke, 2001). Following this notion, it is argued that the cognitive characteristics of students manifest in the quality of the content of their engagement rather than the intensity. More precisely, the content of student engagement

might first reflect whether a student is highly cognitively engaged; that is, whether the student elaborates on available information and uses it as a starting point for generating their own ideas (Chi et al., 2018; Chi & Wylie, 2014). Second, the quality of these ideas, for example whether they are based on sound reasoning or whether they integrate pre-knowledge, gives insight into students' cognitive characteristics. An important example might be the quality of students' answers to a teacher's questions. Incorrect answers can indicate weaker knowledge, whereas correct answers reflect stronger knowledge (Linnenbrink & Pintrich, 2003; Thiede et al., 2015). Altogether, it may be assumed that motivational-affective student characteristics are reflected in the intensity of engagement dimensions, while cognitive characteristics are mostly displayed in the quality of the content of engagement.

Overall, the relation between student characteristics and engagement is well-documented. However, apart from insights provided by two studies (Bae & DeBusk-Lane, 2019; Symonds et al., 2020), research on the relationship between motivation and engagement from a differential perspective—one that considers the individual usage of learning opportunities expressed in engagement patterns that combine behavior, cognition, and emotion in consistent and inconsistent ways—is still sparse. Hence, there is still a strong need for further research exploring student engagement patterns (Lawson & Lawson, 2013; Wang et al., 2019). Yet typical patterns of student engagement in whole-class dialogues and how they may be determined by examining student characteristics remain unclear. There may be subgroups of students, for instance, who avoid participating while following explanations provided by their teacher and classmates attentively and with interest, whereas others might be completely disengaged, experiencing boredom and letting their minds wander. Since both engagement patterns can probably lead to different learning outcomes, it seems important to understand their motivational antecedents as a potential starting point to support students in developing more favorable engagement patterns. However, such detailed analyses remain open thus far (O'Connor et al., 2017; Sacher, 1995; Shi & Tan, 2020).

Now that the path of the process model of motivation (Figure 2) from student characteristics to engagement has been presented in detail, the relationship between engagement and achievement will be examined.

2.2.2 Learning outcomes

Confirming the general process model of motivation and engagement (Figure 2), student engagement is well-documented as the critical pathway to student learning and academic success (Alrashidi et al., 2016). In particular, student engagement in whole-class dialogues

should play a key role in student learning, since learning is assumed to rely on the interdependence of individual cognition and social processes, thus involving an interplay of cognitive and behavioral engagement (Cobb, 1972; Loyens & Gijbels, 2008; Palinscar, 1998; Windschitl, 2002). Based on available information, students may first individually interpret a situation and mentally make sense of the content. They can, then, share their own thoughts and make these accessible to their classmates and teachers as (new) information. To do so, students need to make their particular understanding explicit, structure their thoughts in a way that makes them easy to follow, and provide accepted reasoning (Burns & Myhill, 2004; Decristan et al., 2020). This provides other students with the opportunity to process new information they did not develop on their own. They can reflect on their own understanding in comparison to that of their classmates, eventually identifying similarities, complements, and misconceptions, and build upon them with their own verbal contributions (Burns & Myhill, 2004; Yackel & Cobb, 1996). A social co-construction thus unfolds in that the meaning-making of individual students stimulates the same process in other individuals (and vice versa) towards a shared understanding within the class (Dixon et al., 2009). Moreover, in whole-class dialogues it is typical for teachers to evaluate students' responses and to provide some form of feedback (Mercer & Dawes, 2014). Since this feedback is overt, it provides an additional relevant source of information for all students (Decristan et al., 2020).

Along this assumed interplay of individual cognition and social interaction, studies have been mostly concerned with the influence of verbal participation on student learning, assuming this might be the most influential factor. Indeed, some studies have shown positive relations between the frequency of students' explanatory verbal contributions and their achievement, especially if they are built upon preceding contributions (Sedova et al., 2019; Webb et al., 2014). At the same time, other studies did not find any difference between silent and vocal students' learning gains and achievement (Flieller et al., 2016; Inagaki et al., 1998; O'Connor et al., 2017; Pauli & Lipowsky, 2007). Based on these results, it is argued that actively listening and being cognitively involved in whole-class dialogues might serve as sufficient usage of learning opportunities, since these types of teacher–student interactions are overt to all students (Flieller et al., 2016).

Several studies corroborate this argument. Regardless of whether students were able to actually share their ideas with the class, the very anticipation and intention of providing an answer increased student learning outcomes while it did not matter whether students could actually share their ideas with the class (Böheim, Urdan et al., 2020; Decristan et al., 2020; Stahl & Clark, 1987). Moreover, there is strong evidence that deeper cognitive information processing relates to student learning while surface processing seems to have negative

impacts (Ainley, 1993; Greene & Miller, 1996; Liem et al., 2008; Sedaghat et al., 2011). With regard to students' emotional engagement, it appears that positive emotional experiences (e.g., enjoyment) support student learning, while negative ones (e.g., boredom or anger) are inhibitory (Pekrun et al., 2009; Pekrun et al., 2010; Pekrun et al., 2017; Tze et al., 2016). However, evidence for an influence of situational interest is limited and does not provide a clear picture in relation to student achievement (Rotgans & Schmidt, 2011; Tapola et al., 2013). In terms of engagement patterns, there is a clear tendency that consistently high and consistently low engagement relate to higher and lower achievement, respectively (Conner & Pope, 2013). Further, students seem to be able to compensate for either low behavioral or low emotional engagement with higher intensities in each of the other two dimensions (Bae & DeBusk-Lane, 2019; Wang & Peck, 2013). A lack of cognitive engagement, however, could not be compensated by higher behavioral and emotional dimensions (Wang & Peck, 2013; Watt et al., 2017).

This outline of available research made clear that although all engagement dimensions on their own impact learning outcomes, the effects of individual differences in the form of engagement patterns have only been tentatively determined. There is need for more longitudinal studies that consider the full mechanism of student motivation as an antecedent and achievement as a learning outcome, thereby shedding light on the interaction of the three dimensions of engagement (Eccles, 2016; Finn & Zimmer, 2012; Hospel et al., 2016; Li & Lerner, 2013). As outlined above, the way in which students typically engage in whole-class dialogues as important learning activities in everyday classrooms remains unclear, although some assume that the group of silent students who refuse to contribute their ideas might consist of two subgroups: One that listens actively and is cognitively active and one that might completely withdraw their engagement (Clarke et al., 2016; O'Connor et al., 2017; Shi & Tan, 2020). Such differential usages of learning opportunities might lead to different learning outcomes; silent but cognitively and emotionally engaged students might be able to compensate for their low behavioral engagement (Decristan et al., 2020). Only person-centered studies taking engagement patterns and learning outcomes into account can advance current understandings and clarify whether there are different types of individual engagement that might function sufficiently for student learning outcomes, whether there is a superior engagement pattern, or whether a specific type can be classified as a risk factor.

2.3 Engagement as a window for teachers into students' characteristics

As shown in the previous section, student engagement plays an important role for learning outcomes and differences in student characteristics manifest in the intensity and content of engagement. Therefore, the following section is focused on the teachers' perspective and how they make use of student engagement as a source of information in their assessment of student characteristics.

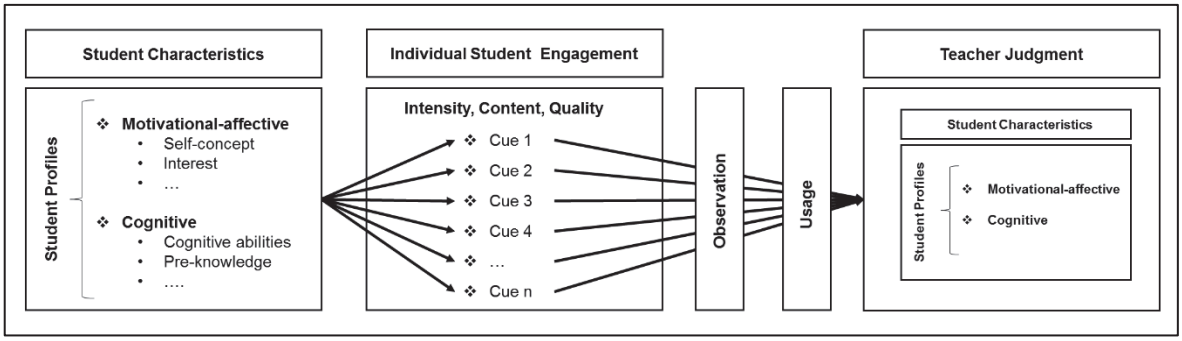
Strong assessment skills are one important facet of teachers' professional competence to make effective educational decisions and adapt their planning and teaching to the needs of individual students (Baumert & Kunter, 2006; Corno, 2008; Schrader, 2009). Students' cognitive abilities (Deary et al., 2007; Roth et al., 2015), achievement (Steinmayr & Spinath, 2009), academic self-concept (Huang, 2011; Steinmayr & Spinath, 2009; Valentine et al., 2004), and individual subject interest (Jansen et al., 2016; Schiefele et al., 1992) are among the most decisive determinants of learning outcomes. Because of this, cognitive and motivational-affective characteristics, as well as their intra-individual combinations, are considered important objects of teachers' formative assessments (Herppich et al., 2018; Loibl et al., 2020). Prior research has mainly focused on the accuracy of teacher judgments (see for a current review Urhahne & Wijnia, 2021). Teachers seem to assess cognitive abilities (Machts et al., 2016) and achievement relatively accurately (Südkamp et al., 2012), while they demonstrate more difficulty in assessing students' motivation in the form of self-concept (Praetorius et al., 2013; Spinath, 2005; Urhahne & Zhu, 2015) and interest (Karing, 2009). Concerning the assessment of both (cognitive and motivational characteristics) at the same time, teachers systematically underestimate the extent to which they are intra-individually combined in inconsistent ways. They seem to intermingle both types of characteristics (Kaiser et al., 2013) and assess their students simply as being consistently average, below-average, or above-average (Huber & Seidel, 2018; Südkamp et al., 2018). Yet experienced teachers tend to be more accurate than student teachers when asked to assign students to particular student profiles with predefined consistent and inconsistent combinations of motivational-affective and cognitive characteristics (Seidel et al., 2020). Furthermore, teachers find more difficult to make pedagogical decisions for students with inconsistent profiles and feel less confident when doing so (Pit-ten Cate et al., 2020). To understand the emergence of these difficulties, attention must be given to judgment processes and their underlying behavioral and cognitive activities; this would allow to identify the mechanisms involved in the formation of accurate and inaccurate judgments (Karst & Bonefeld, 2020; Kosel, Holzberger et al., 2021; Loibl et al., 2020).

Since teaching represents a vision-intense profession in which teachers generate important information by monitoring their students (Carter et al., 1988; Gegenfurtner, 2020), observation and interpretation of information represent relevant behavioral and cognitive activities of judgment processes, respectively (Loibl et al., 2020). Thus, a teacher's ability to make correct observations and form interpretations based on professional knowledge is seen as a central component of their professional competence (Blömeke et al., 2015; Santagata & Yeh, 2016), and is typically theorized and researched under the label of teacher professional vision (Goodwin, 1994; Seidel & Stürmer, 2014; Sherin & van Es, 2009). Following the reasoning presented in preceding sections, students' covert motivational-affective and cognitive characteristics manifest in overt student engagement. Thus, hidden student characteristics are observable in student engagement. In particular, the intensity, content, and quality of content of student engagement together provide a window into students' motivational-affective and cognitive characteristics (Chi & Wylie, 2014; Fredricks et al., 2011; Helme & Clarke, 2001; Skinner et al., 2009). Teachers can monitor whether students raise their hand, fill in worksheets, work together with peers, follow instruction, and come up with their own ideas, and subsequently use these observations as information cues about students' pre-knowledge, individual interest, or self-concept (Reeve, 2012). This notion is also captured in the so-called lens model (Brunswik, 1955) and in its continuation, the realistic accuracy model (Funder, 1995, 2012), from psychological research. Together, these models are used as a basis for the investigation of judgment processes in other research fields, for instance social sciences, business sciences, and medicine (Funder, 1995, 2012; Kaufmann et al., 2013; Kuncel et al., 2013), and have also been more recently recognized within the field of education (Cooksey et al., 2007; Praetorius et al., 2017; Thiede et al., 2015; Urhahne & Wijnia, 2021). The models illustrate how individuals make sense of others' hidden characteristics, such as personality traits, by paying attention to their perceivable, overt features and interpreting them as proximal information cues. It is postulated that teachers are required to observe and use several student cues to infer student characteristics. Only if they combine different cues from one student may they be able to assess motivational-affective and cognitive characteristics in combination (Cooksey & Freeboy, 1986; Nestler & Back, 2013; Thiede et al., 2015). For example, the intensity of student engagement can be utilized as information about a student's level of motivation (e.g., frequent hand raisings as an indicator for high self-concept; Böheim, Knogler et al., 2020) while the quality of engagement content can be used as information about their level of understanding (e.g., correct answers as indicator of stronger knowledge; Thiede et al., 2015). The combination of such information cues enables teachers to differentiate between profiles with different levels of student characteristics. Further, among all available cues for one student there might be some that are more

"diagnostic" (Funder, 1995; Thiede et al., 2015) or "ecologically valid" (Back & Nestler, 2016; Cooksey & Freeboy, 1986; Nestler & Back, 2013) in that they are more specific and conclusive for particular student characteristics than others. Therefore, it is assumed that accurate judgments are dependent on the observation and usage of these more relevant types of student cues. Overall, the lens model provides a suitable framework for the processes of teachers' assessments (Figure 3). Its components of observation and utilization will be outlined in more detail in the following sections.

Figure 3.

Lens Model of Teacher Judgment Processes (adapted from Brunswik, 1955).



2.3.1 Eye movements to observe student engagement

In principle, teachers seem to be able to perceive students' engagement and its behavioral, cognitive, and emotional dimensions (Fredricks, Wang et al., 2016; Lee & Reeve, 2012; Reeve, 2012; Urhahne & Wijnia, 2021). Their concrete behavior of observing students can be detected through their eye movements (Gegenfurtner, 2020; Grub et al., 2020; Loibl et al., 2020), which are differentiated in saccades and fixations. Whereas saccades are rapid movements that bring the objects in front of the fovea so that they can be seen sharply, fixations are moments when the eye is relatively still and visual information is perceived and processed (Holmqvist et al., 2011; Krauzlis et al., 2017). The location and duration of fixations are determined by the person's declarative knowledge (i.e. top-down) and salient situational features like fast movements or bright colors (i.e. bottom up; DeAngelus & Pelz, 2009; Schütz et al., 2011). The measurement of these eye movements through eye-tracking is a relatively new method within the field of educational science (Jarodzka et al., 2017). Initial studies were mostly concerned with differences in eye movement patterns between student teachers as novices and experienced teachers as experts (Grub et al, 2020), and were positioned in the context of research on professional vision (e.g., Stürmer et al., 2017), classroom management (e.g., Wolff et al., 2016), teacher–student interactions (e.g., McIntyre et al., 2019), and teacher assessment (e.g., Kosel, Holzberger et al., 2021). Across

these studies, expert teachers showed a more knowledge-driven pattern of eye movements with more frequent and shorter fixations on relevant areas in the classroom similar to patterns of experts in other domains (Gegenfurtner et al., 2011; Grub et al., 2020). They focused more on students than other classroom objects and monitored the classroom constantly, even when they recognized relevant events or interacted with students (Cortina et al., 2015; McIntyre & Foulsham, 2018; van den Bogert et al., 2014) while student teachers' gaze seems to be driven in particular by active student behaviors (Goldberg et al., 2021). The one study that connected eye movement patterns in a classroom context to judgment accuracy showed that experts returned to the students to be assessed more often with their gaze and that they were more flexible in switching their gaze between students (Kosel, Holzberger et al., 2021). Based on the available research, eye tracking seems to be an appropriate approach to investigating teachers' observation behavior in judgment processes. More studies are needed that focus on the relation of this behavior to judgment accuracy and that investigate how teachers with high and low judgment accuracy differ in their observation of students.

2.3.2 Usage of student engagement

When it comes to the pedagogical interpretation of classroom events, experienced teachers are often found to make better sense of classroom situations than student teachers and beginner teachers (Berliner, 2001; Kim & Klassen, 2018; Meschede et al., 2017; Sabers et al., 1991; Star & Strickland, 2008) due to more encapsulated knowledge structures in which practical experiences and declarative knowledge are interwoven (see for a current review Boshuizen et al., 2020). Nevertheless, differences in pedagogical interpretations are already apparent between student teachers (Stürmer et al., 2016).

In terms of the information that teachers utilize to assess motivational-affective and cognitive characteristics, it was reported with concern that they relied on rather irrelevant background characteristics of students such as socioeconomic status, gender, ethnicity, and immigration status (Bonefeld et al., 2020; Brandmiller et al., 2020; Garcia et al., 2019). So far, research that has focused on the use of observed student cues is scarce. Seidel et al. (2020) reported that although student teachers and experienced teachers, who viewed a classroom video to assess combinations of motivational-affective and cognitive characteristics, did not differ in the number of student cues utilized, student teachers seemed to rely in particular on more salient student cues. The one study by Marksteiner et al. (2012) that focused explicitly on the connection between cue utilization and judgment accuracy showed that although beginner teachers were able to identify diagnostic student cues to detect whether students were lying or telling the truth, they had difficulties in utilizing this information to form accurate judgments.

This initial research showed that our current understanding of teachers' usage of student cues is very limited. This is especially problematic as teachers are willing to assess their students' accuracy but have problems using relevant information (Urhahne & Wijnia, 2021). Therefore, it seems necessary to deepen the initial investigations as a precondition to supporting teachers in the development of their assessment skills. In particular, questions remain as to which student cues teachers utilize and how they apply them when assessing learning-relevant features such as students' motivational-affective and cognitive characteristics and their intra-individual combinations (Brandmiller et al., 2020; Glock et al., 2013; Huber & Seidel, 2018; Praetorius et al., 2017). It is unknown whether teachers focus on the intensity and content quality of student engagement or whether they rely on rather irrelevant information. Moreover, connections between teachers' reliance on student cues and the accuracy of their judgments are so far unclear. There is, for instance, no evidence of differences between how teachers with lower and higher judgment accuracy use student cues, although such cognitive activities of judgment processes may play a crucial role in accurate judgments (Loibl et al., 2020; Urhahne & Wijnia, 2021).

3 Present Research

In general, this dissertation deals with the phenomenon that hidden student characteristics become visible and observable in individual differences in student engagement. Therefore, student engagement has the potential to serve as a window into students' motivation and cognition, and thereby provides an information base for teachers to adjust their instruction or make pedagogical decisions. By considering both of these perspectives, the present project connected psychological research on students' learning-relevant characteristics with research on teachers' assessment skills and focused on an aspect of the engagement construct whose potential has not yet been exploited in previous research. Particularly, it aimed to explore individual differences in student engagement, their antecedents and learning outcomes, as well as to examine the utility of student engagement for teachers' assessment processes of motivational-affective and cognitive student characteristics.

The first study advanced prior research on student engagement by considering students' behavior, thoughts, and feelings as three interacting dimensions of their momentary involvement in learning activities. Student hand raisings were implemented as an external, easily observable behavior, while the cognitive and emotional dimensions were assessed as students' internal experiences. This way it was possible to identify typical patterns of student engagement during whole-class dialogues. Following upon the overall goal of the study, it was possible to examine whether the intensity of hand-raising behavior was a relevant proxy for the intensity of students' cognitive and emotional experiences; and whether hand-raisings were consistently or inconsistently combined with student internal engagement dimensions (RQ 1). These findings may also inform research on classroom dialogues by identifying whether the groups of students who seek to participate vocally and those who avoid vocal participation are each homogenous subgroups or whether they are further differentiable in several subgroups. Further, level of academic self-concept and end-of-the-year grades were considered as an antecedent and outcome, respectively (RQ 2 and RQ3). This allowed not only to identify whether some engagement patterns were particularly important for student learning or whether some engagement dimensions could be compensated by others, but also whether hand raisings were a relevant proxy for student self-concept and later achievement. Do all students who avoid raising their hand suffer from low self-concept and achievement? Do all students who want to participate hold high self-concepts and gain high achievement?

The second study was situated within the context of research on teacher assessment skills and expands upon previous investigations by emphasizing the connection between judgment accuracy and judgment processes. Building upon the notion of teaching as a

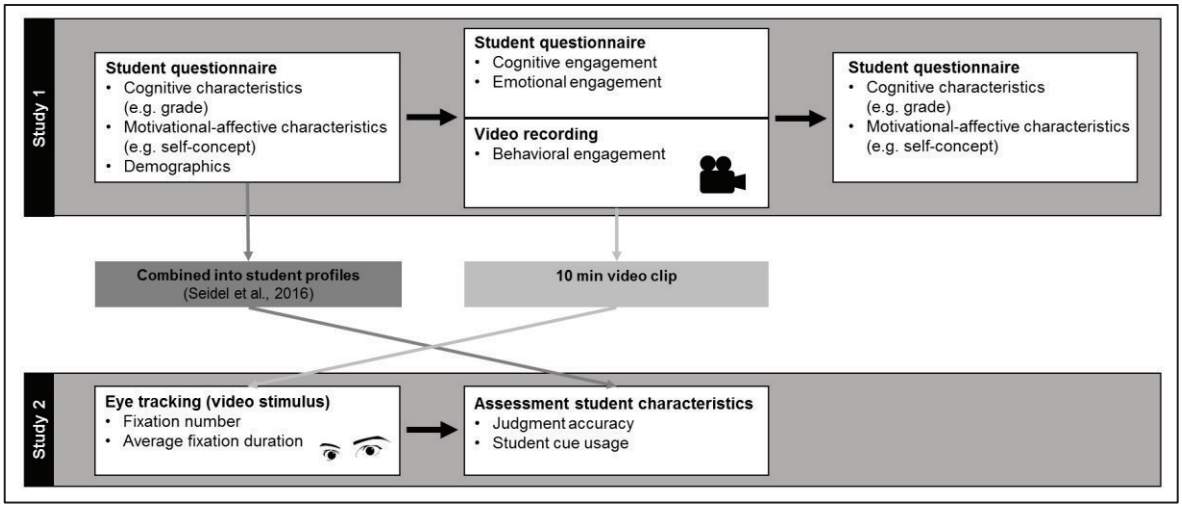
vision-intense profession in which teachers gain information by monitoring their classrooms and closely observing their students, student engagement was considered as a source of information about their motivational-affective and cognitive characteristics. With regard to the overarching goal of this dissertation, the extent to which teachers were able to correctly assign consistent and inconsistent student profiles was examined, and included an investigation into whether they had difficulties with particular student profiles and whether they were making systematic interchanges of profiles (RQ 1). Further, eye movements were implemented as a measure of teachers' observation behavior underlying judgment processes. Therefore, it was possible to identify whether teachers with higher and lower judgment accuracy differed in their monitoring of target students (RQ 2). Finally, the ways in which teachers utilized their observation of student engagement were evaluated as a cognitive activity of judgment processes. The student cues that were reported the most often were identified, as were the ways in which teachers with higher and lower judgment accuracy combined student cues to assess student profiles (RQ3). Together, this provided insight into the utility of student engagement as a window into their motivational-affective and cognitive characteristics. Do teachers utilize the intensity and content of student engagement? And, if so, how do they combine this information to distinguish student profiles that share the level of one characteristic (e.g. motivation) but differ on others (e.g. cognitive)?

4 Methodology

Both studies that form the basis of this dissertation were conducted as part of two consecutive research projects funded by the German Research Foundation (DFG). Study 1 was embedded in the first part of the INTERACTION project, “Opportunities to Learn” (Grant No. SE139/7-1), which was conducted to investigate the interplay of cognitive and motivational-affective student characteristics and their effect on teacher–student interactions. Data for the second study, Study 2, came from the second part of the INTERACTION project, “Students through teacher eyes” (Grand No. SE139/7-3), in which teacher attention processes were explored. A summary of the methodological approaches of the two studies is presented in the present section and their connections are illustrated in Figure 4. Interested readers will find a more detailed description of the samples, procedures, measurements, and analyses in the respective publications (see the appendix).

Figure 4.

Methodological Procedures for Study 1 and Study 2.



4.1 Study 1 – Identifying individual differences in student engagement

This first longitudinal field study was based on a sample of 397 eighth-grade students (M_{Age} = 13.80 years, *SD* = 0.53; 58.90% female) recruited from 20 mathematics classrooms of 18 high-track secondary schools in the metropolitan region of Munich.

At the beginning of the 2013/2014 school year, students’ final mathematics grades from the previous school year, a measure of pre-achievement, and students’ self-concept in the

subject of mathematics (five items; α =.92; Mang et al., 2018) were assessed using a self-report questionnaire. To measure student engagement, one mathematics lesson (45 minutes long) was videotaped in each classroom around the middle of the school year. Within these lessons, most of the time was spent on teacher-centered, whole-class dialogues (80.7%). Following the videotaped lesson, student cognitive (9 items; α = .84) and emotional engagement (6 items; α = .87) was captured using self-report questionnaires previously implemented in a large German video-based study (Seidel et al., 2003). To assess student participation, systematic video observation was applied. Two independent coders (κ = .73; ICC = .98; interrater agreement: 77.1%) counted the number of hand-raisings per student using INTERACT software version (Mangold, 2014). At the end of the school year, students' final mathematics grades were collected as a measure of achievement.

To explore typical engagement patterns and investigate their longitudinal associations with student self-concept as an antecedent and final grades as an outcome, a latent profile analysis (LPA) in combination with a manual BCH three-step approach was applied (Bakk et al., 2013; Bolck et al., 2004). This method is state of the art and recommended when investigating such structural associations (Asparouhov & Muthén, 2020; Nylund-Gibson et al., 2019). In a first step, the number and type of engagement patterns were explored with LPA in Mplus version 8.4 (Muthén & Muthén, 1998-2017). This is a person-centered way of analyzing data that identifies homogeneous subgroups within a sample based on a set of indicator variables. In the present case, the number of hand-raisings and the averages of the cognitive and emotional engagement scales were used as indicator variables accounting for their different distributions as count variable and normally distributed variables, respectively. Models with one to eight profiles were estimated with a maximum likelihood estimator with robust standard errors (MLR). Furthermore, 5,000 starting values and 200 stage optimizations were used for each model to avoid the identification of local maxima. To compare the fit of the models, several information criteria values (AIC, BIC, ABIC; Akaike, 1973; Schwarz, 1978), likelihood ratio tests (BLRT, LMRT; Lo, 2001; McCutcheon, 1987), entropy values (Wedel & Kamakura, 2000) as well as interpretability and meaningfulness of subgroup sizes were considered (Marsh et al., 2009). In the second step, each student was assigned to the most likely profile while accounting for the connected classification error by saving BCH-weights from the first step (Asparouhov & Muthén, 2020). Third, one model was estimated with antecedents, profiles, and outcomes adjusted for the classification error by using the BCH-weights. Direct effects of mathematical self-concept on engagement patterns (controlling for pre-achievement and gender) were estimated with a logistic regression; direct effects of engagement patterns on achievement were evaluated by comparing group means.

4.2 Study 2 – Exploring teachers' judgment accuracy and process indicators

Forty-three student teachers (M_{Age} = 21.59; SD = 1.60; 62.8% female) enrolled at the Technical University of Munich in a bachelor's program to become science and/or mathematics teachers at German high-track secondary schools (high schools) took part in the second study.

Data were collected in the university laboratory. First, participants were introduced to learning-relevant motivational-affective and cognitive student characteristics and their combinations in student profiles: strong, struggling, overestimating, underestimating, and uninterested (Kosel, Wolter et al., 2021; Seidel, 2006). Next, participants were instructed to carefully observe a 10-minute video stimulus showing a typical eighth-grade mathematics classroom with 23 students. The class involved a combination of whole-class teacher–student interactions and a lecture by the teacher. After viewing the video, participants were asked to assess the characteristics of five target students (each featuring one student profile of strong, struggling, overestimating, underestimating, and uninterested identified by Seidel et al., 2016). During the video observation period, participants' eye movements were recorded with the SMI RED 500 binocular remote eye tracker and Experiment Center 3.7 software (Senso Motoric Instruments, 2017b). Afterward, participants were asked to assign each target student to one of the five student profiles (each profile could only be assigned once) and voluntarily note down student cues they had used for their assessment. As a measure of judgment accuracy, participants received one point for each correctly assessed student profile (up to a maximum of 4 points as the fifth correct profile would result from exclusion). To measure the observation of students, eye movements (fixation number and average fixation duration) were assessed in relation to each target student through manually drawn areas of interest (AOI) with the SMI Begaze 3.7 (Senso Motoric Instruments, 2017a). These data were available in a high quality for n = 32 participants (average tracking ratio of 96%, average deviation on x-axis = 0.49° and y-axis = 0.56°). To capture which cues student teachers utilized, the content of voluntary answers (n = 27 participants) to the question of which cues participants had used to assess student profiles was inductively coded by two independent researchers (κ = 0.93). This resulted in five categories—intensity of behavioral, cognitive, and emotional engagement, content of engagement, and student confidence—that comprised 26 single codes in total.

To get an overall impression of how well student teachers assessed student profiles, the distribution of the accuracy scores was visually inspected. Whether some profiles were judged with higher accuracy was investigated with a non-parametric Friedman test for

repeated measures. Additionally, relative frequencies of common interchanges were descriptively compared. To contrast student teachers with high and low judgment accuracy, the sample was split along the median of the accuracy score. These two groups were compared with a series of unpaired t-tests, corrected for multiple comparisons, regarding the number of fixations and average fixation duration for each target student. In terms of the usage of student cues, relative frequencies of each code were inspected to identify which student cues were predominantly reported. To identify prominent differences between student teachers with high and low judgment accuracy in terms of used combinations of student cues, an epistemic network analysis (ENA; Shaffer et al., 2009; Shaffer et al., 2016) was applied. This analysis visualizes the frequencies of code co-occurrences for a particular unit of analysis within a so-called stanza, the local or temporal scope in which the co-occurrences are registered, through the creation of (cumulative) adjacency matrices and their transformation over high-dimensional space vectors into a low-dimensional projected space. In the present case, the co-occurrences of student cues that were registered within single written answers were visualized for the groups of student teachers with high and low judgment accuracy and for each student profile. Therefore, network nodes corresponded to student cues and edges represent the relative frequencies of their combinations. Differences in the structures of networks were identified in two ways: first by comparing the location of network centroids with a t-test along the x- and y-axis, and second by inspecting qualitative differences in the subtracted networks across student profiles that visualize differences between two networks.

5 Summary of Publications

5.1 Study 1 – Student engagement patterns

In the first study (see Article A in the appendix, Schnitzler et al., 2020a), individual student engagement was investigated. Based on the multidimensional understanding outlined in the theory section, student engagement was assumed as a momentary state in which behavioral, cognitive, and emotional aspects simultaneously co-occur. The specificity of student behavioral engagement as an observable feature and of cognitive and emotional engagement as internal dimensions were considered. The number of hand-raisings was used as a unique, real-time measure for student behavioral engagement, and self-report questionnaires were used for student emotional and cognitive engagement. The study aimed to explore typical combinations of the three dimensions within individual students (i.e. engagement patterns). In keeping with the process model of motivation (Figure 2), a second aim was to gain comprehensive insight into the role of these combinations in learning processes and their longitudinal relations, with academic self-concept as an antecedent and achievement as an outcome.

Five distinct engagement patterns were identified with LPA. First, a *disengaged* pattern, with few hand-raisings, and cognitive and emotional engagement lower than the grand mean, was most common among students. Second, students presenting with a *compliant* pattern raised their hands more than the average, while reporting a cognitive and emotional engagement only slightly lower than the grand mean. Third, *silent* students raised their hands least often while reporting being cognitive and emotionally engaged above the average. Fourth, students showing an *engaged* pattern raised their hands around the grand mean but stood out due to their high cognitive and emotional engagement. Finally, a small group of *busy* students raised their hands extraordinarily often and reported at the same time above-average cognitive and emotional engagement. Therefore, only the disengaged students showed a clearly consistent interplay of the three engagement dimensions while all other patterns were rather inconsistent.

Busy students reported the highest self-concept of mathematical abilities, followed by engaged, silent, compliant, and disengaged students. The higher a student's self-concept, the significantly more likely they were to show a pattern of higher engagement (compliant, silent, engaged, or busy) than a disengaged one. Conversely, self-concept did not affect the likelihood of membership between these profiles of higher engagement. Pre-achievement and gender were not related to engagement patterns. Busy students gained highest achievement at the end of the school year, followed by students showing engaged,

compliant, silent, or disengaged patterns. Disengaged students showed significantly lower achievement than their peers with other engagement patterns, who in turn did not differ in their achievement. Therefore, profiles with higher numbers of hand-raisings could be seen as a relevant proxy for higher levels of student self-concept and later achievement. However, profiles characterized by lower numbers of student hand-raisings do not coincide with low levels of student self-concept and subsequent low achievement per se.

5.2 Study 2 – Ways in which teachers observe and utilize student engagement

The second study (see Article B in the appendix, Schnitzler et al., 2020b) sought to advance research on teacher assessment skills. Following the theoretical outline in the preceding sections and the lens model (Figure 3), cognitive and behavioral process indicators were assumed to be critical and, therefore, connected to differences in accuracy of teacher judgment. Teachers' eye movements were assessed as an indicator of their observation behavior through eye-tracking, while cue utilization was analyzed through modern network analysis. In terms of the object of assessments, the diversity of students with regard to intra-individual combinations of motivational-affective and cognitive characteristics was taken into account. The goal was to gain detailed insight into the accuracy of teachers' judgment of student profiles, as well as to compare teachers with higher and lower judgment accuracy in terms of their eye movements and use of student cues.

About one half of the participants demonstrated higher judgment accuracy and assigned three or five students correctly, while the other half demonstrated a lower judgment accuracy, and had difficulty assessing student profiles. The participants tended to assess the uninterested and struggling profiles with a higher accuracy than the strong, overestimating, and underestimating profiles. These differences did not hold significance when correcting for multiple comparisons. Student teachers seemed to have particular difficulty in distinguishing profiles with a similar level of motivational-affective characteristics (e.g., strong and overestimating as well as struggling and underestimating).

With regard to observation of students, student teachers with a higher judgment accuracy showed a pattern with higher fixation counts and shorter average fixation durations on most of the target students. However, these differences were not significant when correcting for multiple comparisons.

Overall, student teachers seemed to use diagnostic student cues in their judgment process. They focused on students' overall class participation, hand-raising behavior, preoccupation

with things other than the lecture, inattention, quality of verbal contributions, general understanding of the subject matter, and lack of confidence. Therefore, they considered the intensity and content of student engagement when assessing student characteristics. The epistemic network model reached good model fit with Spearman and Pearson correlation being equal to 1.00 both for the x-axis and y-axis. The analysis revealed that networks of student profiles that were frequently interchanged have a similar structure—indicating that similar student cues and student cue combinations were used for assessment. The network centroids for the groups of student teachers with high and low judgment accuracy differed significantly in their location along the x-axis, but not along the y-axis. When looking at differences in the utilized cue combinations for both groups across all student profiles, it appeared that student teachers with a high judgment accuracy were using cue combinations as a diagnostic feature for certain student profiles. Those with a low judgment accuracy, however, tended to use a variety of unspecific student cues for all student profiles.

6 Discussion

The overall goal of this research was to uncover individual differences in student engagement and explore these as a source of information for teachers regarding student characteristics. The purpose of this discussion is to look at the results of the two studies in aggregate. To this end, the central findings are presented first, followed by a reflection on theory and methods. Afterwards, implications for practice are proposed and the limitations of the study are pointed out.

6.1 Interpretation of central findings

6.1.1 Student engagement – where the hidden becomes visible

To gain insight into individual differences in student engagement, dominant intra-individual combinations of student hand-raisings (i.e., behavioral engagement), deep information processing (i.e., cognitive engagement), and experience of situational interest and enjoyment (i.e., emotional engagement) were investigated. Similar to previous studies (Bae & DeBusk-Lane, 2019; Conner & Pope, 2013; Schmidt et al., 2018; Symonds et al., 2020; Wang & Peck, 2013; Watt et al., 2017), the five identified engagement patterns comprise a mixture of consistent (*disengaged*), and inconsistent types (*compliant*, *silent*, *engaged*, and *busy*). All patterns found were more or less similar to those already reported in previous research. Although this specific combination of patterns has not been found before, it could be confirmed that engagement patterns observed during whole-class dialogues and teacher–student interactions (both very common and relevant learning activities) basically show a similar form as patterns identified under other research conditions. In the present study in particular, the interplay of hand raisings as an observable behavior and internally experienced cognitions and emotions was investigated. Nevertheless, it resembles findings of studies that: implemented self-reports for all engagement dimensions; considered other aspects of cognitive engagement than deep information processing; included students from different school grades and focused on more long-term forms of engagement. As previously suspected (O'Connor et al., 2017; Shi & Tan, 2020), the study demonstrated that students who avoided active participation in whole-class dialogues fell into two groups: On the one hand, disengaged students, who sat in class without interest or joy, not following the lesson mentally and being reluctant to raise their hands; and on the other hand, silent students, who followed the lesson with interest and thought along, but who were not willing to share their thoughts with their classmates and teacher. Further, among students who sought to be actively involved in whole-class dialogues and raise their hands (very) frequently, subgroups were identified: Compliant students raised their hands, although they did not

experience positive emotions and were not engaged in deep thinking processes; engaged students who raised their hands, thought through the content with joy and interest; and finally, busy students, who raised their hand extraordinarily often while also being highly cognitively and emotionally engaged. These results corroborate the notion that students' engagement in whole-class dialogues is more complex than simply distinguishing between vocal and silent students. Therefore, the number of hand raisings—as a visible indicator of student behavioral engagement—matches the intensity of cognitive and emotional engagement exactly for the group of disengaged students only. For engaged and busy students, the intensities of the three dimensions point at least in the same direction, although to different degrees, so that for these groups the number of hand-raisings might still be a rather relevant indication of students' internal engagement. For the groups of compliant and silent students, however, the number of hand raisings does not represent a robust indicator of their internal mental processes and emotional experiences.

Following the process model of motivation (Connell & Wellborn, 1991; Skinner et al., 2009), relations between the five engagement patterns had been investigated by means of academic self-concept as an antecedent (while controlling for pre-achievement and gender) and with achievement as a learning outcome. In line with prior studies that considered motivational drivers of engagement patterns (Bae & DeBusk-Lane, 2019; Symonds et al., 2020), results indicated that students who were more confident in their mathematical abilities were more likely to be characterized by a pattern of higher engagement. Particularly, higher self-concept significantly increased the likelihood that students would show any pattern other than the disengaged one. To elaborate, the present study expands upon previous findings that indicated a positive relation between student participation and academic self-concept (Abdullah et al., 2012; Clarke et al., 2016; Böheim, Knogler et al., 2020) and provides a more comprehensive picture as relations with self-concept were investigated for each of the five engagement patterns. For those students who raised their hand more frequently (compliant, engaged, and busy patterns), hand-raising behavior appeared to overlap with the level of academic self-concept in such a way that more hand raisings may have indicated students' confidence in their abilities. However, this did not apply to students who avoided active participation and raised their hand only rarely or not at all. While disengaged students were not convinced of their mathematical abilities, silent students did actually report being more confident in their abilities. Thus, while willingness to contribute can serve as an indicator of academic self-concept, avoidance of verbal participation alone cannot. Beyond these insights, the question remains as to what leads students to be, for example, engaged or busy, compliant or disengaged. Here, future research can explore the topic further and take more complex motivational features into account. Just as there are individual differences in engagement, studies have also been

able to identify individual differences in the form of motivational profiles in which, for instance, internally and externally controlled motivations are co-occurring (Liu et al., 2009; Vansteenkiste et al., 2009; Wormington et al., 2012). Also taking this individuality into account may be helpful to understand the emergence of specific engagement patterns. Moreover, social factors could also play a role; it is conceivable, for example, that silent students avoid participation in order to avoid being perceived as “overachievers” by their classmates, or that busy students, for example, want to impress their teachers and demonstrate their strong knowledge (Engels et al., 2016; Nurmi & Kiuru, 2015; Sidelinger & Booth-Butterfield, 2010). Furthermore, contextual features as predictors of engagement have hardly been considered in person-centered studies, although teachers’ provision of structure and emotional support are commonly found to enhance student engagement (Rimm-Kaufman et al., 2015). By considering further motivational features as well as social and contextual factors, the emergence of specific engagement patterns might be even better explained.

Students with different engagement patterns varied in their end-of-the year grades. In line with previous person-centered studies (Bae & DeBusk-Lane, 2019; Wang & Peck, 2013; Watt et al., 2017), patterns of higher engagement related to higher subsequent achievement. Disengaged students received significantly lower grades than compliant, silent, engaged, and busy students, who did not differ from one another in their achievement. These findings also tie in with previous studies examining individual engagement in whole-class dialogue and its impact on learning outcomes. That silent students do not suffer from their low behavioral engagement confirms not only previous person-centered studies (Bae & DeBusk-Lane, 2019), but also supports indications that as long as students are actively listening to the teacher and their classmates, they profit from similar learning outcomes as those students who participate verbally (Clarke et al., 2016; Flieller et al., 2016; Inagaki et al., 1998; O’Connor et al., 2017). Yet, compliant students also received higher grades and seemed to be somehow able to compensate for their lower cognitive and emotional engagement (Wang & Peck, 2013; Watt et al., 2017). This could be because active listening, especially in a teacher-centered, whole-class dialogue, may correspond to surface rather than deep cognitive processing. Future research could follow up here and clarify how compliant students succeed in compensating for their lower cognitive and emotional processes, be it for instance through more surface processes or higher engagement in other learning activities (Chi et al., 2018; Greene, 2015). Furthermore, the present findings expand upon previous ones, in that they provide insight into visible student hand-raising behavior as an indicator for later achievement across the different engagement patterns. The number of hand raisings seems to indicate that students who raise their hand more frequently subsequently achieve higher grades. Nonetheless,

this again does not apply to students who participated sparsely, as the silent students achieved equally high grades as those who showed a pattern of higher participation, whereas disengaged students were at risk of obtaining lower grades than all of their peers.

6.1.2 Student engagement – a window into student characteristics

Since only few findings on judgment accuracy regarding the intra-individual combination of student motivational-affective and cognitive characteristics are available so far (Huber & Seidel, 2018; Seidel et al., 2020; Südkamp et al., 2018), this was investigated in a first step. Significant variation was identified, with roughly half of the participants being successful and assigning most of the five student profiles—strong, struggling, overestimating, underestimating, and uninterested (Kosel, Wolter et al., 2021; Seidel, 2006)—correctly, while the other half encountered difficulties in doing so. This finding enriches professional vision research that regularly emphasizes student teachers' limited ability to interpret classroom events (Berliner, 2001; Kim & Klassen, 2018; Star & Strickland, 2008), although differences seem pre-exist between student teachers (Stürmer et al., 2016). This might be somewhat surprising, since accurate judgments can be seen as the successful application of declarative knowledge in practical situations (Jacobs et al., 2010; Lachner et al., 2016), something that develops mainly after practical experience due to transformed knowledge structures (Boshuizen et al., 2020). Therefore, future research might consider that the group of student teachers consists of subgroups with different skill levels, for example, when compared to experts.

The evaluation showed that profiles with similar levels of motivational-affective characteristics (e.g., strong and overestimating or underestimating, struggling, and uninterested profiles) were the ones that were predominantly mixed up. Hence, participants in this study were better able to assess the level of students' interest and self-concept from observation, while combining these levels with cognitive characteristics was more difficult. This is in contrast to previous studies that indicated that teachers tend to have difficulty assessing their students' motivation. It also goes against as assumptions that teachers can assess cognitive characteristics more accurately than motivational-affective ones, due to the fact that motivation is not directly observable and must be inferred from student engagement (Kaiser et al., 2013; Karing, 2009; Praetorius et al., 2017; Urhahne & Wijnia, 2021). This may be due to the fact that the video-vignette mainly showed whole-class dialogues and teacher lecture situations. Although, such situations in principle provide insights into student knowledge (Black & William, 2009), a current study showed that teachers have difficulties to infer student thinking from observation of classroom situations (Copur-Gencturk & Rodrigues; 2021) possibly because in everyday classrooms only a few

students are given the opportunity to answer particular questions, for the most part (Helme & Clarke, 2001).

In the present research, a special focus was given to teachers' observation and utilization of observations, as behavioral and cognitive activities of judgment processes, respectively, as they had been promoted in the lens model (Brunswik, 1955) and recent considerations of judgment processes (Loibl et al., 2020). Particularly, intensity and content of student engagement were examined as a window into student motivational-affective and cognitive characteristics (Reeve, 2012) for teachers. Since teaching is a rather vision-intense profession in which teachers gain information from monitoring their classrooms (Carter et al., 1988; Gegenfurtner, 2020), eye-movements were compared between participants with higher and lower judgment accuracy indicating their observation behavior. Those student teachers who were more accurate in the assignment of student profiles, tended to show a pattern comparable to experienced teachers, with more frequent but shorter fixations on the target students (Gegenfurtner et al., 2011; Seidel et al., 2020; van den Bogert et al., 2014). Although these differences did not hold significance when correcting for multiple comparisons, the results indicate a connection between expert-like eye movement patterns and judgment accuracy, as has also been shown in a recent study (Kosel, Holzberger et al., 2021). Thus, eye movements seem to be a relevant behavioral component of judgment processes.

In terms of the cognitive activities of judgment processes, *which* student cues student teachers used and *how* they combined them to differentiate between the different student profiles were investigated. According to the inductive coding results, student teachers mainly relied on quality of verbal contributions (i.e., whether these were correct), frequency of student hand-raising behavior, general participation and level of attention, whether students seemed to understand the topic, and, finally, whether students appeared to be unconfident. Besides these prominent indicators, teachers also referred to student emotional experiences. Hence, participants reported a mixture of cues pertaining to the intensity and content of student engagement (e.g., level of participation or correctness of verbal contributions) that may be considered as "diagnostic" rather than irrelevant as they relate to student motivational-affective and cognitive characteristics. Correct answers may point to stronger knowledge and, as found in the first study, frequent hand raisings indicated higher self-concepts. Hence, in combination, such cues can give insights into the interplay of student motivational-affective and cognitive characteristics. These findings align with previous research showing that teachers are not only able to perceive students' engagement overall, but also recognize the three dimensions of behavior, cognition, and emotion (Fredricks, Wang et al., 2016; Lee & Reeve, 2012; Reeve, 2012; Urhahne & Wijnia,

2021) and emphasize the utility of student engagement for teacher judgments. Moreover, the results indicated that student teachers are indeed inferring students' more internal processes and experiences, such as their level of concentration and attention as well as their situational boredom or interest, from their observations (Chi & Wylie, 2014; Helme & Clarke, 2001).

With regard to the question of how teachers combine different student cues to assess motivational-affective and cognitive student characteristics together, an epistemic network analysis revealed systematic differences between student teachers with higher and lower judgment accuracy. Those who were better able to assign student profiles combined student cues about the intensity and content of student engagement that were diagnostic for specific student profiles. Those participants who had problems assessing student profiles, on the other hand, tended to use many different cues and combined them in such a way that they did not clearly point to one particular profile. These findings complement results from studies using text-vignettes (Böhmer et al., 2017), which showed that student teachers integrated as much information as possible while experienced teachers seemed to choose the most diagnostic information. These findings also clarify that this might only account for some of the student teachers. The importance of combining student cues as a cognitive activity of judgment processes became even clearer with other results of the epistemic network analysis that revealed a similar network structure for student profiles that were most often interchanged. Hence, it appeared as though student teachers used similar student cues in combination for profiles that shared only the extent of the motivational-affective characteristics, making it difficult to conclusively distinguish them from one another. Therefore, judgment accuracy seemed to depend on the observation and utilization of relevant student cues, and differences in these activities explain variations in judgment accuracy.

6.2 Methodological reflection and implications for theory

As described in the introduction, the strength of the engagement construct lies in the fact that it is a meta-construct in which the essential processes of doing, thinking, and feeling are brought together (Ainley, 1993; Fredricks & McColskey, 2012). However, this conceptual strength can only be implemented in research practice if methods that actually take the three dimensions and their interplay into account are used (Lawson & Lawson, 2013; Wang et al., 2019). To do so, first, the three engagement dimensions need to be defined as distinctively as possible and the implemented measures need to reflect the definitions and discriminate between the dimensions (Sinatra et al., 2015). Second, simultaneous consideration of behavioral, cognitive, and emotional dimensions needs to be

possible with the applied statistics analyses (Lawson & Lawson, 2013). With regard to the first point, in the present research, self-reports were applied to measure student cognitive and emotional engagement. This followed the recommendation that, despite well-known shortcomings related to ability to recall experiences and social desirability bias (Fredricks & McColskey, 2012; Nguyen et al., 2018), such measures seem to be particularly useful to assess students' internal experiences for which behaviors, language, body, and facial expressions might only be high inferential proxies (Appleton et al., 2006; Pekrun, 2006; Reschly & Christenson, 2012). Moreover, it was necessary to overcome the usage of relatively broad item wording that did not pertain to a particular subject or activity as an engagement-specific shortcoming of self-reports. It was also essential to reflect the definition of student engagements as situational processes. As a result, the implemented item wordings explicitly referred to student experiences during the videotaped school lesson (Fredricks & McColskey, 2012). The scales had high reliability and showed a moderate correlation reflecting their relation as two separate but related dimensions of one overall construct. Given that behavioral engagement refers to students' overt behaviors, classroom observations were used in the present research, in contrast to most engagement studies that used self-reports (Fredricks & McColskey, 2012; Nguyen et al., 2018). Doing so followed the call for the implementation of unique measures that capture the intensity of behavioral engagement as a continuous variable on an individual level. This was in opposition to simply differentiating between engaged and disengaged behavior of individual students or aggregating behavioral engagement at a classroom level (Bae & DeBusk-Lane, 2019; Li & Lerner, 2013). In particular, the number of hand raisings per student was taken as a measure of their behavioral engagement that was previously shown to be reliable and valid (Böheim, 2020). In terms of statistical analyses that consider all three dimensions simultaneously, latent profile analysis was implemented as an advanced person-centered approach that identifies homogenous subgroups within a sample based on a set of indicator variables. The results underlined the detailed gain in knowledge that was possible through the implementation of a mixture of observational measures and self-reports, as well as person-centered data analyses. They highlighted the complexity of students' everyday experiences and the extent and nature of individual differences in student engagement—beyond a division into active versus passive or engaged versus disengaged students. Moreover, it was a useful way of assessing the extent to which students' visible behaviors matched their internal experiences (Hospel et al., 2016; Skinner et al., 2009; Skinner & Pitzer, 2012).

Research has long looked at how accurately teachers can assess the characteristics of their students, and teachers have often been criticized for failing to adequately distinguish between motivation and cognitive characteristics and for performing worse overall than one

would hope (Karing, 2009; Südkamp et al., 2012; Urhahne & Wijnia, 2021). From this, the call for a stronger focus on the underlying processes and their behavioral and cognitive activities as causes of accurate and inaccurate judgments emerged only recently (Herppich et al., 2018; Loibl et al., 2020). In this regard, the present dissertation highlights two modern techniques. First, the tracking of eye-movements allows for an assessment of how teachers monitor classrooms, and the present findings corroborate the relevance of this behavior for accurate judgments. Second, the epistemic network analysis as a method that visualizes the co-occurrences of qualitative data coding (Brunswik, 1955; Funder, 1995, 2012) seems to be sufficient to map the complex nature of the cognitive activities of judgment processes when several pieces of information have to be integrated to assess both motivational-affective and cognitive characteristics in combination. It could be shown not only that differences in judgment accuracy are related to the combination of diagnostic student cues, but also that difficulties in distinguishing profiles can be traced back to the use of similar cues. In this sense, the present research emphasizes that only the connection between judgment accuracy and the preceding process allows for a comprehensive understanding of teachers' judgment difficulties. Since this seems to apply for both behavioral and cognitive activities, analysis strategies that consider these activities are well-suited for mapping the complexity of teachers' information processing in everyday classroom settings.

The results showed that teachers use both the intensity and the quality of engagement content for "on-the-fly assessments" when monitoring a classroom. Intensity of engagement is more of a visual phenomenon, while the quality of the content is also perceived through listening, at least in verbal interactions. However, current frameworks dealing with teachers' professional perception strongly focus on the processing of visual stimuli (Gegenfurtner, 2020). Given that teaching is a social profession and that knowledge is co-constructed through social exchange (Cobb, 1972; Loyens & Gijbels, 2008; Palinscar, 1998; Windschitl, 2002), the perception and processing of auditory stimuli is probably equally important. Models of professional vision could therefore be extended by an auditory component. Here, initial results of eye tracking studies could show that experienced teachers distribute their visual attention over the class even when interacting with individual students (Cortina et al., 2015). Thus, they seem to be able to split their attention across several students as well as across visual and auditory cues. Hence, one task of future research could be to determine how well teachers can simultaneously perceive and integrate visual and auditory stimuli.

Building on this point, considering the content as a further component of student engagement was, with respect to teacher assessments, quite fruitful. This might also account for the student perspective of engagement. So far, engagement has been mostly considered as a mediator between motivation and learning outcome (Connell & Wellborn,

1991; Skinner et al., 2009). Higher motivation increases the likelihood of more intense engagement which in turn leads to higher learning outcomes. Therefore, the focus has been mostly on the intensity of student engagement. However, the question might arise as to how cognitive characteristics, as strong predictors of student learning outcomes, are reflected in the situational processes of student engagement, and whether engagement might also mediate their influence on student learning outcomes. Therefore, it was argued that cognitive characteristics such as knowledge or cognitive abilities become evident in the content of engagement. Future research might elaborate on this notion and investigate whether the integration of a content component of engagement would allow to model the influences of motivational-affective and cognitive characteristics on student engagement and on subsequent learning outcomes. Such an integration could provide an even more in-depth understanding of the situational processes that lead to student learning.

Finally, the introduction to this dissertation claimed that a strength of the engagement construct is its potential to bridge psychological research and classroom research (Li & Lerner, 2013). In the present dissertation, this can be confirmed. On the one hand, it was possible to show how psychological and internal processes of students become visible in their engagement. On the other hand, the high utility of engagement as a window into student internal characteristics and experiences could be shown. To display these mechanisms, two common models were used as a basis: The process model of motivation (Connell & Wellborn, 1991; Skinner et al., 2009; Skinner & Belmont, 1993) and the lens model (Brunswik, 1955; Funder, 1995, 2012). In order to fully exploit the potential of engagement as a link between students and teachers, between learning and teaching, a research framework could be developed in the future to display this function of engagement and guide prospective studies.

6.3. Implications for educational practice

From a practical perspective, engagement patterns can provide a basis for adaptive teaching as teachers could tailor their instruction to support the subgroups more individually (Appleton et al., 2008; Corno, 2008; Hospel et al., 2016). In this regard, disengaged students seem to be a group at risk, as they are not only avoiding engagement but also show unfavorable characteristics like low self-concept and school grades (Decristan et al., 2020). In the long run, this could lead to negative development, as low achievement and self-concept do not only worsen reciprocally (Möller et al., 2011) but also lead to lower engagement and a risk of dropping out of school (Archambault, Janosz, Fallu et al., 2009). Teachers could support disengaged students by establishing a caring relationship with these students, showing interest in them, and providing support through constructive

feedback (Alrashidi et al., 2016; Martin & Rimm-Kaufman, 2015; O'Mara et al., 2006; Wang & Eccles, 2012, 2013). This is particularly important as teachers seem to be more inclined to respond to low engagement with criticism and less attention (Finn & Zimmer, 2012; Skinner et al., 2009). In addition, there is evidence that teachers might also support disengaged students through instructional design. More participation from these students could be fostered through longer waiting times, so that students are able to think longer about teachers' questions (Sacher, 1995). It may also be fostered through more dialogic structuring of whole-class interactions without the norm of hand-raising, in such a way that these situations become more like student-student interactions rather than teacher–student interactions (Dixon et al., 2009). Compliant students with their low cognitive and emotional engagement seem to be at risk of eventually drifting into a disengaged pattern. Support similar to that described for disengaged students has the potential to prevent this development. Moreover, providing compliant students with more cognitively activating tasks could possibly help them to increase their cognitive engagement and show a more engaged pattern. The low participation of silent students does not seem to be a risk factor in terms of their achievement at an individual level. For the class as a whole, however, it means that these strong students hold back their ideas and thoughts and do not share them. From the point of view that learning is a social co-constructive process, the other students might be deprived of the chance to receive content-related input from the silent students (Cobb, 1972; Loyens & Gijbels, 2008; Palinscar, 1998; Windschitl, 2002). Since a recent ethnographic study showed that silent students do not see any added value in actively participating in class dialogues (Sedova & Navratilova, 2020), a more dialogic design of whole-class dialogues in which the students are more responsible and act as a driving force could perhaps change this, so that the silent students also become involved. To address students in such specific ways, teachers need to be able to assess students' individual engagement. Here, Sedova and Navratilova (2020) provided indications that teachers perceive and socially interact with subgroups of disengaged and silent students in different ways that further underpin student differences (Clarke et al., 2016). Teachers seem to put silent students in an expert-like role, in the sense that they are often solicited when nobody else wants to answer a question. On the contrary, disengaged students are deprived from important learning opportunities, as they are mostly addressed with easier questions and classmates are allowed to step in and answer for them (Sedova & Navratilova; 2020). Thus, teacher training and professional development programs may be modified to support teachers in their interactions with the student groups showing different engagement patterns.

With respect to teachers' assessment skills, the findings of the present research imply a need to further support prospective teachers in their development. Assessing students

requires teachers to apply their declarative knowledge toward practical situations (Jacobs et al., 2010; Lachner et al., 2016). Therefore, teacher education should strengthen student teachers' knowledge about student characteristics and their manifestation in the intensity and content of student engagement. This would also clarify that students exhibit individual differences in terms of the combination of their motivational-affective and cognitive characteristics, but also with regard to their situational behavioral, cognitive, and emotional engagement. As student teachers seem to use the intensity of student participation and particularly the number of hand raisings as an indicator for their characteristics, they should be informed that this indicator does not allow for unambiguous conclusions, especially for those students who raise their hand infrequently. Further, teacher education may provide opportunities to practice assessments. As Grossman et al. (2009) argue, this might be effective when tasks are adapted step-by-step to real teaching. Thus, observation of and reflection on classroom videos as well as the implementation of simulations might be options as they can be designed to represent real teaching to varying degrees (Chernikova et al., 2020; Codreanu et al., 2020; Star & Strickland, 2008; van Es & Sherin, 2008). Such practices may help students to make fine-grained differentiations in the intensity of student engagement, to search for and perceive intensity as well as content of engagement, and to use student cues consistently as an indicator for the very same characteristic across several individuals (Nestler & Back, 2013). With regard to behavioral components of judgments, the modeling of eye movements might help learners to monitor students in more effective ways (Gegenfurtner, 2020; Jarodzka et al., 2012; Jarodzka et al., 2013).

6.4 Limitations

When interpreting the reported research findings, some limitations of the studies must be considered. First, reciprocal effects of motivation, engagement, and achievement were not considered (Reeve, 2012). However, it is likely that higher achievement as a result of higher engagement fosters, for example, students' confidence in their abilities. This will then increase their subsequent engagement, leading to an upward spiral which is then likely to be reinforced through positive interactions with teachers. With the consideration of such effects, future research could advance the understanding of the temporal development of student engagement patterns.

Second, engagement patterns were identified only in one single eighth-grade mathematics lesson. Research on the stability of students' momentary behavioral, cognitive, and emotional engagement across the same as well as different learning activities is scarce (Schmidt et al., 2018). Initial research shows that although students might start off with a similar engagement pattern, they can develop different patterns over several school years

(Archambault & Dupéré, 2017; Archambault, Janosz, Morizot et al., 2009). However, these studies considered engagement as a rather general trait-like feature of students assessed only once a year and do not allow for conclusions about the stability of more situational engagement patterns. Therefore, it remains open to discussion as to whether students have a typical pattern in how they engage in whole-class dialogues for particular subjects and also across subjects. For example, do silent students avoid participation in general and enjoy it when busy students share their ideas?

Third, the number of hand raisings was implemented as a rather new measure of student behavioral engagement (Böheim, Knogler et al., 2020; Böheim, Urdan et al., 2020; Decristan et al., 2020). Although it was shown to be a unique, real-time measure that revealed insights into the combination of internal experiences and overt engagement, its utility might be restricted to a small scope of classroom learning activities. Whenever interactions with the teacher are not the focus of the class, for example during group work, it seems necessary to implement other behavioral measures. Depending on the research question, these might be as specific as hand-raising as a single behavior, or as broad as jointly accounting for more aspects of behavioral engagement. As a consequence, intra-individual combinations of other behavioral measures with student cognitive and emotional engagement might then differ from the present ones.

Fourth, judgment process was only investigated for student teachers, which might be interesting as they are in the phase of teacher education acquiring new declarative knowledge that is relevant for assessments. Although it can be assumed that the observation and usage of student engagement plays a similar important role, future research might replicate the findings for more experienced teachers. Moreover, only one video stimulus was used that might have impacted the observation and utilization of student cues in a specific way, as it contained student cues that naturally occurred during whole-class dialogues and teacher lecturing leaving the availability of intensity and content of student engagement a bit unbalanced. Thus, to overcome the limited generalizability of the present study, future research should replicate the findings and investigate their relevance for experienced teachers with different stimuli as well as in real-life teaching. Therefore, it might also be relevant to identify which typical classroom situations contain which student cues that in turn provide information about student motivational-affective and cognitive characteristics. This could clarify which situations are particularly suitable for assessing both type of student characteristics individually and in combination.

Fifth, the second study suffered from a small sample, especially when comparing the groups of student teachers with higher and lower judgment accuracy. Therefore, our findings might be representative for the population of student teachers, but could also underestimate

differences between those experiencing greater success in assessments and those who had more difficulty with regard to the patterns of their eye movements and the utilization of student cues. Since epistemic network analysis can even be used to compare networks across two participants, the implementation of the method was still adequate. Nevertheless, replications with more robust samples would verify the present results.

6.5 Conclusion

The aim of this dissertation was to identify individual differences in student engagement patterns and to examine the utility of individual engagement for teacher judgment processes of student motivational-affective and cognitive characteristics. Therefore, the goal was to take advantage of the benefits of engagement as a meta-construct that integrates behavioral, cognitive, and emotional dimensions; that represents a manifestation of student motivational-affective characteristics; and that therefore connects psychological research with classroom research. The research goal was to understand the importance of student engagement from both student and teacher perspectives. Central to this was the idea that students' overt engagement reveals invisible motivational, cognitive, and emotional characteristics and processes, so that, conversely, teachers can use student engagement as a window into student characteristics. With a person-centered analysis as an approach that allows for an investigation of the interplay of the three engagement dimensions, it was shown that students engage in whole-class dialogues in differential ways. A large number of students appeared to be consistently disengaged while the state of being engaged could take on more diverse forms, from being compliant or silent to engaged or busy. Since the number of hand-raisings for disengaged, engaged, and busy patterns mostly corresponded to the internal engagement dimensions, but not for silent and compliant students, the intensity of hand-raising behavior is not a clear indicator of student cognitive and emotional engagement. Overall patterns of higher engagement related to higher academic self-concept and higher subsequent achievement. Furthermore, it could be shown that higher levels of these characteristics could be inferred from lively hand raising, but that few hand raisings are not synonymous with low self-concept and low achievement. Being one of the first studies that connects judgment accuracy and process, it could be shown that around half of the student teachers were already able to assess the combinations of students' motivational-affective and cognitive characteristics. By considering student teachers' eye movements as an indicator of their observational behavior, and by examining their utilization of student engagement using an epistemic network analysis, it could be shown that both of these components of judgment processes relate to judgment accuracy. The more accurate student teachers showed a tendency toward an "experienced" pattern of eye movements.

Furthermore, they relied on the joint usage of the intensity and content as two information-rich components of student engagement in “diagnostic” combinations that point toward specific student profiles. Overall, the present research highlights the importance of individual differences in student engagement, and clearly shows that students differ greatly in their use of learning activities. These differences, in turn, can be successfully used by teachers to infer underlying characteristics. In particular, the intensity and content of behavioral engagement represents an access to the hidden processes of the students’ motivation, cognition, and emotion.

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Appendix

Appendix A

Schnitzler, K., Holzberger, D. & Seidel, T. (2020). All better than being disengaged: Student engagement patterns and their relations to academic self-concept and achievement. *European Journal of Psychology of Education*. https://doi.org/10.1007/s10212-020-00500-6

Appendix B

Schnitzler, K., Holzberger, D. & Seidel, T. (2020). Connecting judgment process and accuracy of student teachers: Differences in observation and student engagement cues to assess student characteristics. *Frontiers in Education*. https://doi.org/10.3389/feduc.2020.602470

Note:

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