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All better than being disengaged: Student engagement patterns and their relations to academic self-concept and achievement

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Abstract
Student participation and cognitive and emotional engagement in learning activities play a key role in student academic achievement and are driven by student motivational characteristics such as academic self-concept. These relations have been well established with variable-centered analyses, but in this study, a person-centered analysis was applied to describe how the different aspects of student engagement are combined within individual students. Specifically, we investigated how the number of hand-raisings interacts with student cognitive and emotional engagement in various engagement patterns. Additionally, it was analyzed how these engagement patterns relate to academic self-concept as an antecedent and achievement as an outcome. In an empirical study, high school students ($N = 397$) from 20 eighth-grade classrooms were surveyed and videotaped during one mathematics school lesson. The design included a pre- and post-test, with the videotaping occurring in between. Five within-student engagement patterns were identified by latent profile analysis: disengaged, compliant, silent, engaged, and busy. Students with higher academic self-concept were more likely to show a pattern of moderate to high engagement. Compared with students with low engagement, students with higher engagement patterns gained systematically in end-of-year achievement. These findings illustrate the power of person-centered analyses to illuminate the complexity of student engagement. They imply the need for differentiation beyond disengaged and engaged students and bring along the recognition that being engaged can take on various forms, from compliant to busy.

Keyword Engagement patterns · Participation · Academic self-concept · Achievement · Latent profile analysis

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Introduction

Whole-class dialogues are a predominant classroom activity in most educational systems (Seidel and Prenzel 2006; Stigler et al. 1999), which provide students with important learning opportunities because during whole-class dialogues students and teachers jointly construct knowledge and establish a shared understanding (Mercer and Dawes 2014). Therefore, it is seen as critical that students engage in this learning activity to achieve high performance. However, student engagement in whole-class dialogues is complex as it comprises behavioral engagement in the form of active student participation, as well as further aspects of cognitive and emotional engagement (Fredricks et al. 2004). Although these aspects occur to be separate dimensions from one another, they share substantial overlap leading to complex interdependencies (Wang et al. 2019). Hence, disentangling the specific effects of each engagement dimension on student achievement turns out to be a challenging endeavor. In particular, it is yet unclear whether all aspects of student engagement are relevant for learning. Often, external student participation as the verbalization of one's own ideas and answers is identified as a key function of student learning (Sedova et al. 2019), which is associated with the assumption that silent students might miss learning opportunities (O'Connor et al. 2017). In contrast, others claim that it is students' active internal cognitive and emotional engagement in whole-class dialogues that determine learning (Flieller et al. 2016; Inagaki et al. 1998; Stahl and Clark 1987). Students may think about how they would answer the teacher's questions and compare their ideas with those of their peers, thereby integrating identified contractions and overt teacher feedback into their conceptual understanding (Mercer and Dawes 2014).

As outlined above, individual students might show diverse engagement patterns in which consistent and inconsistent combinations of student participation and cognitive and emotional engagement appear (Fredricks et al. 2004; Lawson and Lawson 2013; Wang et al. 2019). For example, some students may refuse to participate and to think deeply about the current topic while experiencing a lack of interest and enjoyment. Others may not be willing to participate but at the same time enjoy thinking about their teacher's questions (O'Connor et al. 2017).

Initial research on engagement patterns provides support for differentiation of student engagement in various patterns (Bae and DeBusk-Lane 2019; Conner and Pope 2013; Schmidt et al. 2018; Wang and Peck 2013; Watt et al. 2017). Along with such a differentiated consideration of student engagement questions arise whether some ways of engagement are more beneficial than others for student learning (Wang et al. 2019), and how student motivation, as a driver of engagement (Connell and Wellborn 1991), relates to these favorable patterns.

Therefore, the current study contributes to previous research by exploring the diversity of student engagement in whole-class dialogues by focusing on the interplay of student overt participation and their self-reported deep information processing, enjoyment, and interest. Thereby, we want to consider the complexity and heterogeneity of student learning and provide ecologically valid insights into student experiences in everyday classrooms (Lawson and Lawson 2013).

Moreover, to understand the significance of such a differentiation into diverse engagement patterns, we investigate the central role of engagement patterns between selected student predispositions and academic achievement as an outcome with a longitudinal design. These analyses can help to clarify whether there is an additional benefit of external student participation beyond internal cognitive and emotional engagement or whether it is for students sufficient to just closely follow ongoing whole-class dialogues and compensate a low participation by high cognitive and emotional engagement. By doing so, we combine within the

study psychologically oriented research concerning individual student differences with teaching research concerning important learning activities in the classroom. Thus, results of this study may be fruitful for future research and teaching practice because the consideration of engagement patterns might be required when researchers and practitioners want to enhance student engagement and performance, for example, through targeted interventions and adaptive teaching.

Student engagement as a multidimensional construct

Student engagement has been commonly described as multidimensional involvement, the extent to which students employ and express themselves behaviorally, cognitively, and emotionally in learning activities (Christenson et al. 2012; Fredricks et al. 2004).

Behavioral engagement is understood as a set of externally observable behaviors (Appleton et al. 2008; Fredricks and McColskey 2012), which comprise several distinct aspects as absenteeism, disruptive behavior, withdrawal, following instructions, and student participation in whole-class dialogues in accordance with rules and classroom norms (Fredricks et al. 2004; Hospel et al. 2016). Participation may take the form of raising a hand to contribute verbally, respond to a question, make suggestions, or ask a question if called upon by the teacher (Böheim et al. 2020; Burns and Myhill 2004; Dixon et al. 2009; Fredricks et al. 2004; Howe and Abedin 2013; Ingram and Elliott 2015).

Cognitive engagement has been defined as students' information processing, which can be divided into deep and surface processing (Appleton et al. 2006; Fredricks et al. 2004). Deep processing involves elaboration and organization, in which students link and organize new information with their prior knowledge. In contrast, surface processing occurs when students simply reproduce information (Chi et al. 2018; Greene 2015).

Emotional engagement is understood as affective reactions to classroom learning activities (Appleton et al. 2006; Fredricks et al. 2004). Two typical indicators of emotional engagement are student interest and enjoyment (Conner and Pope 2013; Schmidt et al. 2018; Watt et al. 2017), two emotions that are closely related and often occur together (Ainley and Ainley 2011).

This tripartite definition of engagement illustrates and acknowledges the complexity of student involvement in learning activities (Christenson et al. 2012; Fredricks et al. 2004). Nevertheless, although presented here as separate dimensions, only quite recently a methodological study clarified that behavioral, cognitive, and emotional engagement should be seen as separate but overlapping dimensions (Wang et al. 2019), which commonly correlate in empirical studies with a moderate to high degree (Conner and Pope 2013; Jang et al. 2016; Li and Lerner 2013; Watt et al. 2017). Therefore, researchers try to identify temporal relationships between the three dimensions (Li and Lerner 2013; Skinner et al. 2008). However, this leaves out that student engagement in learning activities can also be seen as a process in which participation and cognitive and emotional engagement occur simultaneously and interact dynamically with each other (Lawson and Lawson 2013). Therefore, Wang et al. (2019) call for studies which investigate engagement patterns to explore the multifaceted and continuous nature of student engagement to move beyond simplifying distinctions in engaged and disengaged students. In fact, investigations of the simultaneous interplay of the engagement dimensions should enrich the current picture of student experiences in everyday classrooms. However, so far, most empirical studies have investigated student engagement with variable-centered analyses, following the assumption that engagement dimensions are organized

similarly for all students, and providing a single set of parameters to summarize relations for whole populations (Howard and Hoffman 2017; Lawson and Lawson 2013). This approach does not fully use current methodological advances in its differentiation between the interdependencies of the engagement dimensions and identification of subgroups of students that share specific patterns across engagement dimensions (Fredricks et al. 2004). For example, students might share a pattern of low overt participation but still be highly cognitively and emotionally engaged (O'Connor et al. 2017). Person-centered analyses, on the other hand, allow researchers to model within-student combinations of a set of indicator variables (e.g., engagement dimensions) to identify homogenous subgroups of students that show similar patterns with regard to these variables (Howard and Hoffman 2017). In this case, looking at potential differences in engagement patterns during learning activities could exploit the potential of the three-dimensional engagement construct to a greater extent than variable-centered studies, as it improves the understanding of how student participation and cognitive and emotional engagement are combined within individual students (Lawson and Lawson 2013; Wang et al. 2019).

Student engagement patterns

Some recent studies have started to explore patterns across the three engagement dimensions by applying person-centered analyses (Bae and DeBusk-Lane 2019; Conner and Pope 2013; Schmidt et al. 2018; Wang and Peck 2013; Watt et al. 2017). All of them identified patterns with different combinations of behavioral, cognitive, and emotional engagement (see Table 1 for a summary).

Across all studies, consistent engagement patterns with uniform high, moderate, or low values were found for each of the three engagement dimensions. Additionally, the studies identified various inconsistent engagement patterns in which the three dimensions were present in non-uniform ways. For example, a subgroup of students reported high behavioral engagement combined with low cognitive and low emotional engagement. In this case, students indicated to work hard, but they did not recognize the personal relevance of this work, and they did not enjoy it (Conner and Pope 2013). The unveiling of inconsistent engagement patterns exemplifies the power of person-centered analyses and illustrates the complexity of the engagement dimensions' interdependency and the need for a detailed differentiation of student engagement.

The five-reviewed person-centered studies differed in which inconsistent patterns were identified. This may be due to the heterogeneity of the studies, which differ with regard to sample size, grade level, level of generalization of engagement (i.e., engagement in specific learning activities or across subjects), and measures of engagement dimensions. Some used global measures, which capture a variety of indicators for one dimension, while others used rather specific measurements (Table 1). Therefore, Bae and DeBusk-Lane (2019) emphasize a need for further studies that use the traditional division in the behavioral, cognitive, and emotional engagement dimensions described by Fredricks et al. (2004) for specific grade levels, subjects, and countries in order to clearly determine which engagement patterns predominate under which conditions. So far, studies have used only self-report questionnaires to measure engagement dimensions. However, this might provoke social desirability bias in student responses. Hence, for the investigation of the interplay between multiple engagement dimensions, prevalence of patterns with low values on one or more dimensions might be underestimated or overseen. Therefore, Bae and DeBusk-Lane (2019) as well as Li and Lerner

Table 1 Engagement patterns and methods of previous person-centered studies

			Study				
			Conner and Pope (2013)	Wang and Peck (2013)	Bae and DeBusk-Lane (2019)	Schmidt et al. (2018)	Watt et al. (2017)
Pattern							
Consistent							
BE	CE	EE					
+	+	+	Fully engaged	Highly engaged		Full	Engaged
o	o	o		Moderately engaged	Moderately (dis)engaged	Moderately full	
-	-	-	Reluctantly engaged	Minimally engaged		Universally low	Disengaged
Inconsistent							
BE	CE	EE					
+	o	o			Behaviorally engaged		
+	-	-	Busily engaged				
o	o	+				Pleasurable	
o	+	-		Emotionally disengaged		Rational	
o	-	o		Cognitively disengaged			
o	-	-				Reluctant	Compliant
-	o	o			Behaviorally disengaged		
-	+	o			Disengaged		
Method							
Subject			School work	School work	Science	Science	Mathematics
Age			Middle school - Grade 12	Grade 9	Grade 6–8	Grade 9–12	Grade 3–9
BE measure			Global	Global	Global	Global	Hard work
CE measure			Attitudes, personal value	Self-regulated learning	Global	Personal importance	Curiosity
EE measure			Interest, enjoyment	Interest, enjoyment	Global	Interest, enjoyment	Interest, enjoyment

Note. *BE* = Behavioral engagement. *CE* = Cognitive Engagement. *EE* = Emotional Engagement. The upper part of the table presents information concerning previously identified engagement patterns. Therefore, patterns are illustrated by + = high; o = moderate; - = low for each engagement dimension. Moreover, the labels chosen by the different studies are presented. The lower part of the table contains information on the method of the included person-centered studies

(2013) claim that it is important to implement unique real-time measures of student behavioral engagement in future studies such as direct or video observations. Additionally, the dominance of the previous measures assesses engagement generalized for single subjects or across different subjects. Yet an investigation of student engagement patterns in specific learning activities, such as whole-class dialogues, as a powerful and proximal predictor of learning outcomes is outstanding (Schmidt et al. 2018; Skinner and Pitzer 2012).

Engagement relates to academic self-concept as antecedent and achievement as outcome

Student engagement plays a relevant role in school success (Fung et al. 2018; Wang and Eccles 2012a). As the manifestation of students' motivation in (observable) actions, it leads to learning and performance (Olivier et al. 2019). The self-system model of motivational development represents these relationships (Connell and Wellborn 1991). Students hold basic needs for competence, autonomy, and relatedness (Ryan and Deci 2000). Therefore, they evaluate the satisfaction of these needs in so-called self-system processes. These processes are subject-specific and emerge from experienced interactions. In the case of positive self-evaluations, when basic needs are fulfilled, students will engage in the subject behaviorally, cognitively, and emotionally. This engagement will then lead to learning and performance. Thereby, self-system processes relate indirectly to academic achievement mediated through student engagement (Connell and Wellborn 1991; Skinner et al. 2008). Consequently, differences in student self-evaluations should manifest in engagement differences.

One construct capturing student self-evaluations of their domain-specific competence is academic self-concept—the perception of one's subject-specific academic abilities emerging from prior experiences (Shavelson et al. 1976). In support of the model, numerous variable-centered studies have shown that student academic self-concept is one important antecedent of student engagement (Bakadorova et al. 2020; Tas 2016). Students with higher perceptions of their abilities are more likely to participate (raise their hands and communicate their ideas to their peers and teachers (Abdullah et al. 2012; Böheim et al. 2020; Järvelä et al. 2016; Jurik et al. 2013)), to show cognitive engagement (Liem et al. 2008; Walker et al. 2006), and to experience enjoyment (Goetz et al. 2008; Pinxten et al. 2014) and interest (Ainley and Ainley 2011; Denissen et al. 2007). These findings are complemented by a recent person-centered study conducted by Bae and DeBusk-Lane (2019), in which a cross-sectional positive relationship between student academic self-concept and patterns of higher engagement in science was shown.

Also, the linkages between each engagement dimension and student performance are well established in variable-centered studies. Student participation in the form of hand-raising and verbal contributions (Cobb 1972; Flieller et al. 2016; Pauli and Lipowsky 2007); deep information processing prompted, for example, by teacher questions and peer contributions (Chi et al. 2018; Jurik et al. 2014; Liem et al. 2008); and the experience of interest (Jansen et al. 2016; Wigfield and Cambria 2010) and enjoyment (Pekrun et al. 2002) are antecedents of academic achievement. However, taking into account the interdependencies and overlap between the three engagement dimensions, consideration of engagement patterns is important in this regard (Wang et al. 2019). Results from initial studies support this assumption. Students with patterns of higher engagement reported not only higher pre-achievement (Conner and Pope 2013; Watt et al. 2017) but gained also higher performance in knowledge tests (Bae and DeBusk-Lane 2019). Wang and Peck (2013) investigated the longitudinal effect of engagement patterns generalized across subjects on achievement 2 years later. The results suggest that

a lack of enjoyment and interest is compensable by high behavioral and cognitive engagement, while low levels of cognitive engagement are not compensable by high behavioral and emotional engagement and, therefore, lead to lower achievement.

In summary, results from the here reviewed variable-centered studies support the self-system model of motivational development (Connell and Wellborn 1991). However, as outlined, the consideration of the interplay of the three engagement dimensions is more and more recognized as a critical endeavor to understand the multifaceted nature of student engagement and students' everyday experiences (Fredricks et al. 2004; Lawson and Lawson 2013; Wang et al. 2019). Although the first studies started to address this need, especially the longitudinal consideration of engagement patterns as an outcome of student self-evaluations of their competence and as a predictor of academic achievement in one model is still missing. This matter accounts especially for the interplay of overt student participation and cognitive and emotional engagement. Though student engagement in whole-class dialogues is taken as important for student learning, it is so far unclear how students engage in this activity and whether specific patterns of participation and cognitive and emotional engagement are more beneficial for student learning than others (O'Connor et al. 2017).

The present study

With the present study, we explore within-student combinations of overt student participation and internally perceived cognitive and emotional engagement in mathematics lessons for a German sample of eighth-grade students. These three aspects of student engagement are investigated simultaneously to identify predominant subgroups of students with similar engagement patterns. For example, students who do not participate (i.e., do not raise their hands) might still listen with interest and think about the teacher's questions. Thereby, we extend previous research with the present study by implementing a unique real-time measure for observable student participation—the number of hand-raisings—while assessing cognitive and emotional engagement with self-report questionnaires. Moreover, we focus on engagement during the important learning activity of whole-class dialogues in mathematics classrooms. Additionally, we add on to prior findings by considering longitudinal relations with academic self-concept and achievement and addressing the need for subject- and grade-specific investigations. We investigate three research questions, described below.

> RQ1: Which types of engagement patterns concerning student participation and cognitive and emotional engagement can be identified in eighth-grade mathematics lessons?

The person-centered analysis, as an exploratory method, will need to show which engagement patterns predominate. Since consistent low, moderate, and high engagement patterns were identified in previous studies, it was expected that they would be found in the present investigation as well. In addition, it was hypothesized that some inconsistent patterns would arise. However, due to the heterogeneity of inconsistent combinations in prior studies, we did not predict which specific patterns would be inconsistent.

> RQ2: How does academic self-concept of mathematics ability, as antecedent of student engagement, relate to engagement patterns when controlling for pre-achievement and gender?

Taking into account previous findings (Conner and Pope 2013; Watt et al. 2017), it was assumed that higher academic self-concept would make it more likely that students show patterns of higher engagement (Bae and DeBusk-Lane 2019).

> RQ3: How do students that display different engagement patterns vary in their academic achievement at the end of the school year?

It was expected that students with patterns of higher engagement would gain higher end-of-year grades than their peers with lower engagement patterns. Based on the results of Wang and Peck (2013) and the suggestions outlined by O'Connor et al. (2017), it was assumed that low participation would be compensable by high cognitive and emotional engagement. In contrast, low cognitive engagement was expected to result in low achievement, independent of the extent of student participation and emotional engagement, as it was assumed to be not compensable.

Method

Sample

Originally, 501 students ($M_{Age} = 13.82$ years, $SD_{Age} = 0.52$; 57.90% female) agreed to participate in the longitudinal study. However, 104 students had to be individually excluded due to absenteeism ($n = 60$) or lack of consent to be videotaped ($n = 40$) or because they did not answer the questionnaire at all ($n = 4$). Hence, to investigate our three research questions, data from 397 students ($M_{Age} = 13.80$ years, $SD_{Age} = 0.53$; 58.90% female) across 20 eighth-grade mathematics classrooms were used in the present analyses. The 20 teachers ($M_{Age} = 40.24$, $SD_{Age} = 10.91$; 55% female) had an average of 11.26 years of teaching experience ($SD = 10.40$). The teachers and students belonged to 18 high schools in a metropolitan region in southern Germany. Participation was voluntary, and participating teachers, students, and their legal guardians gave their written consent.

Procedure

Data collection for this multi-method study of student questionnaires and video observations took place during the 2013/2014 school year. At the beginning of the school year, prior mathematics grade and mathematical self-concept were assessed through a questionnaire. Three months later, each class was filmed during one mathematics lesson (45 min) according to standardized guidelines (Seidel 2005). All videotaped lessons introduced a new topic related to geometry or algebra to students. On average, 80.7% of the class was devoted to whole-class dialogue. These lessons were representative of students' everyday experiences because both teachers and students reported that the lessons were comparable to their everyday mathematics classes. After the videotaped lesson, students completed questionnaires concerning the cognitive and emotional engagement they had experienced during the filmed lesson. Students' final mathematics grades were collected at the end of the school year.

Measures

Participation In the present study, systematic video observation was used to assess student participation based on the number of hand-raisings. Two independent coders observed the videotaped school lessons, and they were trained until they reached reliable observations (interrater reliability: $\kappa = .73$; ICC = .98; interrater agreement: 77.1%). These coders identified student hand-raising behavior using Interact software (Mangold 2014). They coded events every time a student raised their hand and counted the number of hand-raisings per student. The counts of hand-raising deviated from a normal distribution and followed a Poisson distribution (Coxe et al. 2009).

Cognitive engagement Student cognitive engagement was measured with nine items ($\alpha = .84$), the responses for which took the form of a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The scale included four items regarding deep elaboration, such as "In the preceding lesson, I imagined examples for the content." In addition, it included five items on organizing processes, such as "In the preceding lesson, it was clear to me what was rather important and what rather unimportant regarding the topic." The scale was previously applied in a large German video-based study (Seidel et al. 2003).

Emotional engagement Student emotional engagement was measured with six items ($\alpha = .87$), the responses for which took the form of a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The scale was also applied in a large German video-based study (Seidel et al. 2003). It included three items regarding student enjoyment, such as "In the preceding lesson, I was happy to be there." In addition, it included three items on interest, such as "In the preceding lesson, I would have liked to find out more about the topic."

(Pre-)achievement Students reported their mathematics grade for the previous school year (year seven) as a measure of their pre-achievement and their mathematics grade for the current school year (year eight) as a measure of their achievement. In Germany, grades range from 6 (unsatisfactory) to 1 (very good). These were reversed in the analyses so that higher values represented higher (pre-)achievement.

Academic self-concept Students' self-concept of their mathematical ability was assessed by a five-item self-report questionnaire ($\alpha = .92$). The responses took the form of a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). This scale is well established in the German study context and was developed for the mathematics section of PISA 2012, a large-scale international study (Mang et al. 2018). An example item was "In mathematics, I learn quickly."

Data analyses

Interplay of participation and cognitive and emotional engagement To investigate the first research question and identify student engagement patterns, latent profile analysis (LPA), a person-centered analysis, was conducted with Mplus version 8.4 (Muthén and Muthén 1998-2017). This analysis enables the identification of homogenous subgroups based on a set of indicators. We used the number of hand-raisings and the averages of the cognitive and emotional engagement scales as indicators, and the distribution of these indicators was

considered to estimate the number of subgroups correctly. Hand-raising, as a count variable, and cognitive and emotional engagement, as normally distributed variables, can be considered mixed-mode data with different distributions. Mplus enabled modelling of these data. To identify the appropriate number of latent profiles, models for one to eight profiles were estimated. Each model was estimated with 5000 different starting values and 200 stage optimizations to avoid identification of local maxima (Hagenaars 2006) by a maximum likelihood estimator with robust standard errors (MLR). As implemented in Mplus, missing data for cognitive ($n = 21$; 5%) and emotional ($n = 6$; 1%) engagement were in this step handled with FIML. The number of hand-raisings was available for each participant in the included sample. To identify the number of engagement patterns, various types of information were taken into account (Nylund et al. 2007; Wang and Wang 2012). As information criterion values, the Akaike information criterion (AIC; Akaike 1998), Bayesian information criterion (BIC; Schwarz 1978), and its sample size adjusted version (ABIC) were utilized for which lower values indicated better global model fit. The Lo–Mendell–Rubin adjusted likelihood ratio test (LMRT; Lo 2001) and bootstrap likelihood ratio test (BLRT; McCutcheon 1987) were used to estimate the improvement of a model when one latent profile was added. To evaluate the level of separation between the latent profiles, entropy values were inspected with values closer to 0.80 indicating better separation (Wedel and Kamakura 2000). Moreover, the interpretability of the patterns and the meaningfulness of subgroup sizes were taken into account, as recommended by Marsh et al. (2009).

Linkages of engagement patterns, academic self-concept, and achievement To answer the second and third research question, how academic self-concept predicts student engagement patterns, and how engagement patterns relate to subsequent achievement, a manual BCH three-step approach was conducted (Bakk et al. 2013; Bolck et al. 2004). This is in its current version one currently recommended approach to analyze structural associations between latent profile membership, causal predictors, and distal outcomes. In this analysis, profile membership is considered as a latent variable with an associated measurement error instead of a manifest observed variable (Nylund-Gibson et al. 2019). Therefore, relationships with predictors and outcomes are considered in a structural model with a weighted multiple group analysis in which the weights represent the measurement error of latent profile membership (Asparouhov and Muthén 2020). Practically, we saved BCH-weights when estimating our unconditional model without antecedent and outcome variables to identify the engagement patterns and answer our first research question. These weights were then used to estimate the direct effects of self-concept on engagement patterns while using pre-achievement and gender as covariates and to estimate the direct effect of engagement patterns on achievement in one model. Specifically, the effects of predictor and covariates on latent profile membership were estimated with a logistic regression while varying group means and variances were estimated for the distal outcomes which were then tested for significance with the model constraints. In this step, we followed the current recommendations of Asparouhov and Muthén (2020) to handle missing values for predictors and covariates, in our case self-concept ($n = 35$; 9%), pre-achievement ($n = 31$; 8%), and gender ($n = 3$; 1%), with 100 imputations after the unconditional model has been estimated in order to include BCH-weights in the imputation process. Imputation of missing values on distal outcomes is currently not available in Mplus. Therefore, $n = 2$ (0.05%) of the students with missing grades for the end of the school year were not included in this investigation.

Results

Prior analyses

Descriptive statistics and intercorrelations are presented in Table 2 for all variables. On average, students raised their hands 5.59 times (SD = 5.98), were cognitively engaged at a level that was near the scale mean (M = 2.60; SD = 0.69), and were rather emotionally disengaged (M = 2.16; SD = 0.77).

Engagement patterns

To identify distinct patterns of participation and cognitive and emotional engagement, a five-profile solution was chosen as the final model based on the LPA (see Table 3 for model evaluation criteria) comprising "disengaged," "compliant," "silent," "engaged," and "busy" students (profiles are described in more detail below). As illustrated in Fig. 1, the AIC, BIC, and ABIC level off at the four-profile solution. Similarly, the LMR indicated that the five-profile model did not fit significantly better than the four-profile model. Also, the entropy values did not substantially differ for models with more than four profiles. However, the change in engagement patterns from the four-profile to the five-profile model resulted in two additional meaningful patterns of a substantial number of students. Specifically, in the four-profile model, a subgroup occurred, which showed high participation combined with average cognitive and emotional engagement. When adding one profile to the model, this group was split up into the engaged and compliant profile, which aligned with prior studies and theoretical assumptions. In contrast, the six-profile model did not add any meaningful profile, as the previously smallest profile of busy students was split into two even smaller profiles, one with very high values on all three indicators and one with very high participation and average cognitive and emotional engagement, causing them to lose their relevance. Due to the interpretability and meaningfulness of the identified patterns, we chose the five-profile model, which had an average posterior probability of .82 (see Table 4 for the posterior probabilities of each subgroup).

The labels of the engagement patterns indicate the type of interplay observed between participation and cognitive and emotional engagement (see Table 5 for descriptive results and Fig. 2 for an illustration of z-standardized means).

Disengaged The largest subgroup, containing 37% (n = 146; 60.4% female) of the students, was labeled disengaged. This group, which yielded low profile means below the respective grand means across all three indicators, raised their hands between zero and five times and reported being neither cognitively nor emotionally engaged.

Compliant The second largest subgroup, containing 20% (n = 81; 62.5% female) of the students, was labeled compliant. Students in this group raised their hands between 5 and 18 times, which was above the grand mean, but they reported being cognitively and emotionally engaged at a level slightly below the grand mean.

Silent A subgroup of 20% (n = 78; 56.4% female) of the students was labeled silent. These students raised their hands least often, between zero and four times, but reported being cognitively and emotionally engaged at a level that exceeded the grand mean.

Table 2 Descriptive findings and correlations

	N	Min.	Max.	*M* (SD)	Skew	Kurtosis	α	Correlation				
								1	2	3	4	5
1. Pre-achievement	366	2.00	6.00	3.91 (1.01)	0.15	− 0.51						
2. Self-concept	362	1.00	4.00	2.49 (0.83)	0.14	− 0.94	.92	.63*				
3. Participation	397	0.00	41.00	5.59 (5.98)	1.96	4.92		.16*[a]	.25*[a]			
4. Cognitive engagement	376	1.00	4.00	2.60 (0.69)	− 0.03	− 0.75	.84	.22*	.34*	.21*[a]		
5. Emotional engagement	391	1.00	4.00	2.16 (0.77)	0.29	− 0.68	.87	.16*	.27*	.16*[a]	.52*	
6. Achievement	395	1.00	6.00	3.79 (1.05)	0.14	− 0.35		.71*	.58*	.16*[a]	.21*	.14*

Pre-achievement and achievement were recoded to range from 1 to 6, with higher values representing higher grades

* $p < .05$

[a] Spearman correlation for behavioral engagement as a count variable

Table 3 LPA: model fit

Model	Free parameters	AIC	BIC	ABIC	LMR p value	BLRT p value	Entropy
1-Profile	5	5040.52	5060.44	5044.58			1.00
2-Profiles	9	4079.05	4114.91	4086.35	< .001	< .001	0.86
3-Profiles	13	3921.91	3973.70	3932.45	< .001	< .001	0.80
4-Profiles	17	3866.23	3933.95	3880.01	.011	< .001	0.75
5-Profiles	**21**	**3845.06**	**3928.72**	**3862.09**	**.578**	**< .001**	**0.72**
6-Profiles	25	3822.48	3922.08	3842.75	.101	< .001	0.77
7-Profiles	29	3807.71	3923.25	3831.23	.013	< .001	0.72
8-Profiles	33	3799.05	3930.52	3825.81	.591	.013	0.75

Final model is bold

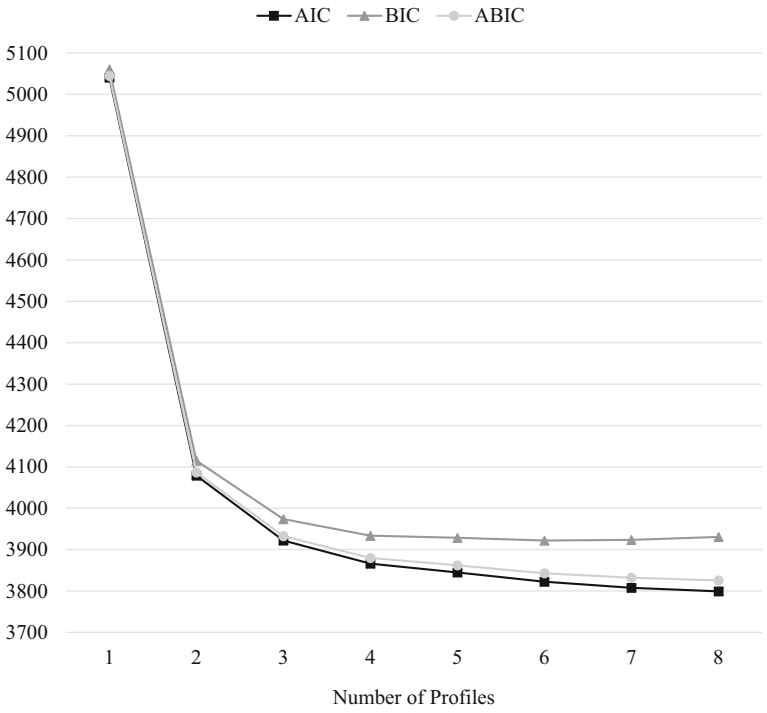

Fig. 1 Elbow plot of information criterion values

Table 4 LPA: average posterior probabilities for the five-profile model

	Label	1	2	3	4	5
Profile 1	Disengaged	**.84**	.06	.09	.01	.00
Profile 2	Compliant	.05	**.82**	.01	.09	.02
Profile 3	Silent	.11	.02	**.79**	.09	.00
Profile 4	Engaged	.01	.11	.11	**.75**	.03
Profile 5	Busy	.00	.04	.00	.03	**.93**

The largest posterior probabilities for each profile are bold

Engaged A subgroup of 16% ($n = 65$; 60.0% female) of the students was labeled engaged. They stood out for their high cognitive and emotional engagement, but they showed comparably lower participation (around the grand mean), raising their hands 4 to 14 times.

Busy The smallest subgroup, containing 7% ($n = 27$, 51.9% female) of the students, featured an extraordinarily high number of hand-raisings (14–41) and high values for cognitive and emotional engagement. Hence, profile means exceeded the grand mean for each indicator. This group was labeled busy.

Table 5 LPA: comparison of engagement, self-concept, and (pre-)achievement

	Disengaged ($n = 146$; 37%) *M* (SD)	Compliant ($n = 81$; 20%) *M* (SD)	Silent ($n = 78$; 20%) *M* (SD)	Engaged ($n = 65$; 16%) *M* (SD)	Busy ($n = 27$; 7%) *M* (SD)
Engagement					
Participation	1.86 (1.46)	9.09 (3.09)	1.81 (1.31)	7.25 (2.70)	22.22 (5.27)
Cognitive	2.06 (0.48)	2.32 (0.44)	3.18 (0.41)	3.28 (0.37)	3.06 (0.58)
Emotional	1.68 (0.57)	1.82 (0.53)	2.57 (0.65)	2.94 (0.48)	2.66 (0.82)
Self-concept	2.19 (0.78)	2.50 (0.79)	2.63 (0.80)	2.76 (0.83)	3.02 (0.79)
Pre-achievement	3.68 (0.95)	3.88 (1.00)	3.97 (0.93)	4.15 (1.07)	4.46 (1.07)
Achievement	3.49 (0.98)	3.93 (0.97)[a]	3.91 (1.10)[a]	4.00 (1.10)[a]	4.22 (1.09)[a]

The subscript letters indicate row-wise non-significance differences of achievement between the latent profiles. Profiles sharing a subscript letter do not significantly differ from one another; for example, compliant and silent students do not differ in their achievement. Latent profiles that do not share a subscript letter differ significantly

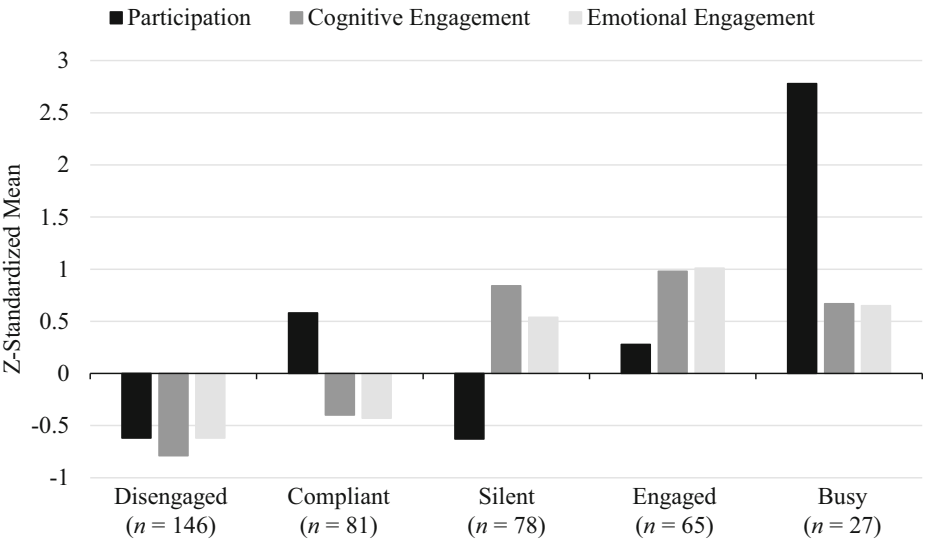

Fig. 2 *Z*-standardized means for engagement pattern indicators across the five latent profiles

Table 6 Regression results regarding the relation of self-concept, pre-achievement, gender, and engagement patterns

	Antecedent	*b* (SE)	*p*	*OR*
Compliant	Self-concept	**0.72 (0.36)**	**.049**	**2.05**
	Pre-achievement	−0.10 (0.27)	.717	0.90
	Female	0.47 (0.43)	.279	1.60
Silent	Self-concept	**1.07 (0.39)**	**.006**	**2.92**
	Pre-achievement	−0.15 (0.28)	.593	0.86
	Female	0.29 (0.47)	.531	1.34
Engaged	Self-concept	**1.12 (0.38)**	**.003**	**3.06**
	Pre-achievement	0.08 (0.29)	.772	1.08
	Female	0.56 (0.46)	.228	1.75
Busy	Self-concept	**1.47 (0.44)**	**.001**	**4.35**
	Pre-achievement	0.20 (0.33)	.548	1.22
	Female	0.33 (0.51)	.514	1.39

b, unstandardized regression coefficient; *SE*, standard error; *OR*, odds ratio. Significant coefficients are bold. Disengaged students served as the reference group

Relations to academic self-concept as antecedent and achievement as outcome

The descriptive results for the second research question show that the busy group had the highest academic self-concept, followed by engaged, silent, compliant, and disengaged students (see Table 5). The results of the logistic regression are presented in Table 6 with the disengaged group as a reference group. Students with higher academic self-concept were significantly more likely to show any other engagement pattern than disengaged. An increase of one unit in academic self-concept made it about twice as likely to show a compliant pattern ($p = .049$), three times more likely to show a silent ($p = .006$) or engaged pattern ($p = .003$), and four times more likely to show a busy pattern ($p = .001$). For all remaining comparisons, when the other engagement patterns were taken as the reference group, differences in self-concept did not significantly influence the likelihood of latent profile membership. Pre-achievement and gender did not significantly predict the likelihood of latent profile membership irrespective of the reference group.

In regard to the third research question, achievement was ordered in the following descending order: busy, engaged, compliant, silent, and disengaged (see Table 5). Students displaying a disengaged pattern received significantly lower end-of-year grades than their peers showing a compliant ($p = .003$), silent ($p = .008$), engaged ($p = .004$), or busy pattern ($p = .001$). However, compliant, silent, engaged, and busy students did not significantly vary in their achievement from another.

Discussion

With the present study, we explored how three aspects of engagement (participation, cognitive, and emotional) are combined within students. Moreover, we investigated antecedents and outcomes of the engagement patterns such as self-concept (antecedent) and achievement (outcome).

Prevalent engagement patterns

The first research question concerned prevalent combinations of overt participation (i.e., number of hand-raisings) with cognitive and emotional engagement. We had expected to find a mixture of consistent patterns in which all dimensions are equally developed and inconsistent patterns in which the dimensions would occur in inconsistent ways with lower/higher values on one dimension than on others. The five identified patterns—disengaged, compliant, silent, engaged, and busy—supported these assumptions. Disengaged students (low participation and cognitive and emotional engagement) showed a consistent pattern, which was repeatedly replicated in previous studies under different labels of reluctantly engaged, minimally engaged, universally low, and disengaged (Conner and Pope 2013; Schmidt et al. 2018; Wang and Peck 2013; Watt et al. 2017). The remaining four engagement patterns, compliant (high participation, low cognitive and emotional), silent (low participation, high cognitive and emotional), engaged (average participation, high cognitive and emotional), and busy (very high participation, high cognitive and emotional) can be considered as inconsistent and resemble also patterns found in prior research with higher behavioral engagement than cognitive and emotional (Bae and DeBusk-Lane 2019; Conner and Pope 2013) or higher cognitive and emotional engagement than behavioral (Bae and DeBusk-Lane 2019). Specifically, our compliant pattern replicates the behaviorally engaged pattern found in one previous study by Bae and DeBusk-Lane (2019). The pattern of our silent students is most similar to the patterns of behaviorally disengaged (low behavioral, moderate cognitive and emotional engagement) and disengaged students (low behavioral, high cognitive, moderate emotional) identified by Bae and DeBusk-Lane (2019). However, the high level of cognitive and emotional engagement within this pattern is unique to our silent students. The pattern of engaged students shows the most similarities with the pattern of pleasurable students (moderate behavioral and cognitive, high emotional) identified in one previous study by Schmidt et al. (2018). However, the high level of cognitive engagement was specific for our engaged students. Finally, the engagement pattern of our busy students replicates a pattern already replicated in several previous studies with high and very high values for all engagement dimensions which was previously labeled as fully engaged, highly engaged, full, and engaged (Conner and Pope 2013; Schmidt et al. 2018; Wang and Peck 2013; Watt et al. 2017).

The identification of these consistent and inconsistent engagement patterns provides ecologically valid insight into the diversity of students' everyday engagement in classroom activities and contributes to a refined understanding of student engagement in whole-class dialogues (Lawson and Lawson 2013). Although students attend the same lesson and are confronted with the same questions by their teachers as their peers, their everyday classroom experiences are substantially different. Students do not only vary in whether they are willing to participate, but they also vary in whether they think deeply about the lesson topic and experience interest and enjoyment. The uncovered predominant patterns of student engagement reflect a more fine-grained differentiation of student engagement beyond the distinction in behavioral, cognitive, and emotional dimensions (Fredricks et al. 2004; Wang et al. 2019). The results show that simple differentiation between engaged and disengaged students cannot fully depict the complexity of student classroom experiences. Instead, further distinctions need to be made, as being engaged can take on many forms ranging from compliant to busy.

As suspected in previous studies (Inagaki et al. 1998; O'Connor et al. 2017; Stahl and Clark 1987), our findings suggest that those students that avoid voluntary participation are divided into subgroups. One-third of them, namely silent students, may listen actively to ongoing

whole-class dialogues and think about the information exchanged between their peers and teachers with fun and interest. Unfavorably it seems that the other two-thirds, disengaged students which make up the most prominent engagement pattern overall, refuse to engage in any way. They do not participate, do not deeply think about the lesson topic, and do not enjoy classroom activities. However, also, those students that participate quite regularly comprise several subgroups. Our results suggest that about one-half of them (compliant students) do not deeply think about the topic of the learning activity and lacks enjoyment and interest. For the other half (engaged and busy), the (very) high number of hand-raisings reflects not only their willingness to share their ideas and answer teacher questions but also their elaboration of the lesson topic, enjoyment, and interest.

The differentiation of participating and non-participating students in different subgroups has a strong practical relevance. Teachers are expected to adapt their teaching practices to individual student needs. To do this, they must first assess student characteristics as knowledge and motivation (Corno 2008). Thereby, teachers rely on the interpretation of observable information cues such as student participation (Loibl et al. 2020; Seidel et al. 2020). Hence, teachers seem to change their teaching practice and experience differences in their relationships with students based on students' behavioral engagement (Hughes et al. 2008; Nurmi 2012). With this regard, our results suggest that student overt participation on its own does not allow conclusive assessment of student cognitive and emotional engagement, motivation, and knowledge. Especially, compliant and silent students for whom the amount of hand-raisings does not align with their cognitive and emotional engagement might suffer from improper instructional adaptations. Silent students, for example, may be confronted with increased teacher control nurturing unfavorable motivational processes and decreased engagement over time due to their low participation (Skinner and Belmont 1993). Thus, future research should investigate whether teachers are aware of subgroups of students with different engagement patterns, whether they are able to assess them accurately, and whether they address them appropriately with their teaching practices.

Self-concept is reflected in engagement patterns

In our second research question, we investigated student academic self-concept, the self-evaluation of their mathematical abilities, as an antecedent of engagement patterns. It was expected that higher self-concept, reflecting the fulfillment of student need to feel competent, would manifest in patterns of higher engagement (Connell and Wellborn 1991). Our longitudinal investigation supports this theoretical assumption and previous person-centered findings (Bae and DeBusk-Lane 2019). The more secure students felt about their mathematical abilities at the beginning of the school year, the more likely it was that they displayed a pattern with (higher) engagement (compliant, silent, engaged, and busy) later on. Hence, self-concept holds potential to explain why students show a pattern of disengagement or engagement but it does not explain which type of engagement (compliant, silent, engaged, or busy) they experience.

Silent students, who avoid participation, do not feel more or less competent in mathematics than their peers, who are actively participating, and the extraordinarily strong participation of busy students is not a reflection of a very secure self-concept. This is somewhat surprising. Because it seems plausible that students who want to contribute verbally (very frequently) have stronger confidence in their competence than their peers who avoid participation because they are willing to take the risk of public evaluation of their knowledge by their teachers when answering teacher questions (Abdullah et al. 2012; Böheim et al. 2020; O'Connor et al. 2017).

Here, peer- and teacher-related factors might come into play. Students who are popular and liked by their peers seem to participate less in classroom activities (Engels et al. 2016). Therefore, silent and engaged students might show comparably lower participation maybe because they care about their peers' impression of them trying to avoid appearing as "over-achievers." Moreover, teachers generally expect their students to answer their questions and pose own ones. Compliant students might participate as a matter of adaptation to satisfy these teacher expectations or because they know it is important to participate in classroom activities for their learning and success, experiencing rather externally controlled forms of motivation (Jang 2008; Ryan and Deci 2000). Busy students, who clearly express their strong willingness to contribute, might do so to impress their teachers (Nurmi and Kiuru 2015), display their high knowledge, or receive confirmation (Sidelinger and Booth-Butterfield 2010). The detailed consideration of engagement in the form of diverse patterns means that more complex motivational and classroom-related causes must be taken into account to explain student engagement. Future research might elaborate on this issue and investigate several potential drivers in combination to explain why students engage in specific ways.

Engagement patterns and their consequences for achievement

To answer our third research question, we investigated the relation between engagement patterns and end-of-year school grades. We had expected that patterns of higher participation and cognitive and emotional engagement would result in higher achievement. Our results support this assumption and show engagement as an important prospective predictor of student achievement in that disengaged students received significantly lower end-of-year grades than their peers displaying any other engagement pattern. This result supports person-centered (Wang and Peck 2013) and variable-centered studies (Chi et al. 2018; Flieller et al. 2016; Jansen et al. 2016) and suggests that several engagement forms are sufficient to use learning opportunities in whole-class dialogues ranging from compliant to busy engagement. Compliant students seem to compensate their low cognitive and emotional engagement by high overt participation and silent students managed to compensate their low overt participation with high cognitive and emotional engagement.

Thereof, disengaged students were identified as students at risk. Their disengagement not only is a result of unnecessarily low self-concept (low pre-achievement was not a significant predictor of this engagement pattern) but also leads to significantly lower performance at the end of the school year. This may result in a downward spiral for this group as low achievement shapes lower subsequent self-concept (Möller et al. 2011) which will provoke even stronger disengagement increasing the risk of school dropout eventually (Archambault et al. 2009). To support these students effectively, teachers could create warm and caring relationships (Wang and Eccles 2013; Wang and Eccles 2012b), as well as provide constructive feedback (O'Mara et al. 2006).

Although compliant students suffer from a lack of cognitive and emotional engagement, they gained similar grades as their peers showing higher cognitive and emotional engagement. This brings up the question of how these students managed to succeed. Typically, teachers pose predominantly closed questions in classroom dialogues, which require students to give short precise answers in the form of keywords or repetition of known information rather than elaborations of their thinking processes (Jurik et al. 2013). Consequently, it might be enough to process this information on a surface level (Dinsmore and Alexander 2012). It is therefore conceivable that participation, especially for compliant students, combines with shallow information processing rather than cognitive elaboration of the lesson topic. Therefore, future studies might explore not only how deep and surface information processing link to an overall global cognitive engagement dimension,

like Wang et al. (2019) did for behavioral engagement, but also how these processing levels are combined within engagement patterns and how they relate to achievement.

Recently the question occurred whether active listening during whole-class dialogues in comparison with verbal engagement would be "enough" for students to learn in everyday classrooms (O'Connor et al. 2017). According to our results, this seems to be the case because silent students were not suffering from their low participation with regard to achievement and even though engaged and busy students were (very) frequently willing to contribute verbally, they did not gain higher achievement than their silent peers indicating that for achievement student cognitive and emotional engagement are more important than student participation. However, different subjects address various skills and provide diverse opportunities for student participation (Grossman and Stodolsky 1995). Thus, it might be that in other subjects not only other engagement patterns are prevalent but also that they relate differently to student achievement. In subjects, which commonly emphasize student elaborate verbal argumentation, like language arts or history, the practice of verbalization of one's ideas might be more important for achievement. Therefore, future studies may focus on subject-specific differences in student engagement patterns and achievement.

Finally, we hoped to capture student participation in a specifically precise way in that we used the number of hand-raisings as measurement of student willingness to contribute verbally assuming that this measure might be less teacher biased than verbal contributions (teachers commonly decide which students are allowed to speak). However, this does not allow conclusions about the quality of students' verbal contributions in case their hand-raising was successful. Some might provide high-quality answers and some might give incorrect answers. Nevertheless, as compliant, engaged, and busy students all received similar high grades, it seems to be unlikely that these three subgroups differ in the quality of their contributions.

Limitations

There are some methodological issues that need to be considered when interpreting the results. First, there was a high level of dropout from the study (104 students) due to the longitudinal design and videotaping. Thus, the final sample was 397 students. Despite this reduction, the sample size is still comparable to the median sample size in other LPAs, which is seen as sufficient (Tein et al. 2013). Moreover, additional analyses revealed that excluded students did not significantly differ from the included students in terms of either academic self-concept or final grades. Students that refused videotaping and were excluded because the number of hand-raisings was not available did not differ from the included students in terms of cognitive engagement but had significantly lower emotional engagement. Due to this exclusion, the emotional engagement might be slightly overestimated in the sample.

Second, hand-raising was used as an indicator of behavioral engagement. Although hand-raising is a practical real-time measure, its usability is probably restricted to the learning activity of whole-class dialogues, which indicates behavioral engagement according to classroom rules. For other learning activities, different behaviors (e.g., persistence or content-related interactions with peers) could better represent behavioral engagement. Future studies may investigate and differentiate the specific indicators of behavioral engagement for diverse classroom activities as well as their relation to cognitive and emotional engagement.

Third, engagement was assessed for only one school lesson and one subject. To date, only students' verbal contributions (Pauli and Lipowsky 2007), general trait interest, and enjoyment have been shown to be moderately stable (Gogol et al. 2016; Pinxten et al. 2014). Additionally,

there is a lack of evidence regarding the stability of emotional and cognitive engagement in learning activities and, not to mention the stability of engagement patterns when engaging repeatedly in the same learning activities. Future research should investigate the longitudinal stability of student engagement patterns and their role in subsequent academic achievement.

Conclusion

The present study investigated combinations of student overt participation and internal cognitive and emotional engagement in relation to academic self-concept (antecedent) and achievement (outcome). With this study, we contribute to the nascent stream of person-centered investigations in the field of student engagement. The person-centered analysis demonstrated the multidimensionality of student behavioral, cognitive, and emotional engagement. The results improve the understanding of variations of student engagement in whole-class dialogues. In this context, hand-raising is a unique and powerful real-time measure to assess student behavioral engagement. For example, students that avoid raising their hands can be differentiated into disengaged and silent students. Furthermore, we can show that being engaged can take various forms ranging from compliant to busy. Our findings emphasize the importance of student academic self-concept for determining engagement patterns and show that patterns of higher engagement lead to higher achievement. Low levels of cognitive and emotional engagement could be compensated by high participation while low participation could also be compensated by high cognitive and emotional engagement. With this study, we have built a bridge between psychologically oriented research regarding individual student differences and teaching research regarding important verbal teacher–student interactions during whole-class dialogues in classrooms. The systematic linking of these two research strands is necessary for further improving the understanding of adaptive teaching in classrooms.

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Current Themes of Research:

Teacher-student interactions in classrooms. Student engagement and motivation. Individual student characteristics. Professional competence of teachers. Teacher Education.

Most Relevant Publications in the field of Psychology of Education:

Böheim, R., Schnitzler, K., Gröschner, A., Weil, M., Knogler, M., Schindler, A.-K., Alles, M., & Seidel, T. (in press). How changes in teachers' dialogic discourse practice relate to changes in students' activation, motivation and cognitive engagement. Learning, Culture, and Social Interaction

Seidel, T., Schnitzler, K., Kosel, C., Stürmer, K., & Holzberger, D. (2020). Student characteristics in the eyes of teachers: differences between novice and expert teachers in judgment accuracy, observed behavioral cues, and gaze. *Educational Psychology Review*. https://doi.org/10.1007/s10648-020-09532-2

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Current Themes of Research:

School conditions and school characteristics. Professional competence of teachers. Instructional quality. Research syntheses and meta-analyses.

Most Relevant Publicationsin the field of Psychology of Education:

Holzberger, D., Reinhold, S., Lüdtke, O., & Seidel, T. (2020). A meta-analysis on the relationship between school characteristics and student outcomes in science and math – evidence from large-scale studies. *Studies in Science Education*, 65(1), 1-34. https://doi.org/10.1080/03057267.2020.1735758

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Current Themes of Research:

Student individual characteristics. Teacher-student interactions in classrooms. Multi-media based tools for teacher education. Research syntheses and meta-analyses.

Most Relevant Publications in the field of Psychology of Education:

Kiemer, K., Gröschner, A., Pehmer, A.-K., & Seidel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learning and Instruction*, 35, 94-103 https://doi.org/10.1016/j.learninstruc.2014.10.003

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